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Types of Generalization in Instruction: Logical and Psychological Problems in the Structuring of School Curricula.

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Preface to the Soviet Edition

Modern automated industry is saturated with technology that embodies recent achievements in science. The creation and use of this technology is making heavy demands on workers' skills. Their occupational training ought to depend on a significant range of systematized scientific knowledge and on an appropriate level of general intellectual development.

The need to meet these industrial needs is leading to a significant increase in the contingents of students in the general-education secondary school.

However, the content and methods of school instruction that developed before the modern revolution in science and technology do not meet the new needs of that revolution. One of the important goals of our socialist society, as is pointed out in the Program for the CPSU [Communist Party of the Soviet Union], is to bring school education into conformity with the scientific and technical achievements of the age.

There are several aspects to solving this problem. Thus, some *sociological and philosophical* questions about the general nature of creating and assimilating human culture on the part of individuals and about the historical modification in the forms of this appropriation are being delineated.

Questions have also arisen about the *logical* structure of modern scientific thought and about the methods of describing and studying it. The third group of questions concerns the *psychological* aspect of the problem. It is primarily a question of the connection between generic forms of thought and the intellectual activity of particular individuals. It is a question of the conditions and principles governing the formation of the mental activity of individuals, which corresponds to potential in contemporary thought. Inseparable from all of this is the pedagogical aspect of the matter, the development of a specific teaching "technology" that implements a certain interpretation of the very nature of the individuals' mastery of culture of society. It is only when these basic aspects are *interrelated* that the problem of bringing the content and methods of education into conformity with modern scientific and technical achievements can be solved deliberately and effectively.

In our research we have tried to pose and develop certain questions connected with *substantiating the design of instructional school subjects in terms of logical psychology.* As is well known, an instructional subject represents a distinctive projection of scientific knowledge onto the plane of mastery. This projection has its own guiding principles, which are determined by the goals of education, by the peculiarities of mastery, by the character and potential of the students' mental activity, and by other factors.

The core of an instructional subject is its curriculum – the systematic and hierarchical description of the knowledge and skills that are subject to mastery. The curriculum, which fixes the *content* of the instructional subject, determines teaching methods, the character of the teaching aids, the periods for instruction, and other features in the educational process. And, what is most essential, by indicating the structure of the knowledge to be mastered and the method of coordinating that knowledge, the curriculum *projects* the type of thought that the students develop during their mastery of the instructional material that is presented. Therefore questions concerning curriculum design, the delineation of the content of an instructional subject (mathematics, physics, biology, history, etc.), are not narrowly methodological questions but *radical and composite* problems in the entire system of educating and developing the rising generations. Designing instructional curricula presupposes not only a reliance on the "positive content" of the respective disciplines but also some clear-cut logical notions about the structure of a discipline as a special form of the reflection of reality, a well-developed understanding of the psychological nature of the connection between the students' mental activity and the content of the knowledge being mastered, and a mastery of the methods of forming that activity. In other words, the design of curricula for instructional subjects entails logical preconditions and closely related psychological preconditions. A critical analysis of these preconditions that underlie the *traditional methods* of designing school curricula, as well as the creation of new logical and psychological principles for designing them, are important conditions for improving modern secondary education.

New methods of designing instructional subjects should project the formation of a higher level in the students' thought than the level toward which the traditional teaching system is oriented. We are advancing a thesis to the effect that it should be the level of *modern theoretical scientific thought*, whose principles are revealed by materialistic dialectics in its capacity as the logic and theory of cognition. On the other hand, the traditional teaching system, although it declares the *principle of the scientific character* of education, *does not possess* (in our view) adequate means of implementing it in a deliberate way. The content and methods of traditional teaching are oriented primarily toward the students' cultivation of the fundamentals and rules of *empirical* thinking – this highly important but at present not very effective form of rational cognition.

The plan of this book is to substantiate the idea that a genuine solution to the problems of modern instructional education from the standpoint of its logical and psychological foundations presupposes a *change in the type of thinking* projected by the content of school subjects and by the methods of teaching them. The latter should be improved within this central perspective – the perspective of the students' development of scientific-theoretical thought.

The need for a close connection between logic and psychology in the study of this problem should be emphasized. Insufficient attention to its logical aspect impedes the psychological study of students' thinking. Analysis of the instruction process shows that, for all its uniqueness, there is in it an appropriate expression of the guiding principle and form of thought as expressed by logic. Comprehensive consideration of the logical, cognition-theory meaning of the fundamental processes and forms of thought (and, above all, of *abstraction*, *generalization*, and the *concept*) is an essential precondition for studying a series of problems in the psychology of teaching – on the study of which, in turn, the design of instructional subjects largely depends.

Although the end purpose of our study is to delineate the psychological features properly speaking in the development of students' thought, analysis of the problems that arise along the way has united the "neighboring spheres" of logic, psychology, and didactics. This is reflected, in particular, in the design of this work and in its chapter titles. In some instances we have stressed, for example, the unity of the psychologico-didactic study of thought, having in mind the following actual circumstance: educational and child psychology is so closely connected with didactics that – as B. G. Anan'ev has rightly noted – a special scientific discipline, "psycho-didactics," has been formed [21, p. 57].

We have chosen *the types of generalization* of instructional material as the special object of our consideration. How is this choice related to the basic purpose of the work? A steady rise in the proportion of *theoretical* knowledge is already actually occurring in modern secondary education. Its mastery, of course, promotes the formation of the students' theoretical scientific thinking. But a proper implementation of this vitally important tendency requires, in particular, special study of a group of problems in logical psychology which concern the nature of empirical and theoretical knowledge, and the correlation of such aspects of man's cognitive activity as the sensory and the rational, the figurative and the theoretical, and the concrete and the abstract. The processes of *mental generalization* and the closely allied processes of forming *concepts* as a basic form of mental activity are the internal base that combines these aspects.

This activity has a number of levels and solves an assortment of problems. We have singled out only one aspect for treatment, but it is one that has an essential significance for disclosing the mechanisms of thought. The peculiarities of the generalization process, in combination with the processes of abstraction and concept formation, characterize the *type* of all of man's mental activity. It is for this reason that we have concentrated our attention on carefully analyzing the peculiarities of different types of generalization and other processes that are directly related to them.[1]

The results of our study can be formulated briefly as follows:

> 1) We have formed a picture of the views of the processes of generalization and concept formation that guide *traditional*[2] educational psychology and didactics in the matter of designing school subjects. Here we detected the one-sidedness of these views, and added the absolutization of the type of generalization that is inherent in the empirical level of thought, as well as the connection between the limitations of that generalization and the typical difficulties encountered by children as they master theoretical instructional material.
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> 2) Surmounting these difficulties presupposes designing instructional subjects on the basis of generalization that is characteristic of *theoretical* thinking.
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> 3) As a result, the possibility of examining ways of using the principles of theoretical generalization for the psychological and didactic substantiation of *new* methods of designing school subjects has opened up.

The book's structure basically reflects the sequence of development of these questions. Here both the results of theoretical research and certain factual data to confirm them (basically using the material of elementary instruction) are presented. The complexity of the problems treated is such that it is necessary, of course, to have many more facts to refine the projected solutions. At the same time, it is these solutions and hypotheses that can serve as a guide for further goal-oriented experimental searches, which are already being done both by our investigative[3] group and by other groups of scholars.

We have given our attention chiefly to analyzing the psychological didactic views on thought that are set forth in scientific transactions, educational texts, and methods manuals. The peculiarities of the teaching practice itself, as guided by these views, are considered to a lesser degree. This is because in psychology there is still a lack of a proper volume of appropriate, especially collected, and systematized facts. Moreover, the task of the first step in our study consisted of a critical analysis of the *theoretical notions* of traditional psychology and didactics about the nature of generalization and of the concept. In the literature there are few works that describe, on the one hand, the internal foundations of these notions and, on the other hand, their possible antitheses. We had to give thorough *documentation* for the purport of the views being criticized, which necessitated extensive references to bibliographic sources. In other words, it was important to provide a survey of these views in their authors' "own language." All of this, it seems to us, sufficiently substantiates the conclusions and hypotheses which we have adduced about both accepted and possible logico-psychological principles in the design of school subjects.

This book was conceived while working with Professor D. B. El'konin, who supported me in the investigation of its central problems – I am profoundly grateful for his scientific supervision and owe him a debt that cannot be repaid.

I have repeatedly discussed the basic ideas in the book with A. S. Arsen'ev, E. V. Il'enkov, and V S. Shvyrev, to whom I am greatly indebted for their friendly attention to this work and for important business advice.

The theoretical theses presented in the book serve as prerequisites for experimental studies being done by a group of associates at the Laboratory for the Psychology of Younger School-Age Children at the Institute for General and Educational Psychology of the USSR Academy of Pedagogical Sciences, as well as by groups of associates of the Tula Pedagogical Institute, the Khar'kov Pedagogical Institute, the Tadzhik State University, with the participation of a large detachment of teachers at School No. 91 in Moscow, School No. 11 in Tula, and School No. 17 in Khar'kov – I am sincerely grateful to all of them for their support in the research and for their readiness and ability to do laborious research on the basis of the experimental instruction.

Professor A. A. Smirnov, the director of the Institute of General and Educational Psychology of the USSR Academy of Pedagogical Sciences, and our colleagues, the psychologists at the Institute, were always of considerable assistance in organizing this research – their attention inspires our group with confidence in the advisability of studying this scientific problem.

1

The Problem of Generalization in Traditional Psychology and Didactics A Description of the Generalization Process and Its Product

Educational psychology and didactics rely, in their approach to the problem of generalization, on what cognitive theory knows about thought and on the actual practice of teaching in the school. In these realms of knowledge a system of conceptions about this highly important aspect of students' mental activity has been established – the system followed by the compilers of textbooks, by the authors of methods manuals, and by teachers. Before treating its theoretical content, it is advisable (in our opinion) to clarify in detail the specific meaning of the concept of *generalization* in psychological didactic literature. Here it is important to delineate the main themes that unite many authors in spite of all of the possible nuances of their particular opinions. There must be a detailed presentation of these central ideas in order to compose a sufficiently integral picture of the views that underlie the design of school disciplines. It is this picture that will serve as material for a subsequent theoretical analysis of the problem.

The term "generalization" is often encountered in the literature on educational psychology and methods. It is used to designate many aspects of schoolchildren's learning process. Two basic groups of phenomena with which the term is usually linked can be delineated. If we mean the *process* of generalization, then the child's transition from a description of the properties of a particular object to finding and singling them out in a whole class of similar objects is usually indicated. Here the child finds and singles out certain stable, recurring properties of these objects. The following statement is typical of works in the psychology of education: "... a generalization is made – that is, similar qualities in all objects of the same type or class are acknowledged to be general" [108, p. 77].

In characterizing the *result* of this process, the child's ability to abstract himself from certain particular and varying attributes of an object is noted. For instance, a student who has actually added 5 sticks and 3 sticks names the sum (8). If he immediately says during a new assignment on adding 5 pencils and 3 pencils: "That will be eight, too" or "It's still eight," then an appropriate generalization is detected in the responses [235, p. 46]. In a history lesson the teacher might ask the children why the caption "Prince Igor' collects the tribute" is not under a picture entitled "The Community." The existence of a generalization, the children's understanding of the typical nature of the fact represented, is expressed in the following response, for example: "Because it is not only Igor' who collected tribute in this way" [91, pp. 38-39].

During generalization what occurs is, on the one hand, a search for a certain *invariant* in an assortment of objects and their properties, and a designation of that invariant by a word, and, on the other hand, the use of the variant that has been singled out to identify objects in a given assortment.[1]

Developing children's *generalizations* and *concepts* is regarded as one of the principal purposes of school instruction.[2] In textbooks on various disciplines the material, as a rule, is arranged so that the students' work with it will lead to the appropriate generalizations. In the methods manuals the teachers are given detailed instructions about how to direct this process, how to verify the level of generalization that the children have reached. We shall treat in more detail the "techniques" of forming generalizations using specific examples.

In the Russian course there is study of the morphological structure of a word – in particular, the children become familiar with the *root* of a word, with *prefixes*, etc. According to the textbook the children do the following work. At first, as they copy certain texts, they single out the words that have a common part in them and underline it (woods, woodland, woodsman**,** woody, etc.). Then they recall the names of similar words that are specially pointed out in the textbook – these words are related in meaning; they have a common part [118a, p. 32]. After this they become familiar with the definition: "The common part of related words is called the root of the words" [118a, p. 33], and they again do a series of exercises on underlining and writing out words with a single root. Here they should be relying on the definition of a root and should be able to single it out in groups of words.

In the lessons the teacher naturally shows the children techniques of comparing comparable words in order to find their "similarities in meaning" and to delineate the common (identical) part. The students' mastery of these techniques is a special instance of the generalization process, the product of which is fixed in the concept of the "root of a word."

Detecting and delineating the stable, repeating element in specific phenomena is also typical of work with historical facts. Thus, the students become familiar with the history of the various nations of the Ancient East, in turn. In comparing their natural conditions, the students find that, for all their differences, Egypt, the countries of Mesopotamia, India, and China were all located in the valleys of major rivers. These similar features permit them to make a generalization – "the first nations in the countries of the Ancient East emerged in the valleys of major rivers" [269, p. 79].

During geometry instruction teachers aspire to provide the students with specific notions about the various angles (for example, they try to demonstrate an angle formed by two legs of the compass, to call attention to the change in the angle between the door and the wall, and so on). It is presumed that here the students' idea of an angle is formed as a generalization of all of the observations within a single concept, whose symbol is two rays emanating from a single point. A large number of facts chosen accordingly is used as a groundwork for creating an abstract idea, to generalize them, about the one quality that unites them [104, p. 27].

Many examples can be cited from different educational disciplines which similarly characterize the generalization process and its product. In "pure" form their features are vividly described in one of the texts on didactics:

> For the independent development of a concept it is necessary, above all, for the students to analyze and compare a rather large number of identical or similar objects that have been especially selected for this purpose and presented by the teacher. Here there is sequential treatment of particular qualifies of different objects, and how these objects differ from one another is determined. There is a selection of the qualities that are common to all of the objects... and these latter ultimately yield a definition of the concept in the form of a list of the common qualities of the objects that are included within the scope of the respective concept [108, pp. 73-74].

Realizing this generalization scheme in the teaching process presupposes a number of special conditions. Above all, a set of particular objects or a collection of concrete impressions is needed.[3] They serve as the raw material for making a *comparison*,[4] by means of which the common, similar, jointly held qualities of the objects are detected.[5] The collections of raw material should be sufficiently diversified and should contain very different variants of the combination of similar qualities with concomitant attributes.

Thus, for the formation of the generalization that underlies the concept of a *prefix*, the sets given for comparison contain words having the some root (with different prefixes) and ones having different roots (with the same prefix), words belonging to different parts of speech, and so on.

The completeness and adequacy of the generalization depend on the breadth of the variations of the attributes that are combined, on the presence in the raw material of highly "unexpected" and "unusual" combinations of the common quality with the concomitant attributes or form of expression. For example, when the students are forming a generalization related to the concept of a *rectangle*, they should see and construct rectangles with highly varied correlations between the sides (in particular, when the length significantly exceeds the width, with the rectangle taking the shape of an extended strip) [235, p. 46].

Generalization is regarded, as a rule, as inseparably linked to the operation of *abstracting.*[6] Delineating a certain quality as a common one includes separating it from other qualities. This allows the child to convert the general quality into an independent and particular object of subsequent actions (the general quality is designated by some *sign* – a word. a graphic diagram, etc.).[7] Knowing what is common, since it is the result of having made a comparison and having recorded the common element in a sign, is always something *abstract,* or *conceivable*.[8]

Thus, when comparing the geographic conditions of various countries in the Ancient East, the student finds that a "location in the valleys of major rivers" is common to them. This feature is separated out from the other natural conditions (climate, for instance), and then figures as one of the factors in the countries' historical development, in the form of an *abstraction* (that is, in the form of the *product* of the corresponding operation) [173].

The special separation, the singling out of what is common and its juxtaposition to the particular – this is the process of abstraction. Thus, when the generalization "the number 3 is 1 more than the number 2" is being formed, there is not only a detection of the similar feature that for *any* objects 3 is 1 more object than 2, but also a separation of this feature from the other object properties (material, size, etc.), as a result of which the given relationship begins to be regarded as a relationship of abstract numbers, as a particular object of the attention, abstracted from concrete objects.

What is the function of the abstract and general in the students' activity? For what purpose do they develop it during instruction? An analysis of the textbooks, methodologies, and methods of students' instructional work discloses the following circumstance: Knowing the general or common quality of a group of objects permits the children to apply appropriate *rules* of operation (for example, orthographic rules are applied on the basis of knowing the common qualities of words or sentences, arithmetic rules – on the basis of knowing the common properties of numbers, and so on). The ability to use a certain rule presupposes a delineation of the quality in an object with which that rule can be correlated. It is connected, in essence, with a whole class of objects or situations (the concept of a "rule" loses meaning when operating with a single object).

Thus, during a dictation (a spelling problem) the child should, in particular, be guided by the following rule: all prefixes are written together with the words, while all prepositions are written separately. But to use it one must know the common attributes of prefixes and prepositions and be able to single them out in any isolated and specific sound combinations in a text dictated by the teacher. Here they at times coincide in the composition of the sounds; it is easy to confuse them and thus to make a mistake. Therefore it is important to distinguish distinctly and to separate from one another prefixes *in general* and prepositions *in general* – independently of their specific phonetic structure.[9]

"Identification" of a given particular, concrete object or phenomenon as belonging to a certain class (on the basis of a certain general property) – that is the real function of the abstract and general.[10] It permits the child to operate with a given object according to a certain rule, although now the action can be "abbreviated." For example, having obtained the assignment: "How many will there be if 3 pencils are added to 5 pencils?" the child who is in possession of generalized knowledge will say at once: "Eight."

Naturally, the precision of the "identification" depends on the completeness of the attributes included in the abstract and general. Moreover, it is often impossible to delineate a group of objects only according to one similar property. This becomes possible when it is generalized according to a number of general qualities. Thus, a rectangle is not only a figure with four sides, but with all right angles, too. For there to be an "identification" of it among the other figures, one must know these two common attributes and, moreover, be able to separate any particular features of the figures from them (position in the plane, correlation of the sides, etc.). A combination of two, three, or more abstract and general attributes which is formed by the significance of a certain word (most often by means of a *definition*) is usually called a *concept.* Generalization and abstraction are indispensable conditions for forming it. The group of generalized attributes of an object is the *content* of the concept.[11]

To be sure, one usually means by a "concept" not just a group of common attributes, but a group of *essential common* attributes. What are the characteristics of the essential? Let us turn to the works on educational psychology and methods.

> ... A necessary condition for correct generalizations is the analysis, through specific examples, of the fact that the attributes that can be widely changed are not essential for a certain concept... . A *necessary condition for the formation of proper generalizations in students is the variation* (change) *in the nonessential attributes of the concepts, properties, and facts when the essential attributes are constan*t [235, pp. 46-47].

“Nonessential” attributes are attributes that change broadly. It is logical to suppose that “essential” ones are *constant*, *stable* attributes that *are retained* in a given group of objects as the nonessential ones change – that is, that they are an invariant and in this sense an “abstract” or quintessence.[12] Such a treatment of the “essential” is contained, for example, in the following descriptions of students’ work in history lessons:

“... Comparing two or more historical phenomena, the students singled out their similar essential attributes, abstracting themselves from the isolated, nonessential ones” [173, p. 78]. And furthermore: “The recurring nature of what is common ... in this series of objects ... becomes more noticeable to the student than the idea that this common element is essential...” [173, p. 80].

The *general* as something recurring or stable is a definite invariant of the diverse properties of objects of a given sort – that is, it is *essential*. In many works the terms “general” and “essential” are used in the same sense:

> To single out essential attributes one must perceive them as attributes common to one series of objects and not proper to another. Abstractable attributes (abstracts) are therefore singled out as *general* attributes and consequently acquire a generalized significance [42, p. 304].

The “essence” of an object is also often interpreted as something “general:” “By revealing the general in objects and phenomena, he [man – V.D.] comes to know what *is essential* for them, their *essence*” [263, p. 243]. “If man ... wants to change reality in compliance with his needs, he must come to know its *essence,* the common attributes of objects and processes, the general rule-conforming relations among phenomena” [108, p. 72].

At the same time, a distinction between the “essential” and the merely “general” is made in a number of instances. Thus, it is pointed out that essential attributes are always general, but nonessential attributes can sometimes turn out to be general, too. “... For instance, the students’ uniform is common or general, but it is a nonessential attribute for describing the students’ progress and behavior” [330, p. 122]. But what then are the grounds for distinguishing between essential and nonessential common attributes?

Unfortunately, in the literature on educational psychology there is no special analysis of this problem. So far as one can judge by the actual division of essential and nonessential attributes in educational material, the former mean such general qualities as are *inherent* (inseparable) in a certain range of objects, *differentiating* it *unambiguously* from any other objects.[13] Thus, in applying the concept of an “exterior angle of a triangle,” the student uses a specified drawing to dismember, on the one hand, the essential attribute that is common to all exterior angles (this attribute is being “adjacent to an interior angle”) and, on the other hand, the nonessential attributes, by which different exterior angles are differentiated (for example, the angle’s size, its arrangement in the drawing, etc.) [144, pp. 24-25]. Here the essential attribute is not merely general but also inseparable from a type of angle such as adjacent angles. On this basis, any adjacent angles are unambiguously differentiated from all nonadjacent ones.

This sort of treatment of the “essential” and the “nonessential” is visible, in particular, in the description of the students’ process of forming geographic concepts of a “lowland” and a “highland,” the geometric concept of a “trapezoid,” and so on [144, pp. 44-45 and 50-51].

The interpretation of the generalization process in the traditional literature on educational psychology as set forth above allows a certain projection of the correlation between *perception, conception,* and *concept.* The raw material for all levels of generalization is isolated, sensorily perceived objects and phenomena in the world around us. In the process of instructing children there is special instruction in how to observe deliberately this sensory-concreted assortment of objects and phenomena, as well as to describe in verbal form the results of one’s observations [31], [104], [298], [330]. The children gradually acquire the ability, on the one hand, to provide a verbal description of objects on the basis of past impressions by relying on visual, auditory, and tactile-motor conceptions, and, on the other hand, to construct appropriate visual conceptions about objects they have not directly encountered, according to the teacher's verbal accounts and instructions.

On the level of conceptions, generalization and abstraction are already taking place, since the child is using words here.[14] Hearing or pronouncing the word "table," he has a visual conception, not of some especially individual table, but of some of the typical, remarkable features of the group of tables which he has perceived and observed previously. This is, as it were, a schematic, visual image of the objects having a single name.[15] In a verbal description of his conceptions, the child naturally indicates precisely these typical feature of the objects, abstracting himself from their many other isolated peculiarities.

> On the one hand, although the sensorially perceived form of an object's conception is still retained in a conception, some secondary attributes have already been discarded and only the most important have been retained in the conception

– this is how the distinctive peculiarities of a conception are described in one of the texts on didactics [108, p. 73].

Thus, a conception as a form of knowing allows one to find similar, coincident, "important" attributes in a group of objects and to separate them from the individual, "secondary" attributes. However, in this form generalization and abstraction are done without sufficient clarity and by no means completely. Here the necessary (essential) attributes can be interwoven with the separable and individual ones – can function in a particular and random form without having the proper coordination and generality. Thus, the visual conception of a *rectangle* can be characterized as follows:

> The visual conception reflects these attributes [of a rectangle – V.D.] graphically: the student mentally "sees" this figure, its equal and parallel sides, and so on.... The conception reflects a given specific rectangle of a certain form, size, and so on. This does not mean that the image reflects only an isolated object. The fact that the essential attributes of a rectangle are expressed graphically in the image attaches a generalized quality to the image. But ... the image itself, as such, does not disclose what attributes of the given rectangle are essential, or common [144, p. 92].

The conceptions formed by students often encompass a certain range of objects and phenomena on the basis of highly general, purely external and diffuse attributes (particularly during the formation of conceptions according to verbal descriptions). In the process of instruction it is necessary to do special and laborious work on specially selected educational material for the students to differentiate accurately in it the fundamental from the secondary, the essential from the external form in which it is manifested, the really general elements from the random and separate ones. Here there is an ordering of the attributes that have been singled out, a designation of them by special terms or by whole verbal formulations, the totality of which determines altogether precisely and *unambig*uously the content of the result of the generalization that has been made – the *concept.*

By virtue of this verbal determination, the generalized attributes become genuinely *abstract* – *abstracted* from any particular forms of their existence. Now they become an *independent* object of further mental activity. In this instance it is "a matter of the complete form of an abstraction, in which the product of the abstraction – the abstract – can be completely divorced from the whole and conceived of separately as something independent, by virtue of its verbal designation" [41, p. 144].

The characteristics of this form of knowledge stand out distinctly in the following description comparing a concept and a visual conception of a rectangle (the basic features of the conception, which we have taken from this description, are indicated above):

> ... The content of the general concept of a rectangle is expressed by a system of judgments about the attributes of this figure. The essential attributes that are common to all rectangles are formulated in the definition of the concept (a parallelogram whose opposite sides are equal and parallel and whose angles are right angles). The visual conception reflects these attributes graphically: the student mentally "sees" this figure, its equal and parallel sides, etc. However, the general

> concept reflects objects and phenomena in a more generalized form: the judgments in which the concept's content is revealed encompass all varieties of rectangles, whereas the conception reflects a given specific rectangle of a definite shape, size, etc. ... In order to attribute these attributes to all rectangles, the student must express these attributes in words as common to all rectangles [144, p. 92].

In the instruction process the "perception—conception—concept" sequence has a *functional* sense – that is, every new concept arises in just this way and within the indicated sequence. This circumstance is expressed clearly in the following statement: "A *concept* is abstracted from the individual features and attributes of particular perceptions and conceptions and is thus the result of a generalization of perceptions and conceptions of a very large number of homogeneous phenomena and objects" [226, p. 8].

The detailed development of educational material in teaching, as a rule, corresponds to this very thesis. The students receive "a large number of homogeneous objects" (or specific descriptions), observe and compare them, forming for themselves a certain conception of the similar, common attributes, and then systematize these attributes and work out verbal definitions – arriving at a genuine abstraction, a concept.[16]

This way of forming concepts is set forth in many works – both domestic and foreign – on educational psychology and didactics (see, for example, the works by D. N. Bogoyavlenskii and N. A. Menchinskaya [41], M. A. Danilov and B. P. Esipov [105], E. N. Kabanova-Meller [144], M. N. Shardakov [330], A. T. Jersild [382], G. Clauss and H. Hiebsch [370], and L. Keleman [384], among others). The results of research on this issue can be expressed briefly as follows:

> In the instruction process the teacher's words organize the students' observations, refining the object of observation, directing the analysis toward the discernment of the essential aspects of phenomena from the nonessential ones; and, finally, the verbal term, because it can be associated with attributes that are singled out and that are common to a whole series of phenomena, becomes their concept generalizer [42, p. 311].

The *guiding principle* of this sequence is stated primarily in the works on didactics (see, for example, [104, pp. 119, 185]), in addition to the fact that in the actual instruction process its particular links, first, are separated in time (first representations, then concepts), and, second, do not follow one another automatically, but require special work by teacher and students in making the transition from the first stage to the second, and from the second to the third. Special difficulties are observed in passing from conceptions to concepts: "The students' formation of correct conceptions representations occurs as a process, whose first stages, despite the teacher's attempts, do not always lead to precise and clearly differentiable conceptions, and the latter are not always easily concentrated in a concept" [104, p. 123].

The movement from perception to concept is a *transition from the concrete or the sensory to the abstract or the conceivable.* What is the function performed by the conceptual generalization that arises in this transition?

Emergence in this realm of generalization permits the students to affect an operation that has considerable significance in all of their school activity – systematization (or *classification*). By means of this operation there is a distribution of objects and phenomena of a certain type "by groups and subgroups in relation to their similarities and differences from one another" [263, p. 249]. The students classify animals and plants (the biology course), parts of a word and a sentence (grammar), plane and three-dimensional figures (geometry), and so forth. The correctness and completeness of this sort of classification depends, naturally, on the precision and completeness with which the concept's essential attributes are singled out and coordinated. One of the basic methods of classification is the establishment of *generic-specific* relationships, the delineation of the genus and the specific differences in concepts. Here there is an opportunity to systematize less general concepts and more general ones.

Thus, in the study of geometry the students establish connections between the concepts of a *triangle* and of *scalene, equilateral,* and *isosceles triangles* (according to the length of the sides), and of *acute, right,* and *obtuse triangles* (according to the size of the angle). Many examples of mastery of a system of concepts in highly different school disciplines can be found. Moreover, one of the central problems of instruction is precisely to give the children a knowledge of *classification schemes* reflecting a correlation among the concepts in a certain area.

Creating such a hierarchy of generalizations is subordinated to the problem of *identifying* individual objects or phenomena as belonging to a certain genus and type, as pertaining to a certain place in the classification according to their properties. In the literature on educational psychology this usually is called of a problem on *applying* concepts.

> Mastering a concept means not only knowing the attributes of the objects and phenomena embraced by the given concept but also *being able to apply the concept in practice*, being able *to operate* with it. And this means that concept mastery includes *not only a path from the bottom up – from separate and particular cases to their generalization, but also the opposite route – from the top down, from the general to the particular and separate*. Knowing the general, one must be able to see it in the particular, concrete case, with which one has to deal at the given moment [263, p. 261].[17]

The students repeatedly have to solve assignments of the following character: find the part of speech to which a given word belongs, the type to which a given arithmetic problem belongs, and so forth. In Russian lessons considerable time is allotted for grammatical analysis, which presents, in pure form, as it were, the application of previously developed classification schemes to the determination of the form of separate words and sentences. This circumstance is clearly realized and implemented by the authors of textbooks and methods manuals. Thus, one of them gives the following description of this type of work: "... In making a grammatical analysis the student analyzes a particular linguistic phenomenon; he *subsumes* particular, concrete instances under general grammatical rules or principles" [149, p. 3011. (Emphasis ours – V.D.) Creating such a classification scheme in the students' heads presupposes a clear-cut division of the identifying attributes of each part of speech. Even the order for enumerating these attributes in a definition should be subordinate to the goals of grammatical analysis: "... Essential attributes must be enumerated in the order in which they are commonly named in grammatical analysis..." [248, p. 30]. "Logical substantiation" of deductions when using a definition actually consists merely in an unambiguous comparison of its attributes with the peculiarities of the word that is being subsumed under the concept.

An important feature of the application of classification schemes is the fact that in assuring adequacy in comparing the "general" with the "individual," the very choice of identifying attributes can change within limits. In other words, everything that assures a *difference* between a given "general" aspect and some other "general" aspect can become "essential" This feature is noted especially in one of the works concerning definitions of mathematical concepts in school: "... One must not think that there is one and only one group of essential attributes to define a concept: the choice of essential attributes for forming a definition from an entire aggregate of attributes is not unambiguous" [226, p. 39].

The following basic function of *conceptual generalization* can be outlined. In the process of learning and practical activity a person uses various *rules* of operation. A condition for the application of a rule in a specific situation or to an individual object is that they first be attributed to a certain *general* class. Therefore one must know how to "see" this general aspect in every specific and individual case. Systems of conceptual generalizations, which provide clear-cut and unambiguous *identifying* attributes for certain general classes of situations or objects serve as the most reliable means of providing this skill.

Concepts should be developed in the students so as to perform this function in a thorough manner. But numerous facts testify that the initial generalizations obtained by the students according to the scheme "from the bottom up" in themselves often do not provide for movement "from the top down," from the general to the particular. If the students have encountered a concrete fact that is new to them, they do not find in it a particular case of a general attribute that is known to them, nor can they dissociate this general attribute (or principle) from the new concrete conditions that "mask" or "obscure" it.[18] *Instruction in the application of concepts or classification schemes to particular objects becomes a particular goal of teaching*.[19] Thus, in the Russian course in the primary grades it turns out not to be easy for the children to apply the general attributes of a *root* which are known to them in order to identify it in groups of appropriate words. In particular, the use of the attribute concerning "semantic proximity of words" comes with difficulty. It is noted in the methods manual that "this difficulty is overcome only by actual work in selecting words having a single root. Gradually the children cultivate an understanding that different words designating objects, attributes, and actions can be related" [149, pp. 471-472].

The transition from the general to the particular and to the concrete functions as an entirely *independent* process.[20] Having mastered it, the students bridge the gap between the concrete and the abstract which exists originally in their consciousness. A basic means of bridging this gap is to enrich the child's *sensory experience.* The more abstract the initial generalization, the more *concretization* its thorough mastery requires. The concretization itself is done during the application of the concept, during the solution of problems on subsuming individual facts under it or during the students' disclosure of general theses through concrete material. Genuine mastery of abstract knowledge occurs in proportion to its enrichment with concrete-sensory content. "The development of the abstract thus depends on the accumulation of conceptions and perceptions" [41, p. 130].

In other words, the formation of a conceptual generalization presupposes not only a transition from the concrete and individual to the abstract and general, but also the reverse transition from the general and the abstract to the individual and the concrete. The latter is movement in thought from the abstract to particular and individual manifestations of the general which are accessible to *sensory* experience. The breadth and diversity of information about the sensory-concrete manifestations of the general serve as an index of the level of mastery of the concept. This idea is distinctly expressed in the following statement in one of the textbooks on psychology:

> It cannot be stated that someone has mastered the concept of an animal if the different types of animals in their variety are unfamiliar to him and if he has no visual images of these animals. *Mastering a concept means mastering the entire aggregate of knowledge about the objects to which the given concept pertains.* The greater our approximation to this, the better our mastery of the concept. This is what is involved in the *development of concepts*, which do not remain unchanged, but which change in their content in proportion as the knowledge expands [263, p. 252].

The Features of Schoolchildren's Concept Formation

As was noted above, the "perception—conception—concept" scheme in psychology and didactics has a functional meaning – that is, it describes the formation of every *new* piece of generalized knowledge. Nonetheless, in child psychology this scheme is also to describe the *age* stages in the formation of the child's ability to generalize. In turn, the determination of the content of instruction (curriculum) in preschool establishments and schools depends on this picture of the development of children's generalization.

It is characteristic of generalization among preschool-age children that it is accomplished on the level of immediate perception, and among older preschool children it is done on the level of conceptions as simple "recollections" of something previously seen. This generalization is by no means complete or precise; in it elements of the essential attributes of objects are mingled with the nonessential ones. Its content is the purely external, striking attributes with an everyday significance, on the basis of which children orient themselves when they perform operations with objects.

At the younger school age (primary grades) generalization is most often carried out on the level of *representations.* Its content becomes qualities of objects which, although external and sensorially given, are still those which provide for sufficient completeness and precision in the use of generalization during the execution of various problems requiring identifying, classifying, and systematizing objects (generalization at the level of "elementary concepts").

At the adolescent and older school ages generalization is produced on the basis of a mental and systemic analysis of the relations and connections among objects. It is also severed from perceptions and conceptions but linked with the delineation and designation of the internal qualities of these objects, an orientation which can occur with a minimal or complete absence of visual components (the level of the concept proper). This sort of generalization possesses the proper completeness and precision. It is used to explain the assorted particular manifestations of the internal qualities and relationships that are reflected in it: this is *theoretical* generalization, which corresponds to the level of scientific thought (it opposes the visual-effective and concrete-pictorial thinking appropriate to earlier ages).

One of the main features of the ontogenetic development of generalization is the transition according to the "perception—conception—concept" scheme. Each of its stages, in principle, corresponds to a certain age and has a quality of its own. At the same time, the generalization that is carried out at every stage has certain similar features. We shall consider them with respect to the younger and older school ages.

Thus, for these ages the scheme also has a *functional significance* – new generalizations are formed on the basis of perceived data or conceptions corresponding to them.[21] Thus, and this is particularly important, the basic *conditions* for the formation of the generalizations underlying the concepts are identical here (they are described in the first section of this chapter).

Actually, a set of specific objects or everyday observations (conceptions), which serves as the raw material for a comparison that reveals something *similar, identical,* or *general* in these objects or observations, is needed. In the primary-grade years, for example, the parts of words that come before the root are compared; the children single out and use the term *prefix* to designate certain general features of these parts, and then rely on them to identify prefixes, to differentiate them from prepositions, and so on. In the more advanced school years, during the study of the physics course, the pupils compare, for instance, situations in which a hammer is struck on an anvil, or a hand on a ball, or a rope with a suspended weight is pulled. In these situations they find and single out something general or similar (the action of forces that are equal but going in opposite directions, etc.). This generalization forms the basis for the concept of Newton's third law, and then is applied for interpreting various instances of the interaction of bodies (for example, for interpreting the conditions for interaction between a cart and the horse that is moving it).

Thus, in the formation of elementary concepts at the primary-grade age and "theoretical" concepts at the older age in school, a central link is the detection and delineation of a certain *invariant,* a stable and repetitive element, that is typical of the collection of objects or of their relations.

Naturally, in both cases the students should have an opportunity to compare, to vary the members of this collection, in order to disclose and to delineate something stable and invariant in them. In this sense the varying of groups of objects for delineating the invariance of an arithmetic sum (5 + 2 = 7 in all object situations) is fundamentally similar to the varying of everyday examples when deducing the law of the mechanical interaction of the two bodies.

In other words, the basic features of the generalization process and of its product, which were described in the first section, are intrinsic to the formation of both elementary and "theoretical" concepts. To be sure, in the "purest" form this description pertains to elementary concepts, for a number of specific features of which special mention should be made are typical of theoretical generalizations.

In works on educational psychology [108], [234], [330] it is usually regarded as a distinctive feature of a theoretical, scientific generalization that it is a generalization of an object's internal qualities – that is, ones that are not perceived directly but that are the product of a deduction, that are obtained by a *mediated* route. Thus, the content of the mechanical interaction described by Newton's third law is determined on the basis of a chain of deductions - it is the *internal* feature of the interaction. The internal structural qualities of chemical compounds or social relationships that are inaccessible to direct observation and that cannot be the object of visual conceptions, for example, are disclosed in an analogous way.[22]

The second distinction is that elementary concepts basically provide for the identification and classification of objects and phenomena, while theoretical ones additionally permit the *explanation* of various manifestations of certain qualities of objects. Therefore the deductive method of reasoning, movement from the general to the particular, from the internal to the external, corresponds to theoretical generalizations. Finally, the third distinction, which can be formulated, as a rule, in an undetailed form and indistinctly, is that a theoretical generalization is constructed not merely by a certain comparison and contrast of objects but by including these operations in a system of investigation, a comprehensive analysis, and so forth.

It must be stated that in teaching all school disciplines, both in the primary and the older grades, there are no clear-cut, rigid criteria for distinguishing between generalizations according to their object content – that is, from the standpoint of the external and the internal, the nonessential and the essential. This circumstance shows up clearly in the comparison of textbooks for a single course written by different authors or at a different time. Prominent authorities often reproach the authors of textbooks because the attributes of the concepts indicated in instruction do not correspond to what is in "science itself."

Traditional pedagogy and psychology adhere to the position that a complete continuity of all types of generalization and the various levels of a concept from the preschool age to the upper grades is needed in instruction. According to this position, at every succeeding stage in instruction, it is necessary to "augment" and reinforce what has been developed and accumulated in the child's previous experience. This attitude runs through works on elementary instruction in educational psychology. They constantly emphasize the need to use the everyday experience, information, and generalizations that children have formed before beginning school. For example, the methodology for teaching arithmetic notes "the possibility of setting up instruction in school as a natural continuation and development of the instruction of preschoolers, of making fuller use of the experience the children have gained even before entering school in operating with groups of objects, their initial knowledge about number and counting, which allows mathematics instruction to go on in close connection with life, from the very start" [209, p. 89].

It is known that the concept of *historical time* has a highly important significance in the teaching of history. In psychology and methodology it is assumed that its preconditions also lie in the child's preschool experience, in the everyday assessments of time intervals that he forms even before his special study of the history course.

> The child's first concepts of everyday time, which arise from his direct sensory experience and which have served for the measurement of a still undifferentiated conception of historical time, are the starting points for subsequent constructions of an entire system of concepts of historical time [269, p. 11].

This attitude does not orient teaching merely and simply toward "continuity," which is necessary and essential in itself; here the continuity is interpreted concretely so that elementary instruction is a *natural continuation* of preschool instruction, actively using and assimilating the children's knowledge that has been gained before school - in particular, their knowledge about number and counting. Moreover, the conception of everyday time is supposed to be a precondition of "the *entire system of concepts*" of historical time – that is, of time in scientifically historical terms. It is natural to suppose that such continuity is inevitably related to the use and cultivation in elementary instruction of the generalization that is typical of preschool students. Of course, it will change in the instruction process itself, but it is what will be the starting point for the school instruction.

So naturally a continuity in the generalization that is typical of the preschool and primary-grade ages is related to the fact that the basic conditions for the formation of this sort of generalization and its substance are *the same*, in principle, in both (the variation of particular features of the objects, the delineation of an identical, inseparable property - an invariant). The didactic manuals and works designed to give them psychological substantiation do not make note of any decisive and radical changes in the *content* of the generalizations that become the object of the students' mastery, in contrast to that of preschool age children.[23]

As for the continuity between the content of the concepts to be mastered in the primary and higher grades, this matter is highly complex and involved. On the one hand, in didactics and psychology there is a thorough awareness of the difference between the level and the potential for generalization among younger and older students. On the other hand, the description and explanation of this difference has suffered from diffuseness and vagueness up to now, particularly when it comes to the connection between the students' mental potential and what is accessible to them in mastering the "fundamentals of the sciences." Thus, one of the methodologies for the teaching of physics discusses the distinctions between what should be provided for students in grades 6 and 7 and what should be given those in grades 8-10. The former should amass a certain fund of factual knowledge, becoming familiar with methods of evaluating phenomena and learning to analyze the qualitative aspect of phenomena. Then, in grades 8- 10, the teachers lead the students "to the analysis of *more complicated* phenomena, to *more profound* theoretical constructs and generalizations..." [128, p. 32] (emphasis ours – V. D.). "More profound constructs and generalizations," of course, can be illustrated by concrete curricular material, but such a purely quantitative description of them on the level of the psychology of methods, in essence, says very little. The main point has not been grasped here - indicate the *qualitative* distinction between the generalizations made by the two groups of students.

The description of the difference in the levels of concepts mastered by children in the primary and higher grades in the Russian course is just as universal and vague in the methods manuals. Thus, the verb is studied propaedeutically in the primary grades, then in a systematic course. What is the difference between the propaedeutic course and the basic course in this topic? “The students have received some information on the verb in the primary grades... This information is insufficient both *in its scope* (for example, the concept of the significance of the present tense) and in its *simplified* formulations ...” [248, p. 146] (emphasis ours – V. D.). This is the sort of work that the sixth-grade teacher should do with students who have received a general concept of a *sentence* in the primary grades: “By questions addressed to the class, the teacher ascertains how well they recall what they have studied, eliminates any gaps that are encountered in the information, and *then expands and enlarges* their knowledge” [248, p. 225] (emphasis ours – V.D.).

Thus, it is a feature of the grammatical concepts to be mastered in the primary grades that they are insufficient in scope and have simplified formulations. Therefore, in the study of the “fundamentals of grammar” as a scientific discipline, the students’ knowledge must be expanded and enlarged, and the gaps eliminated. Here the students in the upper grades do not receive any fundamentally new approach to linguistic phenomena (if they are guided only by the teaching methodologies, of course).

Typically, the manuals on general didactics regard the process of making knowledge more complex chiefly from a purely external, quantitative aspect (the knowledge “is expanded” and “refined”). “In proportion to the advancement in the levels of instruction, the students’ knowledge not only augments in volume, but is constantly becoming more and more precise, increasingly approximating an adequate reflection of reality” [234, p. 108]. In the description of this process there are no indications of the *qualitatively* distinctive forms of a concept in which this increasingly adequate reflection of reality will become possible. In essence, here it is being assumed that the form of a concept that develops as early as primary-grade instruction can function in this role.[24]

As was noted above, generalization for adolescents and older students is actually essentially different than for students in the primary grades and younger students. But, apparently, this qualitative difference shows up very gradually, unnoticeably. Its particular stages are grasped with difficulty by methodologists and psychologists. In the child’s transition from primary to intermediate school, he is not immediately *offered* such special content or such special modes of working with it as would differ substantially from what was previously known and customary or as would clearly indicate a new boundary - a passage to the generalization of the internal qualities and governing relationships of objects, a transition to the realm of scientific concepts properly speaking. The fact of a gradual and relatively drawn-out transition to the mastery of these concepts, the fact of coincidence between this process and the earlier methods of generalization (for the time being), is well known to anyone who carefully observes school lessons. In particular, this fact finds its theoretical expression in the idea of the *continuity* of the students’ concept-formation process that is prevalent in traditional didactics and pedagogy.

In the child’s development in the period of school instruction ... there is no well-substantiated division into steps by which to develop first only specific, individual concepts, and then, starting at a certain age, abstract, general concepts. Concept formation should, rather, be regarded as a continuous process, in which the transitions from concrete concepts to abstract ones go unnoticed ... [108, p. 76].

The Connection of the Theory of Generalization with School Curriculum Design and with the Visual Principle

The ideas of psychologists and educators about the development of generalization in children form an important part of the foundation on which the content and methods of instruction are built. The very method of working out in detail the content of the basic school disciplines (that is, their curricula) has developed historically by considering the stages in the development of generalization that were delineated by traditional psychology and didactics. “The teaching curriculum in the school usually takes account of these principles that govern the development of generalization in students. Students are gradually brought to generalizations through observation and study of what is perceived through the senses – visually given, concrete material" [330, p. 128]. In teaching children, the school must inevitably take into account the degree of development of their thought. Therefore it can be assumed with sufficient confidence that the school curricula to some extent reflect the general course of development of the students' thought" [35, p. 158].

According to these theoretical statements the matter looks like this: There are altogether definite psychological principles governing the general course of development of the students' thought and definite stages in that development. The school curricula that develop in teaching practice take account of these principles in one way or another, reflecting them. Therefore the method of designing them is not arbitrary or "contrived" – these objective psychological principles underlie it. They find their reflection, for instance, in the *concentric* design of the Russian course. In the primary grades the children become familiar, primarily, with the particular external features of linguistic constructions. "The young age of the students in the primary grades makes it impossible for them to understand many of the phenomena and rules of language - thus the need to construct the teaching of Russian concentrically" [248, p. 19]. "The study of grammar in the primary grades has an elementary and practical character" [149, p. 296]. Only in the upper grades do the children move on to a study of real grammar (morphology and syntax).

In mathematics teaching the principles that govern the development of generalization and abstraction find their reflection in the customary order in which arithmetic and algebra are studied. The former is concentrated in the primary grades; the latter is taught only on the foundation of arithmetic and after it.

> In almost all school curricula the study of arithmetic is assigned to children of the primary-grade age, and the study of algebra to those adolescent age. The difference between arithmetic and algebra from a psychological standpoint can be seen in the fact that in arithmetic one operates with numerals to think of particular empirical numbers, while in algebra one operates with letters, which subsume all numbers of a given kind [35, p. 161].

The concentric approach is usually substantiated psychologically in a similar way in the teaching of natural history, history, and other school disciplines. Here, naturally, it is presumed that practical instruction according to such curricula, in turn, forms in groups of students the ordained stages of mental development that have been discerned and described in psychology and reinforced in didactics and in the methodologies.

The guiding principles of mental development are the basis for a number of principles in didactics – in particular, the visual principle. It plays a particularly important role in elementary instruction, for which it is, in essence, one of the building blocks, for the thought of primary-grade students has a concretely pictorial character:

> In teaching younger pupils visuality is the main way of establishing this connection ... [the connection between a new concept and concepts that are already known – V.D.] Visuality makes it easier for the child to understand something new because the child who enters school thinks concretely [266, p. 14].

This principle is also widely used in the upper grades, although, naturally, it changes its external form (for example, observations give way to experimentation).[25]

The principle of visuality is connected by a set of principles with the concept formation scheme that was described in detail above. Perceptions and the conceptions that depend on them are the initial or starting point for a concept (abstraction).

> ... The basis for every abstraction should be a vivid representation of the real things that are to be reasoned about. Therefore every communication of knowledge about real things, in the process of instruction, should begin by creating a *vivid* conception of these things in the students [108, p. 186].

A "vivid representation," a richness in the sensory basis for concepts, presupposes observations of the respective objects or of pictures of them – that is, the visual principle in instruction. Visuality contributes to the formation of clear and precise images of perception and conception, helping the students to move from perceiving concrete objects to abstract concepts of them on the basis of delineating and verbally designating the similar, common features of the objects.

In other words, visuality stands in opposition to verbalism, purely verbal instruction, which is done in the form of abstract reasoning whose point is not clear to the students until a real, object-oriented, sensorially given foundation is placed under it.

The means of visual instruction are usually subdivided into *object* means (real things or their realistic representations), *symbolic* means (graphic, drawing, etc.), and *verbal* means (vivid, detailed descriptions of examples and situations in the textbook and in the teacher's speech). Another subdivision of visuality is also encountered in the literature – "natural" (objects in real nature, assorted things) and "artificial" (any representations of things and their various substitutes, which are applicable only in a classroom setting). In different school disciplines and at different levels of instruction different forms of visuality are applied in highly varied combinations (visuality in arithmetic lessons is different from visuality in geography lessons). However, in every instance there are a number of common features. Thus, the proper use of visuality is related to the teacher's guiding *language*, which directs the children's attention toward isolating the features in the object or group of objects which are to be generalized and abstracted [298]. Furthermore, the transition to the representational, and all the more so to the symbolic forms of visuality should rely – insofar as possible – on object visuality proper, on preliminary observations of real objects and natural phenomena. Thus, in a cognitive respect, "natural" visuality is more significant than artificial visuality, particularly in elementary instruction [31].

Visuality is a special type of cognitive activity with respect to *concrete* objects and phenomena; "it is the practical, *real* analysis and synthesis, which represents the first level of cognitive activity and which in this sense precedes *mental* analysis and synthesis, which is accomplished on a verbal plane" [41, p. 132]. At the same time, according to psychological data, visuality does not isolate perception and conception from integral, analytic-synthetic mental activity. On the contrary: it functions "*as a means that permits the inclusion of these processes in the context of mental activity, thereby stimulating and simplifying it*" [41, p. 133].[26]

In psychology, didactics, and particular methodologies it is constantly noted that visuality alone is not enough for an effective mastery of knowledge. In work with visual aids, visual images emerge in students which, of course, say much but by no means everything about the subject being studied. Here the children are often only spectators for what the teacher is showing. Therefore

> the *active involvement* of the student himself must be added [to visuality]. ... The student's activity reaches its highest limit when he himself is *doing* something, when both his head and his hands are taking part in the work, when there is a comprehensive (not merely visual) perception of the material, when he deals with objects that he can move about at his discretion, combine in different ways, putting them into certain relationships, observing their ... relationships and drawing conclusions from his observations [266, p. 36].

Thus, by working with didactic material with their hands, students create favorable conditions for comprehensive perception of the different qualities of objects, and certain of their combinations allow the children to find certain correlations and to draw the necessary conclusions about them.

The visual principle is a didactically concrete and methodologically specific expression of the notion of the generalization process and its product – the concept – which has been developed by traditional psychology and pedagogy. The methods and techniques of using visuality depend on the stage in the development of generalization at the given school age. The leading role of visuality in teaching, particularly in elementary teaching, indicates that the traditional description of generalization does not just have a theoretical meaning. This description serves as the basis for teaching practice and, in turn, through application of the visual principle, finds its permanent and broad confirmation in it.

2
The Epistemological Essence of the Theory of Generalization and Concept Formation Which is Accepted in Traditional Psychology and Didactics

Traditional Formal Logic on Generalization and on the Concept

We have described in detail the notions of the generalization process and its product which are typical of traditional psychology and didactics. For most psychologists, methodologists, and teachers, these are the basis for the approach to children's mental activity. However, the theoretical literature lacks a critical analysis of the internal meaning of the traditional generalization scheme, although it is the latter that is particularly important for determining the ways of further improving instruction.

The characterizations of abstraction, generalization, and the concept that exist in psychology and didactics coincide, in essence, with their description in *traditional formal logic* (sometimes called "school logic"). These descriptions must be compared, and then the features of the model of thought with which they are correlated must be ascertained.

The modern manuals on formal logic which reflect its classical ideas[1] point out that the *things* surrounding a person have various properties (qualities, actions, states) and occur in various *relationships* (spatial, temporal, causal, etc.) [325, p. 20]. For all of the variety in their specific properties and relationships, things (or objects) can be *like* one another in some way or can differ from one another in some way. When people compare their ideas about this aspect of things, they single out their *attributes.* "Every object has a number of properties in common with other objects, and a number of properties by which it differs from other objects..." [26, p. 31].[2]

The similarity and difference in object – that is, their attributes – are revealed by a logical technique such as *comparison.* The knowing of any object begins when we compare it with other objects, differentiating it from all others, and establishing its similarity with kindred objects [166, p. 129].

Thus, as a result of the comparison of a number of objects, a person establishes their *common* properties or attributes – that is, how they are *similar* to one another, how they are *identical* or *alike.* Through these similar properties a particular object can now be relegated "to some general class with other objects; all objects in general can be attributable to general classes with other objects" [325, p. 19].[3] In other words, certain common (identical) attributes can be used to combine individual objects into a certain aggregate – a *class.*

This "attribution" presupposes a special mental transition from individual, particular objects to their appropriate class on the basis of delineating the properties that belong to each particular object and that are at the same time common to all comparable objects. "This important logical technique, by means of which a mental transition from the individual to the general is accomplished, is called *generalizing* (*generalization*)"[4] [166, p. 150].

The delineation of general properties and the formation of a class of objects are related to the person's mental abstraction from the multitude of other properties of real objects and to the transformation of these general properties (which have now been separated out, or abstracted from the others) into a particular object of thought. This mental delineation of certain properties of objects and segregation from all others is called *abstracting:* its result is called an *abstraction*[5] [166, p. 146].

Every object, even the simplest one, has a multitude of various properties, by which it can be compared with other objects to form certain classes. But the role of these properties in practical life and in the cognition process is far from equivalent. Thus, in an object one can single out attributes that might belong to it in certain conditions and might not belong in other conditions, but still the object does not cease to exist as that object. For example, an automobile stays an automobile regardless of the color of its chassis. But attributes can be singled out in an object which must belong to it under any conditions-without them the object does not exist, and in these attributes it *differs* from all other objects [166, p. 275].

The former attributes are secondary, *nonessential* ones; the latter are basic and *essential*. The delineation of essential attributes and their designation in words leads to a special form of thought – the *concept.*[6] Essential attributes are “attributes without which we cannot think of a certain concept and which set forth the nature of an object” [325, p. 13].

By virtue of the delineation of essential attributes in objects and setting them forth in a concept, the person can precisely *differentiate* some objects from others:

> With the aid of essential attributes the object can easily be differentiated, not only from objects that are patently dissimilar, but also from similar objects that do not precisely coincide with the one that is concerned.... It is for this reason that such attributes are called *essential* – that is, distinguishing in a concept of an object, not that which is accidental for it; not what might be in it but might not be either – rather, what there must be for the concept to correspond to the object [26, pp. 32-33].

In a number of instances the terms “general” and “essential” are used side by side in manuals and textbooks.[7] If the collection of properties allows a certain class of objects to be singled out and differentiated, that collection calls up the content of the respective *concept*.[8]

Thus, we can combine a certain group of plane geometric figures into a class designated “squares” according to a collection of such *common* properties as the following: “having four angles,” “having equal sides,” and “having right angles.” Combining them allows us to differentiate a square precisely from all other figures, even from ones that are quite similar (for example, a rhombus or a rectangle). In other words, these properties are not only common – they also *distinguish* the given class from others; they are intrinsic to it and only to it. Without the combination of these, this class loses its uniqueness and becomes “merged” with other objects. These common and distinguishing properties are the *necessary* properties of the class.

Consequently, *essential attributes* are *common* properties of a group of objects that are *necessary* and sufficient to *distinguish* the group from others.[9] Naturally, establishing essential attributes presupposes singling out the common properties of a group of objects by comparing them and selecting the properties that are sufficient to distinguish the group from all others: “To establish the essential attributes of a concept, one must compare a whole series of objects. This comparison will show what attributes are necessary and sufficient to distinguish the given object from all others ...” [26, p. 35].

Every concept has its *content* and its *scope*. The content of a concept is the collection of essential attributes of a series of homogenous objects represented in the concept [166, p. 282]. Accordingly, the scope of a concept is the collection of objects to which the given concept can be applied [96, p. 19]. Establishing the content of a concept – that is, the precise indication of the essential attributes that are conceivable within it-is a major logical operation, called *defining (definition)* [26, p. 52]. The operation revealing the scope of a concept is called *division;* all of the types whose totality makes up the scope of the concept are indicated here [325, p. 30].

Formal logic points out that the definition of a concept need not be linked with the enumeration of *all* of the essential attributes; this enumeration can be protracted, cumbersome, and difficult to supervise. To bypass this difficulty, appropriate definition techniques must be used. A technique that is particularly prevalent is one in which the content of the concept is revealed by indicating its closest *genus* and the attribute distinguishing the concept as a *type* from other types in that genus [26, p. 57]. Thus, the concept of a “square” is briefly defined as follows: a square is a *rectangle* (genus) *all of whose sides are equal* (attribute of the type or the typical difference).

Of course, this technique is applicable only if it is first established that the concept being defined is a concept of an object belonging to one of the types of a certain genus – that is, it is included in the system of relationships of the type and genus.[10] These highly important relationships have the following meaning. A *genus* is a class of homogeneous objects. A *type* is the objects that enter into the genus and that have distinctive features to distinguish them from other objects of the same genus (typical differences) [325, pp. 13-14].

The logical concept of a “type” is *relative*. The same concept can be regarded both as “type” and “genus.” Thus, in the system of concepts “gas,” “oxygen,” “ozone,” the same concept “oxygen” is a *type* with respect to a gas and a *genus* with respect to ozone [26, p. 43]. Within a system of concepts one can pass from a concept of broader scope to a concept of narrower scope, and vice versa. In the case we have cited, the transition from gas to oxygen and ozone is a diminution in scope, which is called a *delimitation* of the concept. It is accomplished by *adding* certain attributes to the generic concept (therefore, the concept for the type is richer in content than that for the genus). In the reverse process of transition from a smaller scope to a larger one, a certain number of attributes are *taken away* from the type concept, and a generic concept is formed, which thus is poorer in its content than the one for type. This operation of extending the scope and forming more general concepts is called the *generalization* of a concept [324, p. 17].[11] Naturally, a diminution in the content of a concept (its generalizations) is connected with an increase in its scope, and vice versa. Therefore, the formation of concepts that are increasingly broad in scope, the transition to an increasingly "higher" genus is connected with a diminution in the list of attributes which entered into the original concept that was to be generalized. For instance, in generalizing the concept of a "square" one can construct such a system as this: "square-rectangle-parallelogram-quadrangle-plane figure," and so forth. Clearly, every genus is poorer than the type in its content.

The potential for passing from some concepts to others (delimitation and generalization), as well as their division, permits the classification of appropriate objects – that is, their distribution into classes according to the similarity in them. The order for such a distribution has as its goal the subsequent rapid recollection of the names of the objects and definition of their properties [325, p. 117]. In this order every class occupies a stable and precisely fixed place among the other classes [96, p. 38]. Here the division of concepts is best done according to the attributes that are most essential in a practical respect.

In classification, division is done consecutively from top to bottom – from the highest class to the lower ones. Thus, all of the objects encompassed by a broad concept are distributed into classes in succession. These classes in turn are broken down into lower ones, and so on. A structured and detailed system is made in this way, and each of its members receives a stable location here [299, p. 136]. Classification is widely used in the sciences (biology, chemistry, etc.). It helps in developing a rigorous terminology. When there is a definite classification, every object can be precisely relegated to a certain genus and type according to the appropriate attributes, and can be precisely designated with terms; the connection with other similar objects can be revealed.

The first chapters in manuals on formal logic usually begin with a description of the nature of concepts. At the same time there are special sections on the correlation between conceptions and concepts. Their basic content comes down to the following.

Man's initial forms of cognition are sensations and perceptions. Conception is closely related to these – "the image of an object or phenomenon in our consciousness which we are not perceiving at the specific moment" [299, pp. 76-77]. Perception and conception have their visuality in common. But at the same time, a conception can be a visual image, not just of a particular object, but of many similar objects (for example, a conception of a river, or of an airplane). These conceptions are called general [299, p. 78].

Sensation, perception, and conception are the initial level of cognition, on which we reflect sincerely given properties that are capable of being both general and individual, both essential and nonessential, both necessary and circumstantial. Here we cannot yet separate these features. This becomes possible at the next level of cognition – the rational (mental) level, which is characterized by the formation of concepts, judgments, and conclusions. In concepts of objects it is their general and essential features that we reflect [96, pp. 3-4].

We form concepts on the basis of conceptions.[12] "The concept is abstracted from the individual attributes of particular perceptions and conceptions and is the result of the generalization of perceptions and conceptions of an indefinitely large number of homogeneous phenomena and objects" [299, p. 79]. But what is the specific way of "generalizing perceptions and conceptions" that leads to the concept? Let us treat it by considering the following example. We have seen a number of writing desks with very diversified properties – different sorts of wood, different colors, different sizes and shapes. We can abstract ourselves from the individual features of the particular desks and single out only what is essential for any writing desk. Thus the concept of a writing desk in general emerges for us. "In this concept there are no different individual qualities of the particular objects (in this case, writing desks) and only what is common and essential in all objects of this sort is singled out" [299, p. 79].

In some manuals it is noted that a concept representing the essential attributes of an object is devoid of the visuality that a conception has [299, p. 78]. These manuals also claim that a concept has a more abstracted and generalized character, by virtue of which it can represent these properties and relationships among objects which cannot be represented as a visual image (for example, the relationships among the atoms in a molecule) [96, p. 17]. In other manuals the only significant difference in a concept is acknowledged to be that it is an idea about essential attributes and contains them firmly and exactly within itself [26, p. 52]. A conception can also be an idea, but it does not delineate the indispensably essential attributes; it captures what is striking in vividness and unexpectedness.

The comparison or contrast of similar objects or of conceptions of them is a necessary but not a sufficient technique of forming concepts. Another technique is *analysis*, by which the objects and conceptions themselves are articulated into particular distinguishable attributes and elements. On the basis of abstraction certain of these attributes are isolated, as it were, from the rest. The general and essential properties of objects can be considered independently by such a method, by abstracting one from the others. Handling these attributes as some unity (*synthesis*), we extend the resulting complex to all objects of the given genus (*generalization*). These are the basic logical techniques used by a person in a composite way during the formation of a concept [299, pp. 82-83].

In some manuals and textbooks on formal logic it is pointed out that a concept is not only the first and initial form of thought but also its last, highest product, representing the most essential properties of objects. Obtaining this product is a complex process including the formation of judgments, inductive and deductive conclusions, and so on [26, p. 52], [166, p. 282]. A special place in this process goes to inductive conclusions – that is, to conclusions of general theses from individual or particular premises.

In the treatment of different classes of concepts themselves, formal logic singles out, in particular, *concrete* and *abstract* concepts. The former represent actually existing, definite objects (a *house*, a *book*). The latter are a property of objects which is taken in abstraction from them (*courage, intensity, whiteness*). The manuals note that the terms "concrete" and "abstract concepts" are insufficient. The concept of an object or of a property is always *abstract.* Every concept is an abstraction, regardless of what it represents [166, p. 301].

According to the teaching of traditional formal logic, every concept is expressed in a word or group of words, as its carriers (*fire, right triangle*). Words are assigned to certain concepts and simultaneously serve to express them [96, p. 17]. "Language is the *representative* of concepts. We can operate only with the concepts that have received their expression in speech" [325, p. 8].

The Coincidence Between the Psychological and the Formal Logical Treatment of Generalization and of the Concept

We have cited descriptions of generalization and the concept which have been adopted in traditional psychology and formal logic. We shall compare these descriptions in order, first, to delineate their essential features very distinctly and, second, to establish a possible connection and single basis for them.

The essence of either description of *generalization* is that the "general" itself is interpreted as the "identical" or the "similar" in a group of objects. The process of generalization is finding a given "general" element and forming a *class* as its carrier.

Both approaches to the *concept* coincide, even in the details. And, above all, this concerns the interpretation of essential attributes as those that *differentiate* a given group of objects from all others in a certain respect. For the degree of *commonality* of attributes, the *genus-type* relation is regarded as the main kind of relationships of objects and of concepts corresponding to them. Concepts that provide for objects to be differentiated from one another and for their genus and type to be coordinated underlie the construction of classification schemes, whose use permits specific objects to be attributed to definite groups (classes) and designated by some word-term.

A concept-formation scheme such as "perception—conception—concept" is typical of traditional psychology and formal logic. Conceptions, whose comparison is the source of concepts, are themselves visual images of objects that have previously been the object of direct observation. To the extent to which these images can contain the general attributes of objects, the conceptions are close to concepts, and the latter are often difficult to differentiate from the former. In a concept the constituent features are: first, the presence of essential attributes permitting one class of objects to be *distinguished* unambiguously from others; *second*, a verbal expression of the meaning; *third,* this meaning need not be connected with the presence of visual images, but can have an abstract character. The transition from perception through conception to concept is a transition from the sensory, the concrete, and the individual to the mental, the abstract, and the general.

Thus, in all of the basic points the traditional description of generalization and the concept in educational psychology coincides with the formal-logic description so that logic texts can be transferred to works on educational psychology without damaging their meaning, and vice versa. The clarification of this fact has fundamental theoretical significance, in our view. The point is that in traditional educational and child psychology and in didactics, it is accepted to discuss generalization and the concept *as such,* to discuss thought *in general.* The facts show that within the confines of these disciplines, for the present, *only* the formal-logic interpretation of generalization and of the concept can be discussed, as well as only the model of thought that has been created in empirical epistemology (there will be a special discussion of it below). This means, however, that the criticism to which the empirical theory of thought has long been subjected in philosophical literature can and should be extended to interpretation of thought and its processes in educational psychology.

Many characteristic features of curricula and teaching methods are connected in their principles with the approach to generalization and the concept that is inherent in traditional psychology and didactics. The students' mastery of instructional material, as specified by these canons, leads to their formation primarily of the features of thought that correspond to its empirical model and does not reveal or support the features of thought that go beyond its framework. Therefore the criticism of traditional views on generalization and the concept have both an academic and a particularly practical significance. Such criticism permits the revelation of the falsity of making absolute the traditional approach to generalization and the concept, a demonstration of the limits in which this approach is legitimate, and, most important, the outlining of broader prospects for theoretical analysis of the nature and potential of human thought.

The Empirical Theory of Thought as the Epistemological Basis for Traditional Formal Logic and Psychology

Traditional formal logic has an altogether definite notion of the meaning of generalization and the concept in cognitive theory.[13]

According to this notion, individual concrete objects exist apart from man and his thought. It is in all of their concreteness and individuality that they are given over to man's sense organs. Every object exists in time and space, having corporeality, form, and other properties. Every given object, in the infinite multitude of its individual manifestations, can be somehow *similar* to other objects, but this fact adds nothing to its actual existence, nor does it reduce anything from it. To be sure, particular objects can be combined into a class *after comparison* according to this sort of similar property. G. I. Chelpanov expressed this aspect of the matter very well in his day:

> No object is something altogether distinct from all other objects; it is similar to them in some respect; it can always be attributed to some general class involving other objects; all objects in general can be attributed to classes having other objects in common with it [325, p. 19].

A property of a given particular object can be general only insofar as it is attributed to a class. Before this and without this attribution such a property, in itself, cannot be described either as general or as particular. The same property can be either general or particular depending on the other objects with which its carrier object is compared and in what respect it is compared.

Thus, in household use there is such an object as a plate; independently of it and apart from any real connection with it, there is a *wheel on* cars; and in the sky there is such an autonomous entity as the moon. Each one of these exists for its particular purpose, which is independent of the others' purposes, according to particular principles. However, when they are being compared, *from the* aspect *or the standpoint of the person doing the comparing,* a similar, common feature can be found in these different objects – the presence of a *rounded form,* by which they can be attributed to a correspondence class.[14] Of course, this common feature plays an altogether different role in the real existence of one object from the role in another's existence. The presence of *this kind* of commonality has no influence on the real existence of each object included in the group – that is, it is merely their formal commonality. Thus, the group of persons having blond hair can be set aside into a special class, but it is clear that they might be connected with one another in no real way and that this common element does not govern their lives.

We have already mentioned above that such a class can be obtained by comparing objects from one side, as it were, from a point of view that is *external to* them. This is a central feature of the method of finding the formally general, which, incidentally, is directly noted by those who describe this process without prejudice. Thus, the following is stated in a work by Basseng:

> ... After finding that a ball, a bowling ball, and a heavenly body have a certain form as a common attribute, in the future I shall call all bodies having that shape *spheres.* This can also be expressed another way: I '*form the class of spheres*' from all objects having this shape (cited in a book by G. Clauss [160, p. 195]; emphasis ours – V. D.).

Thus, a person "forms" a class when comparing objects that are *really* related in no way and that *really* do not interact with one another. A bowling ball and the planet Mars can be combined in a single class only on the basis of sphericity, which is formally general for them.

This sort of generality arises when an identical property is abstracted and attributed to a class. Only in this act of attribution is a property's commonality detected (as was noted above, a properly belonging to a particular object is, in itself, neither general nor particular).[15] But such an attribution as a feature in the operation of generalization is possible only on a *mental level*. The formally general is present only in a person's thought, in his *concept.*[16] The ball and the heavenly body can be combined *with one another only* on the level of a concept – they have no object connection and exist independently of one another in the real world. These objects are correlated *mentally* with the appropriate class, which is "represented" only in a concept, on the mental level.

A central point in the analysis of the "general" is the question of its reality. It is known that there has long been a struggle between *realists* and *nominalists* on this matter in the history of philosophy. According to the tenets of "extreme realism" (Plato and others), the content of general concepts really exists, independently, *along with* particular sensory things. The proponents of moderate realism (Aristotle and his followers) believe that the content of general concepts exists in reality, but only *through* individual, unitary entities. Extreme nominalists (William of Ockham and others, for instance) deny the existence of the general altogether – it is merely a collective expression or a *name* to designate a quantity of particular objects. Moderate nominalists (Peter Abelard, for example, among others) believe that the general exists, but only in human thought – and this is the condition for its expression in names (this tendency in nominalism has come to be called "conceptualism") [299, pp. 105-107],[160, pp. 194-195], [183, p. 143], [172, p. 410], [97, pp. 210-212].[17]

The conclusions we have drawn about the interpretation of the general in traditional formal logic show that it coincides with the *nominalist* approach to this problem – with conceptualism, to be more precise (the concept is the general representative of particular objects of a certain class in our thinking).

A book by M. S. Strogovich [299] notes that there is a strong materialist strain in the nominalists' teachings, for they acknowledge the real existence of the real world. But, on the whole, their world-view, despite certain grains of truth, should be admitted to be incorrect. "... The nominalists' assertion that particular things, particular objects, really exist is correct..., " Strogovich writes [299, p. 107]. This "grain of truth" which the nominalists hold is also present in traditional formal logic, which also proceeds from the existence of particular, concrete objects. It is seemingly *logical* to adopt the corollaries to this premise which were made by the classical nominalists in their day (and these corollaries, as was shown above, ensue legitimately from the "correct assertion" just cited). Some contemporary formal logicians, on the other hand, do not draw such direct conclusions. Instead of coming to such concrete resolutions, they formulate the following theses, for example:

> "... Their [nominalists' – V. D.] assertion that general concepts are only names and designations to which nothing corresponds in reality is incorrect" [299, p. 107].
>
> "General concepts, if they are true, express real general properties of particular objects that really exist. Particular objects really have something in common, and what they have in common is expressed in general concepts" [299, p. 108].
>
> "*General concepts reflect the real commonality or common nature of existing things or phenomena*" [299, p. 108].

Although concepts reflect the commonality of things, it is the formal commonality. This is the alpha and omega of traditional formal logic. No matter how many times the words "real commonality" are repeated, and regardless of their context, it does not change the essence of the nominalist approach to the problem of correlating the individual and the general, since formal commonality does not express what objects really have in common.

One of the attempts at setting the boundaries of nominalism which occurs, for example, in the work by Strogovic consists in emphasizing the fact that a general, similar property of objects themselves corresponds to the general in a concept. Some other authors also perceive the possibility of overcoming nominalism by way of the acknowledgment of "general attributes of solitary objects which manifest themselves objectively" as the bases for operating with classes (such, in particular, is the position taken by the Polish philosopher A. Shaff., cited in an article by Ch. Novin'skii [228, p. 52]). However, as Novin'skii rightly notes, in our opinion [228], this acknowledgment does not overcome the nominalist position. Nominalists by no means deny that individual objects have similarity or common features (it is only for this reason – according to their point of view – that we can express general conclusions about specific objects).

The principle of approaching generalization only as the delineation of similar properties of objects inevitably leads to a certain variety of nominalism [228, p. 56]. Traditional formal logic has armed itself with this very principle, and therefore within its confines the ancient debate about so-called equivalents of general concepts is solved unconditionally in favor of nominalism.

The delineation of the formally general occurs in the process of comparing individual concrete objects. This sort of comparison can occur both in direct, object-oriented or sensory operations and on the level of images of a conception. People often set up a verbal designation of general conceptions as a "concept" in everyday practice. But logicians and psychologists usually attempt to find the specific quality of the latter. Thus, many of them believe that this specific nature is related to the isolation of essential and nonessential properties, which can still be merged in general conceptions. A concept contains only the essential attributes of object – this is the most prevalent opinion and the concept is to be a means of identifying and unambiguously differentiating objects in the class that corresponds to it. But a person can solve this problem by relying on "nonessential attributes" as well [64, p. 127], [285, p. 147].[18] Moreover – and this is a particularly important feature – in traditional formal logic the essential nature of attributes is *relative.* What is essential in one respect might be secondary or insignificant in another. In principle *every property* can become a basis for generalization and a means of distinguishing appropriate groups of objects – that is, any purely external properties can become the *content* of a concept.

Consequently, the idea of the formally general does not imply an internal, object-oriented criterion for distinguishing between the essential and the nonessential – they are extremely relative and situational.[19] In other words, general properties that have been an object of a conception can become, under certain circumstances – with the same content – the object of a concept.

This is the basis for a fundamental difficulty encountered by traditional formal logic in attempting to overcome the frequently encountered identification between a concept and a conception or any general name.[20] A tendency to differentiate a concept from a conception according to the *form* or *method* of its expression rather than by the character of the content is observed [58], [64]. Thus, in a conception all of the distinguishing attributes of an object are given over to the person visually in a merged, unisolated form. This is sufficient for everyday life, so as not to confuse objects with one another and to "understand" the meaning of words. But if a person is facing the particular problem of enumerating these attributes in verbal form and in a certain sequence, he is obliged to single them out from the blended image, to *dismember* them and indicate them in a quantity and sequence that is sufficient for attributing an object to the appropriate class. From the standpoint of form, a concept functions as knowledge that has been *broken down* into particular attributes, about an object. "To reach a concept, one must break down an image of the object into its constituent attributes and connect them in a certain way.... If we know how to indicate the object's attributes separately, one after another, we possess the concept, but if we are unable to do so, we are at the conception stage" [58, pp. 42-43].

Other features of a concept – its *nonvisuality,* in particular – result from the breaking down of the form. Sensory images cannot reproduce a feature of the breakdown *itself.* But behind the verbal designation of every dissociated attribute there "stands" its conception. For example, when forming a concept of an object designated by word A, we list attributes BCD, to which its general conceptions correspond. They must be broken down again (B is EF, and so forth). The elements of the first definition are now interpreted through simpler elements. If needed, this sort of breakdown can continue to certain simple general conceptions, and then to ones that cannot be decomposed. "No matter what area of knowledge we have taken, we always find these last elements (general conceptions), on which everything hangs and to which ever-later mental formations are reduced" [58, p. 45].

Thus, the general conception of object A contains attributes BCD in the form of a merged sensory image. But the concept of the object A contains these attributes in broken-down and verbally expressed form. In this sense it is not a general conception, although *ultimately,* in logical analysis, it, too, will be reduced to general sensory conceptions as the last elements.

In this approach to the concept it is emphasized that, in contrast to unstable conceptions that are not always distinct and individual, the content of knowledge is best reproduced in a detailed verbal form that has much less ambiguity and is a means of intercourse. It is by words that attributes are broken down, abstracted from others, and receive their distinctive temporal and spatial "development." Thus, "these attributes are distinctive logical coordinates that permit objects to be fixed and retained in the consciousness in the reasoning process" [64, p. 121]. A person who hears or reads a detailed verbal formulation (the definition of a concept) can actually fail to have a definite visual image corresponding to the integral meaning of this formulation during this period, and yet "understand" it, know how to "explain" it. This reveals a characteristic feature of the concept as a particular form of reflection – the *nonvisuality* of its content [64, p. 111]. However, visual conceptions have to lie beyond the particular attributes themselves, which are expressed in words [58, pp. 44-45].

At first the connecting link between word and object was a general conception – the merged sensory image of a number of attributes of the object. Then the concept as a "collection of dissociated attributes" becomes such a link. In both instances these are the *same* attributes, which can be ascribed to the *same* particular objects that are to be generalized. "... Although a class of objects is singled out in a concept, the object of thought is not this class itself; the objects of thought in a concept are the objects in a class, which are conceivable in generalized form" [64, p. 120].

Thus, both in the transition from a perception to a conception and in the transition from a conception to a concept, the formally general attributes of individual objects remain the object of knowledge. In both transitions only the subjective form of "retention" of these attributes changes – not their object content. In the transition to a concept a new feature appears, which is inexpressible in sensory form – the *breakdown* of attributes. In the object itself the attributes exist together. And if a breakdown appears in the concept of an object, it is a certain index of the "purity" of the abstraction of the formally general, of its conversion into an "abstract" as such, which functions as the content of thought, in contrast to conceptions, where the abstraction is still "incomplete."

In works on formal logic it is emphasized from time to time that mental content is *nonvisual.* But, in the first place, as an analysis of the formal-logic scheme for dissociation shows (see the scheme cited by A. A. Vetrov), every verbally dissociated attribute conceals its *general conception,* which can be broken down again when necessary with the aid of speech and of *simpler conceptions,* and so on. In the second place, the problem of “visuality-nonvisuality” is wholly transferred to the psychological level, properly speaking, of the connection between “word” and “image,” the psychological mechanisms of retaining sensory experience in words, of implementing this experience, and so on (for this there exists an extensive literature and a history of the question – see, for example, [328], [335], [343], etc.). One bypasses the logical problem proper, concerning the uniqueness of the objective structure of knowledge, given over at the sensory and the rational levels of reflection. In studies of formal logic one encounters assertions to the effect that the method described in them for forming concepts permits the individual to go beyond the limits of restricted sensory experience and to come to know the connections and relationships that cannot be reflected in general by the sense organs [58, pp. 43-44]. Here two aspects of the question are important. Above all, the objective existence of the connections and relationships that are inaccessible to the sense organs is acknowledged. At the same time, it is pointed out that they can be grasped during the abstracting of formally general properties. But the essence of the traditional formal-logic scheme for concept formation consists in that the attributes of individual and sensory-concrete given objects always figure in this process, and the resulting abstraction is again attributed to these individual objects, which are independent of one another (this follows from the nominalist attitudes of traditional formal logic). “Nonvisuality” is merely the subjective-individual manifestation of a method of using dissociated verbal expressions, in which attributes are designated that are accessible *in principle* to conception and perception (it is *these* conceptions, in which the attributes are merely merged and given in an integral image, that are dismembered).

Sometimes, when questions concerning concept formation are being presented, it is mentioned that the essential attributes of objects which are to be reflected in concepts are not given over directly to the sense organs (see, for example, [30, pp. 94-95]). This might be so if one goes *beyond the limits* of the traditional, formal-logic interpretation of the nature of a concept. But within the limits of this interpretation, there is no point in operating with “essential attributes,” as if they require a particular form of reflection. Here it is not out of place to cite some appropriate statements by authorities. Thus, B. M. Kedrov writes:

> Unconcerned with elucidating what the essential attributes of a concept that is being defined are, or where and how to search for them, formal logic concentrates its attention on the formal aspect of the matter, which also corresponds to its character [57, p. 44].

In analyzing this question, D. P. Gorskii notes:

> For formal logic, discriminating between essential and nonessential properties has no significance. Very different properties that define the same scope [of a concept – V. D.] are regarded as equivalent (identically essential) [99, p. 29].

In the academic edition of a collective book on logic, in a chapter devoted to the concept (V F. Asmus, author), the editors, D. P. Gorskii and P. V. Tavanets, have made a typical comment:

> Formal logic treats the attributes of a concept only from the standpoint of the function of distinguishing between one class of objects that is reflected in a certain concept, and another class. The problem of essence, of the essential in objects is a problem in dialectic logic [199, p. 33].

Our analysis allows us to draw a conclusion to the effect that the traditional, formal-logic scheme for concept formation concerns the generalization and abstraction of merely *sensorially given,* observable, *external properties of individual objects*.[21] These properties are the only content of a concept that can be defined within the limits of traditional formal logic and the educational psychology and didactics that have identified themselves with it. In the description of this form of thought there is no restriction on the grounds that it is merely a *particular* type of concept. The following can legitimately be concluded: the traditional approach to a concept expresses a *narrowly sensationalist position.*

In the traditional formal-logic description of the processes of forming conceptions and concepts, there is a psychological aspect proper. Thus, it is assumed that something *similar* and something *different* in objects is disclosed either by observation or by a visual-operative comparison. Establishing these attributes functions as an *elementary* act, and the attributes themselves – as simple "blocks," from groups of which collections of attributes of varying complexity, which are the substance of conceptions and concepts, are then formed. It is a characteristic of the "mechanism" of concept formation that the person first establishes the features of similarity and difference in the objects, then forms images and conceptions from groups of them, and, finally, breaks down the image into particular attributes by verbal means. Here every attribute is connected both with a certain word (or words) and with some general conception (complex or simple). The entire concept is connected with a certain phrase as its "carrier." Understanding a phrase (or a single word replacing it) means developing a system of visual images (representations) corresponding to these attributes in one's consciousness.[22]

This kind of picture and the principles for substantiating it are quite close to those that were developed by the representatives of empirical associationist psychology in their day. Let us list its basic theses, as they are represented in a contemporary historical survey [233a].

"Sensations" and their copies in the memory – simple conceptions (ideas) – were regarded as the elementary elements in consciousness.

> The work of the mind consists in establishing the differences and similarities in the phenomena of consciousness, in their arrangement and classification. Therefore the following have been acknowledged to be the primary attributes of thought: the consciousness of difference, the consciousness of similarity, and retention, or remembering. The mind produces various kinds of combinations of simple elements of consciousness, grouping them into complex states by association... The content of thought has been reduced to the characteristics of elementary phenomena – simple ideas and their various relationships... It was presumed that complex ideas, although they arise by abstraction and generalization, remain the sum of simple ideas for the consciousness; only their grouping is changed, and no enrichment or deepening of cognition occurs.... General ideas were treated in the spirit of Lockean theory as an abstraction and combination of any properties that are common to a number of complex groups [233a, pp. 4041].[23]

Let us note some more of the typical features of classical associationism's approach to thought: "An abstract idea represents that which expresses what is common in a group of impressions" [233a, p. 43]. "By a lengthy series of different constructions, thought can be broken down into the groups of sensations which comprise it. And ultimately every thought, from the most abstract and complex deductions to elementary intuition, consists in establishing similarity and dissimilarity between two sensations" [233a, p. 46].

If we abstract ourselves from certain of the distinctive terms intrinsic to the psychology of the 19th century (such as "state of consciousness"), *this fundamental scheme* for concept formation (the formation of a "complex idea") fully *coincides* with the one found in many *modern* works on formal logic, educational psychology, and didactics. Of course, the authors of these works might not hold the view that "associations" are the mechanism for forming all "complex groups of attributes" – this is a specifically psychological question. But associationist psychology has developed a number of *general principles* for analyzing mental activity – sequential and one-sided *sensationalism* (the concept of "associationist sensationalism" is included in the history of psychology [378]),[24] a distinctive atomism in the dissociation of mental processes and their products,[25] a consequence of nominalist epistemology. These principles are reproduced explicitly or inexplicitly in works describing the formation of concepts according to the formal-logic scheme. The basic coincidences concern the following points: 1) the establishment of similarity and difference between objects underlies a concept, 2) at the same time, there is an abstraction and generalization of any properties that are common to a number of objects; 3) the transition to a conception and to a concept is a change in the form of knowing without enriching it or making it more profound in essence.

The term "association" itself, which does not ordinarily figure in works on logic, is used in one way or another in psychological studies concerning the relationships between "abstracts" and words (in works on logic there is usually mention merely of the "connection" between the word and the conception, or the word and the concept [64, pp. [121]).[26] Thus, we find the following in the work of D. N. Bogoyavlenskii and N. A. Menchinskaya: "... A word-term, because it can be associated with attributes that are delineated and common to a whole series of phenomena, becomes their concept generalizer" [42, p. 311] (emphasis ours – V. D.).[27]

Yu. A. Samarin [283], [284], P. A. Shevarev [333], [334], and a number of other psychologists, in particular, carry on analysis of school children's mental activity on the basis of the concept of association. The interpretation of the mechanisms for forming an association itself here depends on the reflex theory of I. M. Sechenov and I. P. Pavlov, on the doctrine of higher nervous activity. For example, Samarin notes that associations in contiguity, similarity, and contrast and their dissociations "are the psychological mechanism of the brain's analytic-synthetic activity" [284, p. 408]. Thought is discussed directly as follows: "... The mechanism of associations by similarity (and contrast) ... is the mechanism of imagination and thought" [284, p. 386]. Here Samarin stresses that logical thought is a qualitatively unique process, depending on intra-system and inter-system associations. However, in our view, the very concrete investigative material that is present in Samarin's work essentially retains and confirms the traditional formal-logic scheme for concept formation, which, for all of the good intentions, does not permit an explanation of the real, qualitative, specific nature of thought in concepts.

The nominalism, narrow sensationalism, and associationism that are typical of the traditional formal-logic approach to generalization, abstraction, and the concept have a single source – the interpretation of the general merely as the formally *general* and the reduction of the function of the concept to the delineation of that sort of generality in objects for the purpose of classifying them.

To single out classes of objects according to similar features, to draw up a corresponding classification, and to use the latter for *identifying* specific objects – for all of this formal generalization and formal abstraction are sufficient. This function of a concept can be affected when the person is oriented toward the *external, identifying attributes* of objects. It is this circumstance that is noted by E. K. Voishvillo, having in mind one of the goals of singling out objects – to distinguish them from others: "For this purpose external, sensorily perceived, easily revealed and distinguishable attributes are more suitable as attributes according to which objects in a concept are singled out" [64, p. 127]. The similarity (the general element) that is singled out in a concept here performs the function of a *commutator*,[28] an intermediate link between objects that are already known and classified and those that are still unidentified and unclassified. The latter are to be identified and attributed either to a familiar class ("This thing is a table") or to the realm of the unfamiliar, which is not yet grouped and is merely "awaiting" similar conversion into a class. Naturally, the "known" should have an altogether definite description of the group of attributes and a "rule" for attributing them to objects for the purpose of identifying whether or not they belong to the class (set).

It is this sort of "commutator" function of a concept with content of the formally general that is adequate to that concept that certain authorities on "computer thinking" single out especially. Thus, E. Hunt and C. Hovland write:

> What is a concept? The ordinary usage of the word is not always clear.... Church has proposed a definition that has actually been adopted by psychologists working in experiments in the "teaching of concepts." Church's idea is that any symbol (or *name*) can be assigned to the elements in a set of objects. For any arbitrary object there exists a rule concerning the description of this object, with the aid of which it is possible to decide whether the object belongs to the set of objects for which the given name is being used. The rule for the decision in this instance is the "concept" of the name, and the set of objects forms the content of that name [322, p. 317].

The essence of the formal-logic approach to a concept is grasped in this "idea." To be sure, it must be observed that A. Church [326] did not create but merely gave theoretical expression and refinement to the "concept of a concept," which had actually long existed in traditional formal logic and associationist psychology.

Words (names), in this function of a concept, are needed to "mark" classes and to distinguish between them. The concept functions as an intermediate link in the connection between these words and any objects that can be introduced into the respective class according to the "description." "A concept," E. K. Voishvillo writes, "is ... the mediating link between word and object" [64, p. 122].

The features of this function of the general have been described well by Ch. Novin'skii:

> Comparing a given object with other objects will lead to the recognition of objects that are similar in certain respects, as ones belonging to the same class.... With our senses we single out the concrete and we ultimately also recognize it with our senses. Between the sensory delineation of the concrete and the sensory recognition of the concrete there lies a whole process of operation with the general, with correlations of classes, and so on [228, p. 81].

On this level the formal-logic interpretation of the correlation between the "concrete" and the "abstract" in cognition becomes distinct. Here the *concrete* means an individual, sensorially given, directly observable object itself. The *abstract* is the formally general, which has been singled out and separated from the other properties of the object and which is designated by a word and is the *mental* content of the concept (this follows from the conceptualism of traditional formal logic). Naturally, in factual reality there is no such content: a "class" is a mental formation, an "abstract" it is the repeating property of many objects, which has become a particular and *independent* object of thought. Dissociated and *verbally* established, the abstract content is freed of its visuality, which is reduced to a minimum or disappears altogether. "Nonvisuality" and a purely *verbal* form of expression are characteristic features of *abstract* knowledge proper – that is, of the concept.

Thought on the basis of such concepts consists, on the one hand, in a transition from the sensorially-concrete and individual to the abstract-mental and the formally general, and, on the other hand, in a reverse transition from the abstract to the sensory-concrete during the delineation and identification of certain individual objects as belonging to a given class (the general). Both the *beginning* and the *end* of this process are *sensory-concrete* (its classification and systematization, and its identification and differentiation).

The thought that accomplishes these transitions through formal generalizations and abstractions forms *empirical* concepts. It is this circumstance that is singled out by B. M. Kedrov in analyzing the essence of formal generalization as a method of forming concepts (in his terminology, "formally inductive generalization"). A treatment of each object from the standpoint of the totality of constant attributes that are independent of one another is typical of this method. In the comparison of attributes there have been established the one or ones that are encountered in all given objects – the general attributes. This sort of formal generalization is based on the simple opposition of the general to the particular. This method of forming concepts, Kedrov writes:

> presupposes the possibility of operating with directly perceptible attributes of the objects to be studied. It is particularly empirical. On this logical basis are constructed, as a rule, numerous determinants in the various natural sciences, such as determinants of the higher plants, waterplants, insects, fishes, birds, minerals, rocks, and so on and so forth. Such determinants play an important role in the natural sciences. Their *composition* presupposes the possibility of passing from the most particular, specialized attributes ... to the most general attributes (within the confines of the given classification area) by sequential, formally inductive generalization [159, p. 49].[29]

The composition of empirical determinants on the basis of external, directly perceptible attributes is the real function of formal generalization. Such determinants are very important, of course, in the sciences for surveys of material and for classifying it. People constantly need something like these determinants in daily life, to designate certain objects and phenomena in words, in the description of events, and so on.

The formal-logic scheme for concept formation (let us add, for "empirical concepts") includes both the formation of "everyday" concepts (better: the *significances* or *meanings* of words) and scientific concepts (more correctly: "*empirical* concepts in science").[30] The specific features of concepts in the *theory of science*, properly speaking, are not expressed by formal generalization, since formal generalization is limited to the range of directly observable phenomena.[31]

It is known that one of the leading problems in the theory of cognition has always been to determine *precisely the uniqueness and qualitative features of the form of scientific concepts* in contrast to everyday ones. If formal-logic analysis does not capture this uniqueness, it means the following: Traditional formal logic, by its own scheme for generalizing and forming concepts, reveals only what is *identical* for everyday and scientific observations, which does not express the specific nature of the latter as *scientific* generalizations in contrast to everyday ones.

Thus, traditional formal logic, educational psychology, and didactics describe only *empirical* thinking, which solves the problems of classifying objects by their external attributes and the problems of identifying them. The realm of thought processes is here limited to: 1) a comparison of the concrete-sensory data for the purpose of delineating the formally general attributes and drawing up a classification, and 2) the identification of concrete-sensory entities for the purpose of including them in a certain class.

John Locke, the English materialist philosopher of the 17th century, has given the most distinct formulation of the theory of these thought processes and its epistemological attitudes (narrow sensationalism and conceptualism). This theory is usually called the *empirical theory* of thinking (abstraction, generalization, and concept formation). It had its roots in ancient Greek philosophy and in the philosophy of the Middle Ages. It underwent considerable alteration and refinement in modern times (the French materialists, Immanuel Kant, and others). It was Locke, however, who expressed most precisely a number of features related to the nature of "general ideas" and their sources, which then served as a theoretical support for empiricism in the natural sciences, including psychology, as well as didactics and all of the special methodologies [360].

In the 18th and 19th centuries this theory became the substance of school texts on formal logic and had a substantial influence on psychology and didactics.[32] This is how A. N. Leont'ev characterizes the situation:

> During almost all of the 19th century the scientific psychological notions about thought developed under the influence of formal logic and on the basis of subjective-empirical associationist psychology. The psychological analysis of thought was reduced chiefly to singling out particular mental processes: Abstraction and generalization, comparison and classification. Different types of judgments and deductions were also described, with these descriptions borrowed directly from formal logic. The question of the nature of concepts was also illuminated in the spirit of formal logic. Concepts were represented as the product of a distinctive "stratification" of sensory images upon one another, in the course of which the non-coincident attributes of the perceived objects are obliterated, but their general attributes are reciprocally strengthened, forming the substance of the general notions and concepts that the person associates with the appropriate words [191, p. 86].

The influence of the empirical theory of thought on formal school logic, on traditional psychology, and on didactics has been retained until now, as we have seen. There were objective reasons for this to have happened. Until very recently, the basic concerns of educators and psychologists in most of the economically developed countries have been connected with elementary education. It provided children with elementary skills in reading, writing, and counting and expanded their conceptions of their surroundings. The aims of this education are particularly empirical and utilitarian.

Developing children's empirical concepts has been a basic concern of didactics and of the psychology that accompanies it. In the actual education process, particularly beyond the primary grades, of course, complicated questions in the cultivation of scientific-theoretical thinking in students have arisen. But they have often been solved spontaneously, without any adjusted conception of its laws and the methods of pedagogical "utilization" for them. Therefore the empirical theory, with all of its preconditions and corollaries, has remained the dominant theory of thought processes.

On the Relationship Between Traditional and Modern Formal Logic

We have repeatedly emphasized above that we are considering the doctrine of generalization and the concept which is intrinsic to *traditional* formal logic. But what is its relationship to modern logic? In our philosophical literature it is currently an accepted practice to distinguish between formal *logic* and *dialectical logic* (the question of their correlation is a subject for discussion). Many experts believe that *modern formal logic* is *mathematical logic* (it is understood to be a modern phase in the development of formal logic). However, there is also the view that formal logic is an *independent* discipline, along side mathematical logic, although the latter is genetically connected with the former. In our opinion, the former view is the more justified, and we shall be presenting its substance briefly here according to the work by P. V. Kopnin and P. V. Tavanets [171].[33]

The *theory of deduction*, of *inferential knowledge*, is the central problem in formal logic. Its object is to ascertain the rules and forms for one judgment's following from others that have been previously established on the basis of the laws of identity, contradiction, the excluded middle, and sufficient basis. Concepts and judgments are here regarded only to the extent and from the standpoint necessary for explicating the conditions under which judgments follow (it is this "process of sequence" that is studied by formal logic in all of its completeness and depth). A major step in the development of formal logic was the application of new methods of investigation and the extension of the forms for the proofs that were being studied – that is, the emergence of mathematical logic as *logic* in subject and *mathematics* in method. Its most essential difference from nonmathematical logic involves the *universal* application of the method of formalization (calculation). One of the major problems in mathematical logic as modern formal logic, as the theory of formal deduction, is the establishment of the compatibility and completeness of axiomatically constructed calculations.

The object of logic, which originated in antiquity, has *changed* in the course of history, and only with time has this general discipline concerning the laws of knowing been subdivided into two disciplines. It has been divided into *dialectical* logic, which studies the forms of thought in their evolution and interrelationship, and into formal logic, whose object has been most clearly delineated only in the 20th century (this is the theory of formal deduction). Therefore there must be a rigorous *distinction* between modern formal logic (that is, mathematical logic and its preconditions in history) and *traditional* or classical logic. Traditional logic formed part of philosophy and was a distinctive theory and method of cognition. It was not purely formal, either, since it regarded the laws and forms of thinking as principles of being at the same time (materialists and idealists have treated being itself in different ways). Its laws of thought have served as the basis for the *metaphysical method*.

The classical authorities of Marxism-Leninism have criticized this traditional formal logic. "Dialectical logic is the negation of the formal logic that precedes it, as a method and theory of knowing" [171, p. 50]. This is another level in the development of the philosophical doctrine of thought, which absorbed everything that was relatively true in traditional logic, which had now detached itself from philosophy and become transformed into a *special* branch of scientific knowledge.[34] Modern formal logic studies a special and particular aspect of thought and is no longer a method of knowing. In its investigations it uses the categories of cognition that are developed by dialectical materialist philosophy, by dialectical logic. Modern formal logic has a quite different relationship to philosophy from that of traditional logic.[35]

When there was no dialectical logic, normal (traditional) logic solved questions that went beyond the limits of its present object. "For example, it had its own theory of abstraction, its own theory of concept formation. In particular, in solving the question of concept formation, formal logic saw only one side in this process – the delineation of the similar and the general in objects" [171, p. 53]. Now *these are not its questions.* Now these are the questions of dialectical logic, which, naturally, "sees" much more in the concept formation process than does traditional formal logic.

P. V. Kopnin and P. V. Tavanets take special note of the fact that our textbooks on formal logic contain what is not part of its scope (for example, in the teachings on the concept there is exposition both of that which pertains to it and of that which goes beyond its limits) [171, p. 37].

In our view, the theses that have been cited permit a proper assessment of the traditional formal-logic doctrine of generalization and the concept, as well as an outline of the theoretical principles toward which the modern psychology of thought should be oriented.

This question is natural: why not follow *modern* formal logic in defining ways of forming concepts? It is important to keep several circumstances in view here. First, this logic does not concern itself with the processes of forming and developing concepts. It takes them as if they are "ready-made." Second, it regards concepts primarily from the standpoint of their *scope.*[36]

Therefore, for instance, for this logic two attributes are equivalent if they determine the scope identically, although they might be unequivalent in meaning (one attribute might be "essential," and the other not). Third, this logic is especially interested only in the function of a concept as the *differentiation* of one object from another or of one class from another.[37] Fourth, in a concept and in any of the other forms of thought, in principle, it can be interested only in what is somehow necessary for ascertaining the conditions for a formal sequence of judgments, the conditions for the formal correctness of a deduction. Modern formal logic abstracts itself from all of the other ("meaningful," so to speak) aspects of a concept as from aspects that are not proper to its basic subject (in a number of areas it therefore takes on the force that "meaningful" arguments lack).

Psychologists and didacticians are primarily interested in the problems of the origin and formation of concepts both in the history of science and in the thought of the students who are learning it.[38] Therefore, for all of the importance of assessing the laws revealed by modern formal logic, and the need to use its methods at certain stages in studies in educational psychology, in the approach to the general and radical questions of the nature of a concept, it is advisable to proceed from the principles of dialectical logic.

Above we have indicated the characteristic features of the "*modern*" formal-logic approach to the concept and, among them, the reduction of the function of the concept to "differentiation" and the indistinguishability of "essential" and "nonessential" attributes. Still, somewhat earlier, we attributed the same characteristics of a concept to traditional formal logic. Is there not a contradiction here? There is not if a number of conditions are taken into account. The real subject of modern formal logic developed gradually, but its essence, naturally, was found a very long time ago (thus, it was in the 19th century that an interest arose both in the theory of deduction and in the methods of formalizing it). It was within traditional formal logic that both its "insensitivity to the real distinction between the essential and the nonessential, and the restriction of a concept's function to "differentiation" were detected. This had no significance for reaching its main goal – the creation of a theory of deduction. But it did have a significance – and a negative one – when this same logic, for certain historical reasons, laid claim to a general theory of concept – that is, to that which was not "within its potential." For a while these features were not clearly revealed, and therefore the area of competence of traditional formal logic was actually confined to the realm of empirical concepts.

Attempts at solving the general problem of the nature of concepts, in the absence of means of distinguishing between the essential and the nonessential, when reducing the function of concepts merely to "differentiation," mention the theoretical *weakness* of this approach to thought, which, on a epistemological level, hinges on nominalism and a one-sided sensationalism. But with a conscious understanding that the problem of the "essence" and of the general nature of concepts is not the problem of formal logic, that, what with the uniqueness of its purposes, it can fully satisfy the function of "differentiation," taking it in a certain particular cross-section. This becomes the method of abstraction from everything unimportant from the standpoint of the internal problems of modern formal logic, and the real epistemological state of affairs in such an abstraction is quite different.[39]

We have presented only one approach to modern formal logic, but, in our opinion, it is the most acceptable one. There are, however, other positions. B. M. Kedrov has formulated one of them in detail [158]. From his point of view, the general fundamentals of formal logic (elementary formal logic) retain an independent significance to this day. It is a philosophical discipline rather than a specialized one. Some of its principles have been borrowed from mathematical logic, which is concerned with its own problems that verge on mathematics (which is a specialized discipline). The essence of the general fundamentals of formal logic, which, together with dialectical logic, also studies the forms of thought, is that it takes these forms as if ready-made, developed, beyond formation and development. It is the logic of the first, the initial level of cognition, at which there is a primary sifting of the real content of thought from fictions and fantasy. This level is necessary and inevitable – hence the study of its principles both in scientific cognition and in the ontogenetic development of the child's thought retains significance. "In order to reason and to think dialectically, there must be elementary training in proper thinking, as a precondition..." [158, p. 70]. Formal logic also teaches this elementary thinking in its general fundamentals, which depends on four well-known laws (of identity, compatibility, etc.).

This position, for all of its external abstruseness, has a direct relationship to psychology and didactics, since it consecrates the stability of the formal-logic stage in the development of the child's thought. "Elementary formally logical thought ... is the first level in any logical thinking. ... A transition from the initial, formal-logic level of thought to the dialectical thinking of the adult is a necessary common element" [158, p. 80].[40] To be sure, Kedrov does not touch directly upon the question whether formal generalization and formal abstraction necessarily enter into such thinking (he is speaking mainly of the four laws). But, in essence, they apparently should be considered a "necessary element" in any thinking.

In our view, there are some essential contradictions in this position. It is assumed that formal logic makes a study of ready-made knowledge, its structure "in abstraction from the process of thought's movement to truth" [158, p. 115]. From the particular standpoint in which concepts, for example, are not the principal object of investigation but serve merely as a feature in revealing the conditions of "logical sequence," this sort of abstraction is apparently justified and legitimate (modern formal logic, as mathematical logic, also does this). However, when the meaning of the philosophical discipline, which makes a special study of forms of thought, which even though elementary are studied as principal and basic to its analysis, is retained for formal logic, this abstraction is not legitimate. Can we really know the "simple" without studying the processes of development that lead to it, without studying the movement of thought itself? Of course not! Therefore such logic is doomed to the position of a descriptive discipline, which will still be absorbed by a discipline that explains the essence of complex and elementary forms from the development of thought – that is, by dialectics.

Furthermore, the assertion that the initial stage in cognition is studied by formal logic, and the subsequent stages by dialectical logic would be a consequence. However, B. M. Kedrov especially emphasized the feature that dialectics investigates the process of cognition from its initial points to its highest forms – that is, as a *whole.* "... Dialectical logic begins every investigation anew, that is, from the same point from which formal logic also begins, but from the outset it takes an altogether different route" [158, p. 107]. If it is presumed that dialectics can disclose the content of the initial level of cognition within its integrity, then, it is asked, what falls to the lot of formal logic? This remains unclear.

In daily life and at the very initial stages in an investigation, the empirical method of concept formation is preserved. Formal logic, formerly studied, made it absolute. This role (but now without making the results absolute) could be reserved for it. But this is hardly advisable, for the same process can be investigated by dialectical logic, which thus can include the *subject* (but not the interpretation) of traditional formal logic. But this very logic has narrowed its subject. Having abandoned claims to making a study of the "stages in cognition," it is studying all forms of thought from end to end (both simple and complex), but from a certain point of view – from the point of view of a "formal logical deduction." It ascertains the conditions and methods of formalizing knowledge and using it. But this feature, of course, by no means exhausts the content bearing process of cognition.[41]

The types of logic and of their problems are differentiated most consistently and clearly, in our opinion, in the first position we have described. This position corresponds, on the one hand, to the entire history of the development of philosophy, to the history of the gradual dissociation of many particular scientific disciplines from its realm of competence (including that of formal logic proper) and, on the other hand, to the real division of scientific labor in the solution of modern logical problems. Dialectics (like logic and the theory of cognition at the same time) studies the laws of the historical formation of scientific thought, but formal logic concentrates its attention on questions in the formalization of knowledge having an essential significance for understanding the "mechanisms" of human mental activity.

With this we end our description of the interpretation of generalization, abstraction, and the concept in traditional formal logic and psychology, and of its epistemological foundation – the empirical theory of thought. The goal of the next chapter is to provide a critical analysis of the consequences of using this theory in constructing the educational process.

3

A Critical Analysis of the Empirical Theory of Thought The internal Limitations of the Empirical Interpretation of Generalization and of the Concept

To find any “identical” property, one must have a *range* of real objects for comparison. But how is this range determined – what serves as a basis for delineating it? It is not difficult to observe that forming a group of similar objects presupposes the *existence of knowledge* about this property that is similar for this. For some logicians this circumstance has been a basis for the assertion that abstractions and concepts by no means arise in the way described by empirical theory. For example, C. Sigwart notes that “a comparison of different red things by their color is possible only if the indicated abstraction has already been carried out” [123, p. 284]. It can be presumed that “concepts should ultimately be acquired by a different method, not by the method of this kind of abstraction, since they merely make the process of this abstraction possible” [123, p. 281].

Without an hypothesis of the general as the real basis for choosing objects, this kind of comparison must take place purely arbitrarily, and then what is compared is a matter of indifference. M. Drobisch spoke ironically apropos of this in his time, noting the possibility of comparing a raspberry bush, not only with a blackberry bush, but with a tortoise as well [371]. Here, as G. Lotze notes, cherries and meat can be reduced to the group of *red, juicy, edible* substances [389]. But people actually do not take this route and do not set up such arbitrary groups; they apparently have some particular criteria for singling out and combining objects into really kindred groups; these criteria are what is not grasped by the empirical scheme for the formation of abstractions and concepts.[1]

Formal comparison is possible only on condition that the properties of every particular object be distinct, isolated, and independent of one another (this is precisely the precondition in empirical theory). In this case the attributes in which the objects in the given situation *differ* from one another are unimportant for their unification into a class on the basis of a common attribute, are unconnected with this common attribute, and do not proceed from its existence.

In this framework the following ironic observation by F. Engels is instructive: “Just because we include a shoebrush in the same category as mammals does not mean that milk glands will appear in it” [6, p. 41]. A similarity between the shoebrush and mammals can be found, of course, but will it be a combination underlying which there would be a *real unity* of similar objects that determines their other features, including different ones? Clearly, there is no real unity here, either of the similar objects themselves or of their similar and different properties. Such combinations are possible only according to purely *external*, relatively independent and isolated properties of things.

This, as it has been agreed upon to state, is merely an *abstract identity of objects*. In it the “similar” and the “dissimilar,” the “identical” and the “nonidentical,” the “same” and the “different” are simply *divorced*, and divorced formally, since when the basis of comparison changes (and this can be done arbitrarily), the identity becomes a difference, and difference becomes identity.

This sort of divorcing of the general and the particular, the common and the different, lies at the very basis of the empirical scheme of generalization. Some authors aspire to remove this “indifference” of the general to the particular – that is, the abstractness of identity – by the following arguments. Thus, D. P. Gorskii, analyzing the relationship between the general and the individual, notes that the general properties intrinsic in a class of objects have an individual aspect in *each* of them (for example, the property of “possessing the power of speech,” which people have in common, has individual, inimitable peculiarities for each particular person) [97, p. 226]. But this merely indicates that the “general” is not an absolute coincidence, an absolute sameness, and has certain variations. The question is different: Does the formally general imply a set and a type of these variations? Clearly, establishing the property of “possessing speech” implies no types of variation in any way, although in reality there are some. The conception of this property can be used to draw a sufficiently clear-cut distinction between persons, who possess speech, and dogs, who do not possess it, but without any auxiliary idea of the variations and individual peculiarities in people’s speech itself.

E. K. Voishvillo indicates that an abstraction from the differences in objects when they are being generalized in a concept does not mean ignoring differences in general. Here there is an abstraction from *what the differences are*, rather than from the fact of their existence itself. Thus, the concept of a "rectangle" implies *any* rectangle, which has a certain relationship of its sides. The question of the character of the differences remains *open* [64, pp. 117-118]. One does not have to make particular mention of the fact that *any* object merely possessing the property that underlies the generalization is fixed in the generalization – that is the alpha of the empirical scheme. The omega is the recognition of differences as such, for it is from them that abstraction occurs. The problem is elsewhere: does the idea of a certain similarity include the idea of *certain* differences, the idea of *what kind they are* at last in type, in character?

Of course, when a classification of certain objects has already been set up and a hierarchy for their generic-typical properties has been established, the *appearance* of a unity of the similar and different properties is created, for within the classification one can pass from one level of generality to another (the operations of generalizing and restricting concepts). But it is impossible to deduce one property from another from inner necessity here, for they are independent of one another. The real problem is precisely in finding a form for a concept in which the derivation of properties would be possible, and the form would imply the character of the differences as well.

The notion that the *class* that is fixed in a concept is not an *integral* formation is in opposition to the hypothesis of properties or objects that are independent of one another. When the formally general is singled out, there is abstraction even from the real connections among properties and objects that can be observed [64, p. 250]. T. Kotarbin'skii clearly delineates this feature in the following words:

> ...A class is understood, however, not to be a whole whose particular elements are parts, but to be something else, something such that, when we are speaking "about this," we are somehow speaking indirectly, by means of this very thing, about each of the individuals included in this something, rather than about the whole that is made *up* of them [172, p. 277].

If we acknowledge that in reality there are still integral formations consisting of "individuals" as their own parts, then we can construe the impossibility of establishing these integral formations with the form of concepts which is meant for representing "classes."[2] Insofar as, according to the principles of dialectics, natural entities are an interrelated whole, the *limitations* of the concept of a class as a means of knowing become clear. On this level the empirical scheme of generalization and abstraction loses its real cognitive significance and is converted into a method of delineating and distinguishing between entities according to certain of their external properties, into a means of creating new *terms*, designations and names. As L. Tondl' rightly notes in speaking of the empirical theory of abstraction which comes from Locke, "the process of abstraction itself ... loses its cognitive significance and is in no way capable of serving to obtain new knowledge."

"This sort of empirical theory of abstraction has led by a direct road to the recognition of the problematics of abstraction as a semantic problematics" [304, p. 132].

The study of integral objects, of their formation and functioning, is one of the central problems in modern scientific knowledge. The empirical theory of thought cannot describe the process of solving it, since its principles presuppose, from the outset, an abstraction from the integral nature of objects, from a consideration of the real interrelationships of their aspects and properties. Engels has directly pointed out that the ideas of Locke and other metaphysicists have obstructed "the path from an understanding of the particular to an understanding of the whole, to a comprehension of the universal connection among things" [6, p. 369].

Science aspires to pass from the description of phenomena to the disclosure of *essence* as their internal bond. It is well known that essence has a different content than directly given phenomena and properties of objects. Karl Marx, in criticizing the position taken by popular economists, wrote:

> ... The popular economist thinks that he is making a great discovery when he – instead of revealing the inner connection of things – claims with an important aspect that things look different in phenomena. Actually he is pluming himself

> by firmly adhering to the semblance and taking it for something definitive. For what purpose is science in general then? [13, p. 461].

As was shown above, the empirical scheme for generalization and the formation of concepts does not provide means of delineating the essential features of an object itself, of the internal connection of all of its aspects. It does not assure a divorce of phenomena and essence in cognition. The external properties of objects, their "semblance," is taken as final here. Typically, in the last century and at the beginning of this century, the concept of "essence" itself was reprehensible in the mainstream of positivistic currents in philosophy – and these absorbed the principles of the empirical theory of thought.[4] And this was not accidental, since the representatives of these currents did not have the logical means of revealing an essential, inner connection for complex biological and social entities, for example. In the encounter with these *integral entities*, the interpretation of "essential properties" as merely *distinctive* ones was a complete failure.[5] E. V. Il'enkov, in one of his works, wittily describes the misadventures of the empirical notion of "essential attributes" in attempts to define the concept of such an ordinary, easily differentiated entity, known to everyone, as "man" [134, pp. 29-37].

It would seem that it is not difficult to do this: one must take the common, similar attributes that all people have and that differentiate them from all other animals. But the following difficulty immediately appears here: what living beings must be included in the range of persons in order to delineate their common features? Thus, Aristotle did not include slaves in this sphere when he developed his celebrated definition of man as a "political being." He ascribed slaves to a different "genus" – they were "speaking tools" (this was entirely natural for an ideologist of the slaveholding class). Apparently, one must have a certain idea of "man" in order to select the sphere of "people" itself for the delineation of similar features.

What are these general features? The French writer Vercors, in a pamphlet-novel entitled "Men or Animals?" [57], outlined in vivid form the different typical views of man in the modern world. Thought and speech are what people have in common, but what are these? These have difficulties of their own.

From the standpoint of the empirical scheme for concept formation something must be found in every person (an "abstract") that is inherent in all other individuals. Attempts to construct a definition of "man" along this route have led to the delineation of merely externally identical attributes that manifestly do not define man's essence. It is known that a real scientific definition was found in another way – in the analysis of a universal, real basis for everything human in man. It was the *production of the tools of production* (this is how Marxism defines man's essence). In a brief definition it is expressed as follows: "Man is a being that produces the tools of his labor." Modern science concurs with this interpretation of the essence of man. However, as is easily observed, a great many indubitable representatives of mankind do not fit this interpretation of the essence – if we preserve the empirical interpretation of "essential attributes" as differentiating objects in one class from objects in another class. Mozart, Raphael, Pushkin, and Aristotle do not "fit," for none of them was a being producing the tools of his labor. We might attribute to "men" in the empirical interpretation of this concept only ... workers in mechanical engineering plants or workshops [134, pp. 42-43].

And if we still attribute all of ourselves to men, this indicates, first, the existence of different methods of generalizing and attributing objects to the respective concepts, and, second, the impossibility of developing a concept of the essence of man in a comparison and delineation of the formally similar properties of *all* people. Here the empirical scheme for generalization and the formation of concepts simply does not "work," cannot be a means of delineating the essence of entities and of operating with that essence in thought.

It is important to keep the following feature in mind. The essence of an object or the internal connection among its properties is differentiated from externally observable and directly perceptible phenomena. Sensationalist theory[6] cannot explain how content that was manifestly lacking in the initial sensory data is detected in a concept. For these data have merely changed their form (perception—conception—concept), not the composition or the character of their attributes. To be sure, one usually speaks of the "nonvisuality" that arises at the level of a concept. But its appearance, which is explainable by the absence of an actualization of the images of conceptions when using linguistic means, does not disclose the mechanism by which properties of objects not given in perception and conception are *introduced* into the concept. The central idea of classical sensationalism is precisely that all of the content of a concept can ultimately be *reduced* to direct sensory data and to *finding* the appropriate sensory correlate for any abstract attribute. From this point of view an essence should also have a direct sensory expression. And if scientific concepts demonstrate the opposite, then empirical theory cannot explain these facts. In some instances they are ignored in one way or another (this is the position taken by logical neopositivism), in others they are masked or interpreted on the path toward an eclectic combination of empirical theory and other theories of concept formation (in particular, this is how many psychologists and didacticians behave when they are obliged to deviate from their initial traditional positions).

These features of the empirical scheme of generalization and concept formation show its fundamental *weaknesses,* its fundamental *inapplicability* to the interpretation of the processes of *scientific generalization and the formation of scientific concepts.* Actually, this scheme has no criterion for combining objects in a group that would be a group of genuinely interrelated objects rather than a random conglomerate of externally similar things and phenomena. This scheme, which rests on the principle of an abstract, formal identity, opposes the "similar" and the "different," the "general" and the "particular," and does not indicate a method of interconnecting them within an integral, single object or within a coherent integral group of objects. A consequence of this is the impossibility of expressing an object's *essence,* the internal link among its properties, within the framework of this scheme. Guided by the principles in this scheme, man is obliged to remain on the plane of external properties of an object that are independent of one another.

A fundamental limitation of the empirical scheme results from its epistemological attitudes. The nominalist tendency inevitably leads to the impossibility of singling out the objective content of concepts, the object sources of this qualitatively particular form of reflection. The sensationalist attitude, which is closely related to this, impedes a proper explanation of the conditions and means of reflection of the essence of objects in the form of a concept, depriving its content of qualitative distinctiveness. A number of the principles of associationism that presuppose reducing the content of thought to elementary sensory data harmonize well with both of these attitudes. All of these attitudes are closely related. Their sequence inevitably leads to the weaknesses that are found in the empirical theory when confronting the problem of the formation of scientific concepts, real theoretical generalizations and abstractions.

At present, among our philosophers and logicians, as well as psychologists and educators, there are almost no consistent defenders of the empirical theory who consciously adhere to its fundamentals. Above we have noted repeatedly that this theory is used as if it goes without saying, and one must reckon with it *de facto.* Some of its points are often combined with the principles of mathematical logic, and at times an attempt is made to combine them with some of the theses in dialectics. In all of these cases it is emphasized that the protogenic form of this theory, as outlined by Locke, ostensibly treats the processes of generalization and concept formation *in a simplified way,* when in fact they are more complex, and so on. This is correct. But the entire question is in how to interpret this "complexity." One can attempt to reveal it while *retaining* the initial scheme, merely dressing it up in details or else eclectically connecting up the attitudes of fundamentally different approaches. This, in essence, is the position taken by a number of authors of texts on formal logic, as well as by many psychologists and didacticians who are concerned with theoretical questions in the formation of students' thinking. But one can proceed from the fact that, in principle, this scheme does not satisfy modern notions about thought, whose "complexities" should be disclosed in other ways and with the application of other starting points. This approach is the truest one, in our view.

The attempts of the first sort do not lead to success. Thus, A. A. Vetrov, whose approach to the problem of the concept we have described as narrowly sensationalist, himself criticizes the limited sensationalism of the empirical interpretation of a concept. From his point of view, one of Locke's mistakes was to acknowledge the limitless possibilities for the creation of conceptions. In Locke's opinion, one can create a general conception, not just of man, but of an animate being in general as well. Vetrov believes that these possibilities are not infinite. They are sufficient to create conceptions of man, but they are scarcely sufficient for a conception of an animate being [58, p. 40].

Here the question comes down to the quantitative boundaries of a conception. Unfortunately, Vetrov does not remark that this *does not affect* the essence of sensationalism. He believes that to create a concept of man means to *dissociate* the attributes of a conception verbally. But a conception of man does not contain his universal characteristics. And the matter here concerns, not his quantitative boundaries, but qualitative substance – the formally identical attributes that are grasped by the conception, for all of its dissociation, do not express a universal feature, the essence of mankind."

Vetrov believes that limited sensationalism can be overcome on the way to disclosing such a specific feature of the concept, such a distinction between it and general conceptions as the presence of dissociation in form, attributes. Here, it is said, one cannot have a visual image of an object stand immediately behind verbal formulations of the attributes in the definition of a concept. This sort of reduction can be accomplished only in steps [58, p. 46].

Here he is not considering two central issues. First, classical sensationalism demonstrated the reducibility of the entire content of a concept to sensory data only *ultimately,* while well aware of the intermediate procedures of both deduction and reduction. Second, agreement that sensation is the source of knowing is not identical to acknowledging the complete identity of the content of a scientific concept having theoretical form with the external, immediate attributes of the object represented in it.

The one-sidedness of classical sensationalism in no sense means that sensory data are supposed to be the source of all rational forms of knowing. Concurrence with this forms the ABCs of any materialism, which is always "sensationalistic" from this point of view. Classical, Lockean sensationalism as a particular area of cognitive theory (we are speaking of materialist sensationalism, which recognizes the objectiveness of reality) consists in establishing the complete *identity* of all "elements" of the content of thought (the concept) with the external, directly perceived, general attributes of an object, which open up the way to comparison. These attributes can be perceived, conceptualized, and conceived of – but it is *they* that are and *only* they. This also means *reducing* a concept's content to sensory data. It also means describing concept formation as a change only in the form of recording and expressing the general attributes of objects. In addition, it implies a *one-sided* sensationalism in interpreting the nature of a concept, beyond whose limits empirical theory does not go. Therefore to reproach its creators about "oversimplification," about ignorance of "complex techniques," and so on, is simply *wrong* from the standpoint of those who continue, preserve, and, finally, give greater complexity to – in proportion to the new means – their initial principles. One must either concur with them or repudiate them. All or nothing! Such is the theoretical alternative that is revealed in the history of philosophy and psychology.

The Results of Using the Empirical Theory of Thought in Educational Psychology and Didactics

One of the main preconditions of the traditional system of instruction is that the children are to learn certain facts about the natural and social world around them, then use these facts to solve a certain range of practical problems. In principle it would be desirable for students to learn this knowledge through direct observation of phenomena and objects, through comparing them, singling out what is central, remembering the important facts and subsequently applying them in certain everyday-life situations.[7] But this route is impracticable in its pure form since the range of information which the student is to master is broader than is accessible to his direct observation. Moreover, facts about many phenomena and objects have already been accumulated, systematized, and described by other people. The experience of others is here conceived as the extended and intensified experience of an *individual* person which is expressed in the same form in which – on occasion – any knowing individual can formulate it. This experience must be conveyed to the students through speech or visual representations. The teacher carries out the organization of immediate experience and the transmission of mediated facts.

A *compendium* of facts about things and a more or less accurate description of them are transmitted to the students. Thus, in life people often have to do computations – to deal with such distinctive "things" as numbers. Consequently, children also must be given information about numbers (whole and fractional numbers) and about the decimal system and must learn to use it. In everyday life modern man is constantly encountering mechanical, thermal, electrical, and other physical phenomena – the facts about them are given in a physics course. The content of other school subjects is singled out analogously (for example, the need for proper spelling requires certain grammatical information). The definitions and concepts learned in school describe in verbal form the different aspects of things and phenomena which are perceived *directly* or which have previously been observed by other persons.

This occurs in most open form in the primary grades, although such a tendency is also retained later on.[8] It would seem that, upon entering school, children should get a different content and a different form for its expression from that with which they dealt at home or in preschool. But this is what they are striving *not to* do. On the contrary – educational psychology and didactics recommend that teachers use the preschool everyday experience of becoming with things and phenomena in every possible way, merely expanding and refining it as a good basis for mastering the school curriculum. It is thereby acknowledged that, in fact, both the content and the method of acquiring knowledge in preschool life and in specialized school instruction have *uniformity in type and sequence.*

Typically, in those instances where a departure from the concrete, everyday images that are habitual for the children is outlined in the school, the proponents of the particular significance of everyday experience in the students' intellectual development point out the negative consequences of this fact. Thus, S. P. Baranov, who has specially studied the role of sensory experience in elementary instruction, laments that the seven-year-old child "gradually leaves the world of concrete images for the world of abstractions, the world of concepts; he leaves, while parting with the concrete images that are closest and clearest to him." To be sure, the "world of concepts" is goodness knows how abstract – everything, in principle, remains similar to the former experience, only cardboard mushrooms appear instead of woodland ones, and sticks appear instead of apples to be counted. But even this transition to didactic aids that are still quite similar to "nature" ought to be welcomed. However, from Baranov's point of view, this objectively unhealthy transition occurs, "negatively influencing mental and moral development" [31, p. 8]. Thus a conclusion is drawn to the effect that it is important to use and enrich the child's *concrete* everyday experience; it is on its basis that grammatical and arithmetical abstractions arise. "It is in the period when the child is living by concrete images and impressions that his sensory experience must be systematized and generalized, and, on this basis, rudimentary arithmetical and grammatical concepts formed" [31, p. 12].

Baranov's appeal is purely rhetorical, for his "wish" is being carried out every day in most school practice, where since the beginning of time there has been a striving to use children's immediate experience to develop their concepts. But *what* concepts? Of course, empirical ones, which *coincide* in form and content with everyday information about one's surroundings. To be sure, they are more systematized and conscious, for an articulated, verbal form is attached to them.

Relying on the empirical theory of thought, educational psychology and didactics adhere to two corollaries with respect to instruction. *First,* the real source and basis for the formation of students' conceptions and concepts is perceived to be in *natural things and phenomena themselves,* which can be given to the children directly or through verbal descriptions (analogously – through pictures). *Second,* the full value of the concepts and even the level of the children's intellectual development is put in relation to the completeness and the detailed development of the information about "nature." Other people's experience (the knowledge received from the teacher) should be superimposed on the child's own life experience – in their fusion there becomes apparent the homogeneity of the content of the two kinds of experience, the possibility of expanding one's personal knowledge through information received from others.[9]

The central element in this position is not the demonstration of the significance of past knowledge in general (it would be a truism to advance such a thesis in the theory of instruction), but to indicate the need for the school information to *correspond* to the content of the students' experience. There is no need to prove that the children's "personal" past experience involves empirically developed notions of their surroundings.

Of course, this experience should be used in instruction, but only through a substantial reconstruction *within a form of scientific knowledge that is qualitatively special* and new for the student, which in no way corresponds, and cannot correspond, to simple life experience. The past knowledge of everyday procedures must be included in instruction, but only as general prerequisites that are not specific to the content and form of the scientific concepts. Only by knowing the peculiarities and the specific nature of the latter can one develop questions about the role of past experience in a concrete way. Apart from this there is a slurring of the *qualitative* difference in everyday experience and scientific knowledge; a natural subordination (and, as a result, a distortion as well) in the form of the latter to please the former occurs. But this is one of the characteristic consequences of the application of the empirical theory of thought in educational psychology and didactics.

Within the framework of the application of this theory, the persistent execution, in school practice, of the idea of the *continuity* of all of the stages in learning becomes explainable. A statement about the continuity in the acquisition of knowledge and the children's mental development would again be banal. But the emphasis on continuity includes not only and not so much this feature as a theoretical shelter for the *impossibility* of showing, within the limits of the empirical theory, the qualitative uniqueness of the passage from the preschool child's everyday conceptions to concepts that the schoolchild is to master, the transition from empirical concepts to scientific ones. Then there remains the traditional formula to the effect that "from grade to grade, the students' knowledge is made broader and deeper" (we have cited examples of these explanations above). There is usually no attempt made to have any significant delineation of the qualitative features of knowledge that is being mastered by students in the primary grades in contrast to preschoolers. An extreme empiricism, pragmatism, and utilitarianism in the content of teaching appears too manifestly in the traditional primary grades.

If one attempts to find indications of the time and the period for the appearance of the qualitative uniqueness of the knowledge that is presented to the students, there is no clarity or definiteness on this question in didactics. To be sure, when the development of children's thinking is being described, there is a special indication of upper-grade students' ability to master theoretical knowledge, scientific concepts and principles properly speaking (see Chapter 1). But the entire problem consists precisely in not merely establishing the actual state of affairs in school or the actually observable abilities of students in the upper grades, but in revealing the logical and psychological content of the *theoretical form* of knowledge. Only on this basis is it possible reasonably to raise the question of the conditions and means of forming theoretical thought both among older students and – why is this now to be different? – among younger ones. At the same time, only with a comprehensive analysis of this form is it possible to set up a correspondence between the modern principle of a scientific approach (and this is a leading principle in our didactics), on the one hand, and the content and methods of developing the basic school subjects, on the other.

Realizing the didactic principle of the scientific approach in instruction under modern conditions is by no means an easy matter. And, as follows from all of the preceding analysis, it cannot be developed successfully on the basis of the empirical theory of thought. Unfortunately, up to now it has been the most detailed foundation in educational psychology for designing school disciplines and organizing the mastery of knowledge in school. The incompatibility of the consequences of this theory with modern views on the "scientific nature of the content of instruction" is particularly prominent in the following circumstances.

It is known that scientific knowledge is not a simple extension, intensification, and expansion of people's everyday experience. It requires the cultivation of particular means of abstracting, a particular analysis, and generalization, which permits the internal connections of things, their essence, and particular ways of idealizing the objects of cognition to be established.[10] But educational psychology and didactics, following the empirical theory, actually ignore these peculiarities of scientific knowledge in the design of school subjects. The thesis that students should directly master knowledge about things substantially complicates the theory of instruction the search for ways to realize the principle of the scientific nature of school education. The sciences in their *modern* form (and it is only about this that there can be discussion, and only here do new problems in education arise) do not have things themselves and their immediate manifestations as their object. Knowing them requires the construction of special *theoretical abstractions*, the isolation of some definite connection among the things, and the conversion of that connection into a particular object of study.

A. N. Kolmogorov has made special note of this feature in describing the object of mathematics as a science:

> ... Mathematics studies the material world from a particular point of view.... and *its immediate object is the spatial forms and quantitative relationships of the real world.* These forms and relationships in their pure form, rather than concrete material bodies, are the reality which mathematics studies [164, p. 11].

In principle the object of any science is isolated from concrete material substances in the form of a certain connection, and it is the latter that becomes, in "pure form," a special object of study. In the history of every science there is a period of the development of its subject (although in essence this process is constantly continuing), a period of forming a view of the material world that is specific for it. In this process the form of the *theoretical* relationship to this subject is forged, and *theoretical* concepts emerge. Their sources are in the things themselves; they reflect the processes of development of these things, but it is in the form of a theory that reveals the interconnections of the things and their laws in "pure form," in universal form.

A full-fledged mastery of theoretical scientific knowledge presupposes a preliminary construction in the students' minds of the subjects of the respective disciplines, their formation of a capacity for a *theoretical* approach to things. For the child who has only a direct appraisal of the world around him, this theoretical view of things is unusual, *not given* in advance, and does not arise in and of itself. During school instruction (and here is its basic task) it is important, from the outset, to *divorce,* for the students, the immediate properties of things and their possible refractions in a theoretical concept. Learning will then unfold according to the laws of the subject of the discipline itself, in accord with the forms of its concepts. Consequently, the theory and practice of instruction faces a large problem-finding means of constructing, in the children's thinking, "models" of the subject of each discipline that is included in the list of school disciplines, and giving the children methods of progressing in this "model." Encountering this problem, the empirical theory of thought proves powerless. For it a "man—description of things" scheme exists, but "man—things—theoretical model of the connections among things" scheme does not exist.

The history of the development of science is evidence that the appearance of certain fundamental new facts and ideas leads, in every science, not to a simple extension of knowledge and refinement of concepts, but to an essential reconstruction of the entire integral edifice of the science, to a change in the role and meaning even of the most seemingly "simple" and "long-known" theses. The sciences are renewed as integral systems. Herein is the specific nature of theoretical knowledge (see, for example, the analysis of this question in A. S. Arsen'ev's work [25], among others), This stands out particularly distinctly in the example of mathematics (see [50], [258], etc.),[11] but to some extent it is also typical of physics, biology, linguistics, and other disciplines. The design of school subjects must come to terms with this major feature in the development of the sciences whose fundamentals are studied in school. The methods of designing these subjects that have been adopted, which are based on empirical theory, however, do not correspond to the requirements for solving this problem.

Adhering to notions about "expanding and intensifying" knowledge, the authors of school curricula most frequently construct them along a *subject-thematic* principle – that is, they expand the range of the phenomena described, introduce new topics, siphon off supposedly antiquated topics and unimportant questions, and so on. Thus, physics and many other disciplines (linguistics, geography, biology, etc.) in recent decades have substantially developed their own general concepts and have altered their subjects. However, these circumstances have had relatively little influence on the content of the school courses.[12] And actually, according to this principle, no matter what changes were made in the disciplines – physics, for example – we still have *levers* ("mechanics"), *electrical devices* ("electricity"), and many other objects in our surroundings. Their properties must be known, and their rules of use are important in various everyday situations, and therefore the appropriate information should be included in the elementary physics course. Of course, science has discovered new entities; new branches of it have appeared (atomic physics, for example). The new technology that is related to them is being introduced in production. Facts about them should also occupy a definite place in the curriculum *along with* "old" topics. The new facts are usually given at the end of a previously developed course.

If one is guided consistently by the empirical theory of thought, then improvement in the content of school subjects should inevitably take place in the form of a constant *intensification* of more and more new topics around a relatively unchanged nucleus of the traditional course.

Since – in the light of this theory – concepts are treated as forms of fixing the external distinctive properties of surrounding objects, and the latter are more or less stable in their significance for us, a modification of the concepts can involve only their "refinement," their "better definition," or an "updating of the illustrative examples." The "development" of knowledge can be interpreted here only as an extension of its scope, for, within the confines of the empirical theory, there is no means of analyzing the interconnection between the form and the content of knowledge or of making a permanent theoretical penetration deeper into a subject's essence as a transition from a first-order essence to a second-order essence, and so on.

The logic of these transitions, and consequently the logic of the conceptual apparatus of science, remain by the board with this theory. The central features of theoretical concepts – the changeability in their structure, the change in the correlation between the concepts of the *simple* and the *complex,* the *external* and the *internal,* the *empirical* and the *theoretical – remain unattended* or poorly realized. These correlations are not absolute but historically changeable. F. Engels has put special emphasis on this highly important circumstance: "The theoretical thought of every epoch ... is an historical product that adopts very different forms and even very different content at different times" [6, p. 366]. Recent decades in the development of science have reconfirmed this profound dialectical thesis. But in educational psychology and didactics, in the practice of designing school curricula, it has not had any substantial reflection.

A development of the instructional material that directly corresponds to the basic steps in the empirical history of a certain discipline is typical of the subject-thematic method of curriculum design. Thus, in the empirical description of the history of mathematics the following general sequence for changing the basic study objectives is outlined: at the start, numbers (arithmetic) were the central objective, then identity transformations and equations (algebra), then differential and integral calculus (analysis), and, still later, operations on sets, mathematical structures. The school curriculum follows this sequence exactly – that is, an expansion in the range of the objectives that are studied. Arithmetic is studied in the primary grades, algebra in the intermediate ones, and the elements of analysis in the upper grades (and that has been comparatively recently). The correct thesis on the need to begin instruction from the sources of knowledge actually turns on a certain external *chronologism* here.[13] This is inevitable, since the idea of changing the subject and the conceptual apparatus of a science as integral formations in which new entities and methods of analyzing them change the very foundation of science and the character of the interrelationships of its parts is foreign to the empirical theory of generalization.[14]

The traditional design of school curricula corresponds to an outmoded view of the function of learning and of its role in the life of the child. Learning is often regarded merely as the mastery of *knowledge* – without specifying the *sort* of knowledge that is to be mastered in school, as opposed, for example, to the knowledge being mastered in play (the preschool age), in independent reading of books, in vocational activity (the upper grades), and so on. This sort of undifferentiated interpretation of the content of school instruction conceals an actual reduction of the entire range of possible knowledge to empirical knowledge, which, in turn, presupposes an altogether definite *type of mastery,* which is intrinsic to the *vocational* instruction that developed several centuries ago. The chief feature of the latter is the mastery of *practical* skills and operations of a general-cultural or production-oriented nature (skills in reading, writing, and the like, for instance) on the basis of empirical information about language, mathematical entities, and so forth. At one time the mass school embodied this type of learning. Later it was preserved in more or less pure form in the primary grades (for the overwhelming part of the population it was also the final stage in education until recently); but many of its features have been extended to the upper grades.[15]

For some time the *contradiction* between developing intermediate education and the vocational type of training being transferred into it was not made sharply manifest and, in theory, was not realized (although this contradiction was partially detected in certain discussions on problems of so-called "formal" and "real" education). Only now, when the real problems of intermediate schooling are being increasingly revealed, when intermediate education is becoming genuinely universal in a socialist society, is the contradiction being clearly felt. Intermediate school education is called upon to provide the children with genuinely scientific concepts, to develop their scientific thinking and their capacities for further *independent* mastery of an increasing amount of new scientific knowledge (an analysis of the problems that arise in this connection for educational psychology is contained, for example, in one of the works by A. N. Leont'ev [193]). Solving this problem, requires, in our opinion, a change in the very principles for designing school subjects, the organization of a new type of mastery, of a new structure for the entire instructional activity of students.

Naturally, new logical, psychological, and didactic problems related to determining the relationship between the sciences and the respective school subjects, on the one hand, and the analysis of the structure of scientific concepts from the standpoint of incorporating them into the school curriculum, on the other hand, arise here. Investigations of the structure of scientific knowledge and studies of its relationship with other forms of knowing should become prerequisites for the creation of school curricula and methodologies of teaching, prerequisites for the psychological study of the principles governing the mastery of knowledge, the formation and development of students' thought.[16] But these problems of paramount importance not only cannot be solved; they cannot even be properly channeled into the traditional empirical theory of thought.

Let us consider some other consequences of the application of this theory in educational psychology and didactics. Above we described in detail the epistemological essence of its basic theses. Nominalism, narrow sensationalism, and associationism are not just its "academic" features, but the attitudes that are actively manifested in the methods of solving many general and particular questions in educational psychology and methodology.

Thus, the *nominalist* attitude leads to a negation of the existence of the *factually general* as the foundation for the unity of certain entities in a concept. Since the general is regarded as what is similar or identical in many objects, then to single out the similar properties, the operation of comparison, which solves the problem of generalizing the material in *any* concepts regardless of its concrete content and concrete peculiarities, is sufficient.[17] Underlying the formation of the concept of number is a comparison; the biological concept of life is also formed by a comparison; the concept of the stages in the development of nations relies on the same comparison operation. Since it is applied to any range in objects that are somehow similar, its formal character completely corresponds to the formality of the general attribute that is singled out.

In assigning a decisive role in the generalization process to a comparison that is suitable for all occasions in life,[18] traditional educational psychology thus closes off the way for the study of the child's *concrete, content-based operations,* by which he might detect, delineate, and establish a method of interaction of the different properties – such concrete, content-based, aspects for an object as determine its inner unity, its existence as a specific, integral object. This method of interaction, the inner connection among the features of the given object, cannot be detected by any comparison, since a comparison can single out in it only some formal feature in common with the other objects, but not the general basis for the specificity of the given object.[19]

The absolutization of the role of comparison, which is inevitable in the nominalist attitude toward empirical theory, impedes the study of the objective structure of specific operations, by which the child *discovers* for himself the aspects of reality that are represented by certain concepts (in the subsequent exposition we will show that, unfortunately, both psychology and the particular methodologies have a very wrong notion about children's activity in the course of which such important concepts as word and number are formed).

Without the means of disclosing the objective basis of the systematic, integral structure of an object itself, traditional educational psychology transfers the question of "systems" onto the plane of classification or systematization of *knowledge,* which leads to the establishment of generic-typical relationships among concepts. The hierarchy of these relationships becomes the formal framework within which the relationships of concepts in any area can be expressed.

Operating with concepts and working on the level of concepts thus comes down to moving "up" and "down" this staircase of relationships. The movement itself is concentrated on two basic operations of the formal type: *First,* on the ability to enumerate a full set of attributes to characterize the objects according to a certain degree of generality. *Second,* on the ability to make objects of greater generality concrete by passing to objects of lesser generality; at the limit, this is the ability to indicate the real, individual objects that possess a given set of attributes (subsuming under a concept). The second of these operations is as formal as is comparison. Having a certain rule, one can subsume appropriate objects under *every* indicated group of attributes. Typically, it is this aspect of "work with a concept" that has primarily been reproduced in "computer thought" (see the article by E. Hunt and C. Hovland [322]; their approach to the concept is presented above).[20]

Of course, man's "work" with concepts is not reduced to these formal operations. The basic function of a concept in a mental act consists primarily in assuring the *discovery of new aspects* of an object, an advancement into its content, rather than in subsuming objects under already-known attributes.[21] But empirical theory does not describe or reveal this central function of the concept. Typically, most of the modern psychological studies of concept formation in children are constructed under its influence. Special attention is paid to the study of effective methods of forming the operation of "subsuming under a concept" (many studies have been done in this area, relying, in particular, on the doctrine of the step-by-step formation of mental operations of P. Ya. Gal'perin; see, for example, the works by N. F. Talyzina [301], among others). In our view, one of the reasons for this state of affairs is the patent underestimation of the special logical-psychological study of the very nature of concepts, their different types and levels, which leads to an uncritical borrowing of long-established approaches to this problem that identify "any generalization" with empirical generalization, and the form of "any concept" with the verbally articulated form of describing the distinctive attributes of objects.

In its approach to mental operations as *formal* operations whose content can be *any* properties of objects according to circumstance, traditional psychology follows the nominalist attitude in the empirical theory of generalization, according to which the reality of the properties of individual objects and their formal representation in thought must be *divorced,* from the outset. Important conclusions follow from this. Since operations are regarded as elementary formal descriptions of mental activity, then a hypothesis about the existence of their *own* principles to govern their development, as well as about certain age stages in this process, is completely legitimate. Therefore in psychology one quite often speaks of the "development of comparison in students" (a detailed analysis of it is done, for example, by I. M. Solov'ev [297]), about the "development of generalization," about the "development of analytic-synthetic activity," about the "development of classification," and so on. It is also natural to observe the "inadequate level of development" of *these* operations in particular students ("weakness in generalization," etc.). A requirement about the need for special pedagogical work on "developing comparison developing generalization," and "developing analytic-synthetic activity" is legitimate.

Here the problem of the dependence of the structure and level of these operations on the real, concrete *content* of the knowledge being mastered by the children, on the aspects and types of that content, is removed. The determining significance of content in the emergence and development of mental operations and in their structure is not studied. On the contrary – the possibility of including some content or other in mental activity is placed in direct dependency on the previously achieved level of development of the formal operations themselves, including dependency on the characteristics of that process. This divorcing of the content of knowledge and the operations themselves, when their formal character is being made absolute, is possible only at the level of empirical concepts that establish the formally general features of objects. Thus the description of these operations that occurs in traditional psychology concerns only the empirical level of thought.

The nominalist character of the empirical school of concept formation clears up the meaning of the well-known requirement that instruction move from *the particular to the general.* According to this scheme there is really no general as such; it is represented only on a mental level. Naturally, it is the *product,* the *result,* of a comparison of individual objects, the result of their generalization in a concept of the class. In all cases it emerges as the result of an ascent from the sensory-concrete to a mental abstract, which is expressed in a word. Within this scheme the terms "empirical" and "theoretical" receive their own particular interpretation. The former is sensory-concrete. The latter is abstract-general, verbal. The goal of thought is to achieve a "theoretical" level of knowledge. And the higher the level of generalization – that is, the greater the range of assorted objects included in a given class, the more abstract and "theoretical" the thought. The ability to think abstractly is treated as an index of the development of the intellect.

However, here it is not usually observed that every object is taken extremely one-sidedly, from the standpoint only of its similarity with other objects – apart from a disclosure of the conditions for the existence of an integral object in its specificity. Hegel, in his day, wittily demonstrated that such abstract thought is most often encountered in life. It is precisely in abstraction that people think for the most part, latching onto particular aspects of an object that are in some respect similar to something else, and these particular features are ascribed to the whole object as such without ascertaining the internal connection of all of its aspects and features. Thinking abstractly is the easiest of all [77].[22]

From the standpoint of the empirical theory of generalization the identification of theoretical knowledge with *verbal knowledge* is inevitable. A "theoretical concept" is a concept with a minimum of visual-pictorial supports, with a maximum of verbal constructions. Clearly, the use of object aids, external means, in instructional activity is represented here as operation with individual attributes of objects on a concrete-empirical plane, which is opposed to the abstract-theoretical plane. On the other hand, the transition to operating with the meanings of words, a liberation from object aids, functions as a transition to the "theoretical plane," to the plane of reliance on a concept's general attributes.

But school practice, as well as daily life, shows that operating with abstract knowledge with a minimum or a complete absence of visual supports is a highly difficult task. Therefore one must always return to such supports. Now they can be schematic, "generalized," not as detailed as the supports needed to develop the abstractions themselves. Subsuming objects under a concept consolidates the abstraction more and more, saturating it and making it concrete with various particular cases and examples (it is for this reason that the child's skill in "citing examples" or appropriate illustrations is a criterion of real mastery of an abstract concept). In other words, the well-known *principle of visuality* assures a thoroughness in empirical concepts both in the ascent from the sensory to the abstract and in operating with the abstractions themselves.

It is easy to observe that in these instances the distinction between a conception and a concept becomes relative. In essence, a definite boundary is usually not drawn here. In works on educational psychology, didactics, and particular methodologies these terms are used here and there as if they were synonymous or of a single order ("The students form conceptions and concepts about..."). They have the same objective basis, and in form they are closely connected – one changes into the other and vice versa. It is also noteworthy that a conception and a concept can be created about anything one wishes in the world – we speak of the concept of a *house* and the concept of a *nation,* the concept of *rain* and the concept of *number,* the concept of color and the concept of the *universe.* Every conception, with appropriate articulation and verbal expression, can be clothed *in the form of a concept.* This circumstance, better than any other, betrays the narrowly sensationalist attitude of the empirical theory of concept formation. A practical consequence of it leads to ignoring a higher purpose of this high form of human thought – a purpose higher than establishing any externally recurring attribute of any objects.

Let us consider another theoretically important question. In many manuals and studies on educational psychology and didactics, when the way to form concepts that is set forth there is being substantiated, the following statement by Lenin is cited: "From lively contemplation to abstract thought *and from it to practice* – this is the dialectical route to knowing the truth, to cognition of objective reality" [17, pp. 152-153]. This statement is cited particularly in the works in which the traditional empirical theory of thought is subsequently presented (as was shown above) [31], [41], [104], [330]. The authors of these works believe that this statement briefly reproduces the scheme of transitions from perception and conception to abstract thought and from it to the application of concepts in practical situations, a scheme that they develop in their studies in educational psychology. Thus, the "dialectical route to knowing" allegedly corresponds to this scheme. Does it indeed do so?

Above all, Lenin's statement must be analyzed while preserving its *context completely*. Only then will the meanings of the terms used here ("contemplation," "abstract thought," etc.) become clear, as well as the full meaning of the statement itself, which *recapitulates* a system of profound judgments, which, moreover, are related to a number of statements by Hegel that are cited and evaluated by Lenin.

In his *Science of Logic* Hegel sets forth a dialectical approach to the concept, to abstraction. In particular, he analyzes the reasons for the limitations of "rational abstraction," which in his time had an interpretation that coincides with the current traditional, formal-logic approach to abstraction. Hegel presented this point of view, according to which a certain attribute is removed from the rich and full sensory diversity (the concrete). As the content of an abstract concept, it is of course poorer than the sensory concreteness ("lean abstractions").[23] Guided by this sort of notion of an abstraction, one can come to the conclusion that thought that operates by abstractions cannot soak in the wealth of sensory concreteness. But since it is precisely this sort of knowing that is particularly necessary, one must be content with mere "contemplation," perception by the senses.

Hegel objects categorically to the absolutization of *this sort* of interpretation of abstraction. He directed all of the power of dialectical analysis toward substantiating the full possibility of expressing reality in the form of *abstract thought* in a *richer* and *more complete* way than can be achieved at the sensory level. But for this to happen, there must be a different definition of the features of abstraction and of the concept from the one given by traditional formal logic. In particular, he writes:

> ... The thought that abstracts should be seen, not merely as setting aside sensory matter, which does not suffer any harm thereby in its reality – it is, rather, a removal of the latter and a reduction of it as a simple phenomenon to the essential, which is manifested in the concept alone (cited in [17, p. 152]).

Having extracted this passage from Hegel, Lenin makes the following argument: correct thinking, ascending from the concrete to the abstract, does not deviate from the truth but *approaches* it; "*all* scientific (correct, serious, not absurd) abstractions reflect nature more profoundly, more truly, *more fully*" [17, p. 152]. Thus, Lenin notes the cognitive feature of abstraction that has no place within the confines of its traditional interpretation (where it *waters down* the initial sensory-concrete knowledge). But the specificity of abstract thought, its potential for going beyond the limits of the sensory-concrete, is thereby disclosed (the potential for knowing an object "more deeply," "more fully") In the words of Hegel, as cited by Lenin, such thinking leads us "to the essential, which is manifested only in a concept." Here what is central is that it is in a concept and *only* in a concept (in the dialectic interpretation of it) that the essential, rather than the "lean abstract," is grasped.

Thus, for Lenin the specific nature of abstract thought as a *particular* and necessary link in cognition is related to the dialectical character of abstraction itself, which *enriches* cognition during the transition to the essential (and *all* genuinely scientific abstractions are such). It is known that Lenin stressed the dialectical nature of the transition from sensation to thought: "It is not only the transition from matter to consciousness but also the transition from sensation to thought, etc., that is dialectical" [17, p. 256]. Lenin gives the following description of a dialectical transition: "How does a dialectical transition differ from a nondialectical one? By a leap. By contradictoriness. By an interruption in the gradualness" [17, p. 256].

The dialectical quality of the transition from contemplation to thought consisted in an "interruption in the gradualness," in a "leap," in the appearance of a new form of reflection that is *qualitatively* different from the preceding stage in knowing. Abstract thought can reflect what is not given to contemplation and conception and what is grasped in a concept – this is what is *essential* or *universal* in an object.

In one of the sections of *Philosophical Notebooks*, Lenin describes the general course of cognition briefly as follows: "A concept (cognition) in being (in immediate phenomena) reveals the essence (the law of cause, of identity, of difference, etc.) – such is the *really general course* of all human cognition (all science) in general" [17, p. 298]. But the interpretation of the essential universal in dialectics is different from the one in traditional formal logic. Lenin took an approving attitude toward Hegel's formula on the universal that includes the whole wealth of the particular and the individual (this universal allows us to understand why scientific abstractions are richer and fuller, rather than poorer, than the sensory-concrete). The empirical scheme for generalization does not presuppose this sort of universal.

Now, having considered the context of Lenin's conclusion about the dialectical route to knowing, let us return to his celebrated formulation about the stages on that route. It literally follows the thesis that all *scientific abstractions* reflect nature *more completely*. Consequently, Lenin, *in the first place*, stressed the specific nature of abstract thought as a stage in knowing; *second*, scientific thought was what was meant by "abstract thought," *third*, abstraction itself was understood dialectically here, rather than in the traditional formal-logic interpretation. All of this indicates the incompatibility of the meaning of Lenin's thesis on the dialectical route to knowing with the empirical theory of thought. By merely inserting one's own meaning willfully into the terms used, one can use this profound dialectical thesis as substantiation for the traditional empirical scheme of cognition. As was shown above, it describes the abstracting of the formally general properties of objects (which *waters down* the sensory-concrete) without revealing the specific nature of the scientific concepts as reflections of the essence of objects.

There is another link in Lenin's thesis on the route to knowing – the transition *to practice*. It is known that including practice as a criterion of truth in the theory of cognition was the supreme upheaval in this discipline. The concept of "practice" is far from simple. The classic figures of Marxism-Leninism meant by "practice" human activity that is socially productive, transformative, oriented towards objects and rooted in the senses, and developing historically (briefly, this is the "history of productivity"). Marx, criticizing Ludwig Feuerbach, made special note of the potential for simplifying and debasing this concept [15, p. 1102]. Of course, any attempt at using this concept in the theory of instruction should be preceded by a careful analysis of its epistemological meaning and a special introduction of its possible psychological aspects.

Unfortunately, in many works on educational psychology this condition is not fulfilled. Often the word "practice" implies any everyday situation in which an individual is to act or to apply certain concepts in one way or another. This is often conspicuous for the link that realizes the "dialectical route to knowing."

Thus, the book by D. N. Bogoyavlenskii and N. A. Menchinskaya first cites the aforementioned thesis of Lenin's; and then the transition from abstract thought to *practice* is interpreted as a transition from the abstract to the sensory-concrete (to concrete situations, work processes, and the like). These authors, for example, write:

> ... The ability to reason theoretically about a certain system of operations by no means always assures an ability to execute the same system of real operations – that is, mental synthesis is often violated when it is transferred to the plane of practical operations [41, p. 138].

Moreover: "... The words which they (the students – V D.) used in defining a concept have turned out to be empty terms in this practical situation, terms not reflected in the students' actions" [41, p. 140]. The ability to act in compliance with "theoretical arguments," or the reflection of the meanings of words (definitions, concepts) in the execution of real operations, is here interpreted as a thorough-going transition from "abstract knowledge to practice" [41, p. 137]. Indeed, these psychological phenomena are kept entirely within the scheme of the empirical theory of thought, which envisages a transition from "verbal knowledge" to the delineation of appropriate objects, to the following of "abstractions" in object situations.

4
The Empirical Character of Generalization as One of the Sources of Difficulties in Mastering Instructional Material

The Basic Difficulties in Mastering School Grammar

As was shown above, some didactic principles, methods of designing instructional subjects, and particular methodological techniques rely on the empirical theory of generalization that has been adopted in traditional educational psychology. The question arises about how the application of this theory is reflected in the results of the school instruction itself, in the features of children's mental activity as they work according to the generally accepted curricula. From the sum total of the many aspects connected with the question, we shall be treating only those that directly pertain to the problem of concept formation and that at the same time have certain factual data pertaining to them. For this purpose let us turn to some materials gathered during the investigation of the peculiarities of students' mastery of certain concepts in grammar, mathematics, history, botany, and geography.

One of the leading instructional subjects is Russian grammar (morphology and syntax). It is well known that learning it elicits many difficulties among students both in the primary and in the higher grades. There are grounds for supposing that one of the chief causes of these difficulties is related to the uniqueness of the processes of abstraction and generalization which students are to implement during their mastery of grammar. There are appropriate facts in many psychological works (for example, [38], [39], [43], [114], [117], [233], etc.).

Sound-combinations in oral discourse and letter-combinations in written discourse transmit a definite sense or meaning in a generalized form. A person understands this meaning of the particular words and sentences – that is, their real or *lexical* meaning. But in language there are also special *grammatical* meanings that are inherent in the structure of the language. In everyday speech we are not aware of them, but in the study of grammar it becomes necessary to single out and be aware of these meanings. Thus, in a word, linguistics singles out a number of grammatical meanings in accordance with the word's morphological structure.[1] The root of a word is the carrier of its basic material meaning, into which auxiliary shades of meaning are introduced by *prefixes* and *suffixes. Inflections*, or *endings*, convey the relationships between the words in a sentence. At the same time, inflections serve to delineate such meanings as the number and gender of nouns.

In analyzing grammatical meanings, a person must abstract himself from the concrete meaning of discourse and cultivate a different attitude toward language from the one he develops of his practical everyday use of the language. Grammatical meanings are the second level of abstraction, which is related to abstraction from the lexical meaning of words (that is, the first level of abstraction). The fact that the grammatical meanings do not coincide with the lexical ones is essential. For example, the words *running, work*, and *reading* actually designate actions, but in their grammatical significance they are substantives, designating objects (objectified actions) [39, pp. 118-119].[2]

Every grammatical meaning has a certain form for its expression in certain linguistic elements. For example, number, gender, and case meanings are expressed by inflections. The unity of the grammatical meaning and the form of its expression (unity of the semantic and the formal aspects) is a definite *grammatical category*. An analysis of the *relationships* that exist between form and meaning (content) in language leads to the formation of grammatical concepts [67, p. 376], [38, p. 86]. [39, p. 120].

As D. N. Bogoyavlenskii notes, experimental material permits two problems related to students' solution of grammatical problems to be delineated. There is the problem of *correlating vocabulary and grammar* and there is the problem of *correlating form and content*. There are numerous facts showing the negative influence of vocabulary on the formation of grammatical abstractions. These facts are observed at different levels of instruction when the children are becoming familiar with a *new* concept and, at the same stage in instruction, when the linguistic material is being *made more complicated* [38, p. 86]. Let us consider these facts.

In a work by S. F. Zhuikov data are cited to indicate that when grammar is being taught according to the usual methods in grades 1 and 2, favorable conditions are not created for the children to delineate a word properly as an independent linguistic unit having both a lexical and a grammatical meaning. In these grades the students make poor progress (in comparison with preschool students) in distinguishing a word as a linguistic phenomenon and as the fact in reality itself that it designates. None of the first graders and most of the second graders who took part in Zhuikov's tests were able to describe properly the difference between a word and the fact it designates. Particular words were singled out in a sentence only insofar as they were connected with visually representable particular facts. Otherwise, a word-phrase was indicated as a particular word [116, pp. 62-64].

A. M. Orlova has described a method of acquainting primary-grade students with the sentence, which constantly figures in the children's work on language from the very first days of their stay in school but gets no definition. The children themselves actually create a notion of what a sentence is. In special experiments first graders were to call some material either sentences or not sentences. It turned out that the argument for finding the sentences was ... the number of words. If there were two or more words in the material, that meant it was a "sentence," but if there was one word, it was not a "sentence." This particularly external, pragmatic criterion proved to be highly tenacious. It was found among third graders, and, in altered form, even among older students [233, pp. 280-284].

Clearly, in these conditions students in grades 1 and 2 had to solve grammatical problems by pre-grammatical methods. Essentially, the children have not developed grammatical abstractions, an ability to abstract themselves from the concrete meaning of words, an ability to delineate their morphological units, an ability to orient themselves to the particularly grammatical attributes of a sentence [116, pp. 129, 135]. The children acquired these abilities spontaneously, by constant trials and errors. Here the grammatical attributes that are singled out are often poorly realized and, as a rule, do not constitute a complete system.

The weakness and instability of grammatical abstraction itself evokes the children's primary orientation – entirely naturally – to the immediate meaning of words, as is indicated by the numerous facts of "naive semanticism" (to use Bogoyavlenskii's terminology) that is found among students who are becoming familiar with few grammatical concepts. A work by L. I. Bozhovich [43] describes some facts where some of the students in grades 2 and 3 took account of only the material *significance* of the words that were to be compared and on this basis recognized (or did not recognize) them as "kindred," as having a single root. *Warden* and *wardrobe* are not related words, since "*A warden is a person, but a wardrobe is a thing.*" The words *watch* and watchman are also unrelated, "*because the watch runs, but he stands on duty*." Here the vocabulary impedes analysis at the level of grammatical abstraction. Similar facts have been obtained in studies by D. N. BogoysvIenskii [37]. K. G. Pavlova [236], and other authors. A naive semantic evaluation of the material could appear, for example, in the following response by a student about the meaning of the term "related words": "*Mother, son,* and *father* are related words" (the study by K. G. Pavlova). Considerable material describing different features of this tendency is contained in the work by S. F. Zhuikov [116]. Let us dwell on his data.

It is known that differentiating nouns, verbs, and adjectives causes significant difficulties for students, since they have to overcome the distinctive discrepancy between the everyday meaning and the grammatical meaning of the words "object," "action," and "attribute." Thus, in everyday speech practice an "object" designates things, visual objects. But in grammar "objectness" is abstract, related to certain formal peculiarities of words, and is expressed in the form of gender, number, and case. For children, the word "action" is usually related to the notion of a direct, physical action. In grammar, however, it encompasses not only these actions, and is expressed by certain formal parts of a verb. A grammatical "attribute" encompasses both the quality and relationship of an object (including the relationship of belonging). Here the lexical meaning of some words externally coincides with the grammatical meaning (for example, nouns designating particular visual things); for other words it does not coincide (for instance, verbs designating states). Therefore an errorless differentiation of words into the respective categories presupposes an orientation to their generalized, formally grammatical features.

However, as studies show, when grammar is taught in the primary grades by the usual methods, favorable conditions are not created for children to form the special grammatical meaning of the concepts of an "object," an "action," and an "attribute." Thus, in the study of nouns the instructional material uses, basically, words designating visual objects (clothing, animals, etc.). The objects rather than the words prove to be the chief object of the children's attention. In the study of verbs the acting objects, rather than the words designating action, become the object of their attention [116, pp. 149-150].

The results of this sort of instruction are quite significant (see, for example, [38], [116], [306], etc.). When second graders were asked to note the words pertaining to objects, actions, and attributes, many of them grouped them on a nongrammatical basis, relying on their conceptions of the facts of reality rather than on the grammatical peculiarities of the words themselves. Thus, some students attributed certain nouns to words designating objects, on the basis of their conception of an inanimate object. *Bed* was an object, since "It does not walk or run but stands; it is called an object." The noun *house* also designates an object, since 'It is big and does not run; people live in a house. ..." Clearly, on this basis, nouns such as *happiness* were not taken for words denoting objects, because happiness – in the students' opinion – cannot be taken into one's hands and felt. Similarly, when attributing verbs to words designating action, the students referred to an acting, moving object. But when they encountered words that were unrelated to the conception of an acting object, these words were not recognized as ones designating an action. The children's constant *confusion* of words in different grammatical categories was observed in the experiments. For instance, their conception of an inanimate object allowed them to attribute both nouns and verbs to words designating objects: "*To stand* is an object, since a desk stands."[3] The conception of an acting object can be a basis for attributing both verbs and other words to words designating action: "*Joiner* is an action because he is alive, he can walk...." To be sure, along with this kind of grouping, cases of the children's considering an abstract meaning of an action ("to do something," and so on) were observed. But here the children were unable to attribute the words that established the appearance of a quality to the words designating action, and, along with this, nouns were attributed to the category of words designating action: "*Movement* is action because if you move something there will always be action."

We shall cite some numeric data to characterize the second graders' differentiation of nouns, verbs, and adjectives as words denoting objects, actions, and attributes (after working on the appropriate topic). The experimental material included 75 nouns of various meanings (from ones designating concrete objects to ones designating abstract concepts – *desk, blackboard* and sleep, movement), 54 verbs that differed in vocabulary and grammatical characteristics (coinciding – to *work*, not coinciding – to *whiten*, and directly contradictory – to *idle*), and 22 adjectives. The tests involved 93 participants. The data obtained (in %) are shown in Table 1 [116, p. 163].

The percentages of proper classification of words for each category were low. The students confused words in different categories – and this occurred much more often than when the words remained merely unidentified.

Table 1

Parts of speech	Attributed to words denoting			Not noted
	Objects	Actions	Attributes	
Nouns	62.7	15.0	8.7	13.6
Verbs	14.4	56.4	8.2	19.0
Adjectives	20.5	12.9	54.9	11.7

These mean data conceal very different figures for the proper qualification of particular words. Thus, for nouns they will vary from 95.7 to 31.2% (words such as *desk* and *whiteness*). Nouns designating visual objects (*blackboard, bird, girl,* etc.) were the best identified; but nouns with abstract meanings were identified by far fewer students (*kindness, running, daredevil,* etc.). The figures for adjectives fluctuate between 58.0 and 32.2% (*white – bearlike*), and for verbs – between 83.9 and 36.6% (*to walk – to dawn*).

An analogous test was done with third graders (111 of them) before their special study of nouns, verbs, and adjectives as parts of speech. The data (in %) are shown in Table 2 [116, p. 169].

Table 2

Parts of speech	Attributed to words denoting			Attributed to prepositions	Not noted
	Objects	Actions	Attributes		
Nouns	57.9	5.2	13.1	1.6	22.2
Verbs	6.0	75.4	10.1	0.6	7.9
Adjectives	5.7	14.1	60.9	1.0	18.3

These data are evidence that students in both the second and third years of their instruction, working according to the ordinary curriculum, poorly differentiate words in grammatical categories that are known to them.

Here there is a distinct tendency to identify words in different categories according to their material significance – that is by nongrammatical attributes, on the basis of the *conceptions* elicited by these words.[4]

During the special study of the three parts of speech, the children receive their definitions and do exercises in grouping the words using the definitions. Exercises requiring indication of particular grammatical attributes of words (number, gender, case, etc.) are practiced extensively. But, as studies show [116], [306], identifying these particular attributes is still a long way from understanding and using *systems* in analyzing them. Therefore, when required to recognize parts of speech, most of the students in grades 3 and 4 use questions as a basic means – but the system of grammatical attributes (forms of change) are not used as indicators of parts of speech [116, pp. 213-216]. Thus, in some tests by G. P. Trofimovich, 80 students in grade 4 were asked to note in a text (120 words) the words that changed: 1) in case and number, 2) in case, number, and gender, 3) in person, number, and tense. Of the words in the first category, 24.9% were singled out correctly, and for the second and third categories the figures were, respectively, 28.2% and 49.7%. In other words, the fourth-graders were poor at differentiating nouns, adjectives, and verbs by forms of change, since they did not understand the essence of changing grammatical forms [306]. As a result, *incompleteness* in concepts of these three parts of speech, a *weak mastery* of the form in which they change, and a *poor differentiation* of them are typical in students [116, p. 222].

Some materials in a work by N. P. Ferster [314] on third graders' distinctions of verb tenses show that children often orient themselves to the semantic differences of the tenses, solving problems on the basis of the concrete meaning of the sentences (thus, there were about 30% errors in distinguishing verb tenses in broadly representative interrogative and negative sentences). This is found particularly clearly when words that contradict the temporal meaning of the verb are included in a sentence (for example, "*At this time* the Young Pioneers *returned* from camp"). Here the verb tense was determined, not by its grammatical meaning, but by the meaning of the words *At this time.*

The influence of vocabulary is also detected in the upper grades. Thus, some appropriate facts were found by N. P. Ferster in grades 5 and 6 in the study of the students' mastery of the concept of verb aspect [313]. In their practical work the students often ignored the formal attributes of aspect (incidentally, they were indicated in the textbook) and recognized the aspect of specific verbs according to the *semantic* criterion of *completeness,* which was interpreted quite ambiguously. In the analysis of certain sentences from the standpoint of the definition of verb aspect, there were 33.4 and 40.0% mistakes made.

Typically, the influence of the semantic aspect of language on its analysis can be retained right up to grade 10. For example, the specific meaning of certain words has hindered students in the upper grades from isolating their roots (a study by D. N. Bogoyavlenskii and V N. Odintsova [401].

We have cited the facts of the negative influence of vocabulary on the formation of grammatical abstraction properly speaking. At the same time, as was noted above, Bogoysvlenskii has indicated another problem that arises in the teaching of grammar – the problem of *correlating the form and the content* within grammatical analysis itself. Studies show that students' formation of a proper understanding of this correlation and of an ability to assess the relationship of both of its components is related to significant difficulties. The students' primary orientation either to the formal attributes of linguistic phenomena or in the semantic-content ones, without an establishment of their proper unity, is constantly observed in school practice. Instances of the primary use of semantic attributes are described above ("semanticism"). We shall also indicate some examples of a different order.

Thus, in a work by L. I. Bozhovich [43], some of the subjects in grades 2 and 3 wrongly qualified as "related" the words that had the same sound-letter components but that were remote in meaning (for example, *cast* and *castle*). Bogoyavlenskii has also ascertained a one-sided delineation of the formal attribute of a root (one subject believed the words *gray* and *grave* had the same root) [37]. K. G. Pavlova observed the same wrong generalization students were including a clearly external and formal attribute in the concept of a "root;" they supposed that a root consisted of three letters (the choice of words in the textbook affected the emergence of this generalization). Some children had difficulty and were slow at abandoning this sort of generalization [236].

Numerous facts concerning the one-sided orientation of students in various grades to the semantic attributes alone or to the formal attributes alone have been described in a work by A. M. Orlova on the mastery of syntactic concepts [233]. In some special experiments students in grades 3, 5, 6, and 8 were to emphasize the subject and predicate in specially selected sentences. Although they knew the definitions of these concepts, including both the attributes of form and attributes of content, the number of instances of one-sided orientation was still great. Table 3 shows the percentage data for erroneous delineation of the subject [233, p. 56].

Table 3

Type of Erroneous Solution	Percentage of mistakes by grade		
	3	5-6	8
Word having the significance of a “psychological subject” of the sentence is singled out instead of the subject, on the basis of a semantic criterion alone.	49.1	18.9	3.8
A direct subject whose form coincides with the nominative case form is singled out instead of the subject, on the basis of a formally grammatical criterion alone (the question *What?*)	29.2	22.6	28.9
A direct object whose form does not coincide with the nominative case form is singled out instead of the subject, on the basis of a formally grammatical criterion alone (the question *What?*)	12.5	9.7	0

The sentences which the students analyzed, besides the subjects, had nouns possessing some attribute of a subject while not being the subject. This word could designate an object in the psychological sense (“the *girl’s* head ached”) or might be a direct object and answer the question *What?* analogously to the subject (“Everyone does morning exercises”). Clearly, a proper dileneation of the subject is possible when relying on the integral structure of this concept.[5] But by the nature of the mistakes one can judge about what actually was the reference point for the students. The materials in Table 3 show that the students in all of the grades often made mistakes by relying only on a formal criterion (the question *What?*) and singling out a direct object instead of a subject (even in grade 8 there were 28.9% of such errors of the total possible number). In grammatical analysis the students most often dealt with a subject that was not accompanied by any rival word – the children used only this practically sufficient criterion. A high percentage for mistakes that arise on a semantic basis is typical (in grade 3 – 49.1%, in grades 5 and 6 – 18.9%). This indicates that pre-grammatical methods of analyzing linguistic material play a considerable role in the primary grades and are slowly overcome in the intermediate grades.[6]

Similar phenomena were found by A. M. Orlova with respect to the finding of a predicate among students in grades 2-4 [232]. Two series of sentences were given for analysis. In the first the verbs designated real actions (*to wash, to litter*), and in the second – states, an absence of action, and so on (*to miss, did not clean*). A difference between the series was observed in each class. On the average, 14.3% mistakes were made in the first series for all grades, and 33.4% in the second. In other words, many children, when singling out a predicate, customarily oriented themselves only to its content attributes. It has also been established in a number of studies that an identification of the predicate with the verb, a striving to single out the predicate by using a so-called “verb” question, is typical of students in the primary grades (as well as of some students in grades 5 and 6). Universalization of this technique, as Orlova has shown, leads to many mistakes in grade 5, when students ostensibly should be mastering the “correct definition” of a predicate and methods of expressing it. Even strong students reproduce knowledge acquired in the primary grades there, and only with leading questions do they restore the facts that have been acquired later on [232, pp. 317-318].

Orlova’s study shows many areas in which the students’ judgments about grammatical facts are influenced by “everyday” semantics, the meaning of various terms used in ordinary spoken practice. Thus, students in grades 6 and 8 were to determine the type of sentences that had words with a manifestly expressed meaning of indefiniteness (*someone, each,* etc.). Their syntactic function was different but they were most often subjects. It was presumed that the vocabulary of similar words, despite the formally grammatical features of the sentences, would provoke the students to qualify them as indefinite-personal sentences. In many cases this was what happened. In grade 6, of 60 solutions, 23 were wrong (38.3%), and in grade 8, 13 of 60 solutions were wrong (21.7%). Some students, despite a proper analysis of the sentence, still attributed it to the category of indefinite-personal ones by proceeding from a dominant orientation to the semantic indefiniteness of particular words. Here the influence of the everyday meaning of *indefiniteness,* which differs from the grammatical meaning, was clearly detected [233, pp. 76-77].

Summing up material from many works, D. N. Bogoyavlenskii draws a series of general conclusions. First of all he notes that abstraction from the concrete meaning of words and sentences – as a necessary condition for forming grammatical generalizations – presents a *highly complicated* problem for students. Having achieved the needed level of generalization in one series of grammatical phenomena, students again deviate from the grammatical method of thinking when operating with new phenomena.

> In other words, it can be stated *that in those instances where accomplishing grammatical abstraction causes difficulties, students betray a tendency to substitute for the grammatical solution of a problem a solution that follows from the peculiarities of the concrete, logical meaning of speech*. This tendency is not the exclusive property of the thinking of a child at a certain age; as we have seen, it is manifested at very different age levels [38, p. 90].

What is the basic reason for the persistent influence of vocabulary on the mastery of grammatical concepts in school? Bogoyavlenskii perceives it in the decisive significance of the *concrete* meaning of words and sentences in everyday speech practice, which constantly dominates "weak and undifferentiated" grammatical abstraction [38, p. 90]. A. M. Orlova also stresses the fact that the reasons for difficulties in approaching language as an instructional discipline are hidden in the facts about the child's free speech contact with his surroundings. Here grammatical analysis requires the use of ways that are not repeated in the everyday speech contact dominant among students. The use of everyday terminology in grammatical analysis also hinders them [233, pp. 10, 136, 197]. S. E Shuikov writes repeatedly about students in the primary grades frequently working with grammatical material by pre-grammatical methods, with important concepts remaining "everyday" concepts for them here [116, pp. 171, 277]. Incidentally, as Orlova indicates, traces of the formation of concepts that are not full-fledged at the elementary levels of becoming familiar with them continue to operate even in the upper grades [233, pp. 298, 317].

The facts concerning certain students' primary orientation toward formal attributes, in Bogoyavlenskii's opinion, are the fruit of instruction itself. They arise when students single out an external aspect of linguistic phenomena but make an inadequate connection between it and the analysis of semantics. The child already knows about the twofold character of linguistic attributes (semantic and formal), but still experiences difficulties in establishing a proper correlation between them [38, p. 93].

The indications that, throughout the school instruction in grammar, students retain a persistent tendency toward a *pre-grammatical* method of thinking are only a curtailed statement of the facts. The opposite side is the same statement of the weakness of grammatical generalizations for many students. It is also clear that the children's experience and means of everyday use of language have a strong influence in school instruction. The question lies elsewhere: how has a situation of which *fundamental internal* difficulties in the children's mastery of school grammar are typical become possible? This question can be answered if two general features that emanate from all of the materials cited are taken into consideration.

First, the child who comes to school is *not introduced* to that unique school subject that is called "grammar." He does not develop a *new* attitude toward language which is specific to linguistics and that, from the outset, "suppresses" directly the everyday evaluation of linguistic phenomena. In other words, specifically grammatical abstraction – that is, a *theoretical* approach to language – is not developed or polished in the child. On the contrary – the teaching methods and the textbooks *preserve* (or, at least, destroy very slowly and uncertainly) the particularly empirical, everyday view of language, the particularly external and poorly realized techniques of analyzing it.[7] Typically, in the transition even in the upper grades to the systematic grammar course, some basic "flaws" in the original attitude toward language permit themselves to be felt, largely among a considerable number of students.[8]

Second, students in the primary grades do not form the original particular operations with language by which one can discover and establish the genuine object of grammar in it – *the relation between form and meaning.* Typically, although the children have difficulty doing so, they do single out two aspects – the formal and the semantic – in a word and in a sentence. But then many of them orient themselves sometimes toward one aspect, sometimes another, without establishing their necessary unity. Without a special delineation of this relationship as the particular object of analysis, a delineation done during the child's *initial* entry into grammar – this kind of unity – must then be established in every *particular* case. Therefore students independently use the means that is customary for them – semantic evaluation, and then return again and again, with the teacher's help, to an unstable connection of the two aspects. Children do not develop a *general* means of delineating and retaining the *relationship* of form and meaning itself. Hence the slipping into an orientation toward some one of its components and, finally, toward the most habitual one, reinforced by experience. This "one-sided analysis" is constantly reproduced both in the primary grades and in the upper grades (at first in morphology, then in syntax).[9]

These features of the design of an instructional subject and of the method of introducing the child to "knowledge" lead *naturally* to "weak grammatical abstraction," to a "departure from the grammatical method of thinking," to a "tendency to rely on the concrete meaning of speech" – that is, to the phenomena so often observed in students working with the traditional curriculum and methodology. In turn, they themselves here implement the attitudes of the theory of generalization and concept formation that were presented in detail above.

Thus, the attitude toward a continuity between the primary grades and preschool childhood is being carried out completely here, as is the attitude of having every possible use of the children's life experience in instruction. Ignorance of the specific nature of theoretical generalizations was reflected in the fact that children do not develop particular operations, in a deliberate way, of delineating and distinguishing grammatical categories, the relationship (unity) of form and meaning in language.[10] All of this leads inevitably in this instance to the students' retention of a pregrammatical approach to language and to a prolonged, persistent tendency to rely on its lexical attributes – that is, to the assortment of *negative* practical consequences that are described above.

The grammar course in the primary grades is regarded as particularly propaedeutic with a practical orientation. But, as we are seeing, this comes dearly for the *entire* system of language instruction in school. In essence, this sort of content and orientation is also preserved in disguised form in intermediate school. To ascertain this circumstance, it is very important to consider D. N. Bogoyavlenskii's position [38] on one, at first glance, particular question. It is known that a specific means of *identifying* linguistic phenomena – the *formulation of questions* – is prevalent in both the primary and upper grades. But, as Bogoyavlenskii stresses, so-called grammatical questions do not *indicate* attributes that enter into the content of *scientific* concepts. With the aid of questions one can, for example, properly group parts of speech *without knowing* grammar (see S. E Zhuihov's work [115]). But these questions are of practical importance in permitting classification of a word while avoiding the difficulties of semantic analysis and the inhibiting influence of vocabulary. The result here is *the same* as when using grammatical abstraction proper, which relies on a preliminary analysis of the semantic and formal aspects of language. This coincidence of results is possible by virtue of practical skill in coordinating the grammatical forms of question and answer (for verbs: "What is he *doing*?" "He is *writing*, he is *playing*, he is *sitting*," and so on).

Bogoyavlenskii believes that, from both a linguistic and a psychological standpoint, the use of questions *does not develop* an understanding of the peculiarities of the grammatical structure of language. Recognition of linguistic phenomena through questions is not founded on an understanding of grammatical principles. The forms of abstraction and generalization that are typical of grammatical thought (analysis of the relationship between the formal and the semantic aspects) are not practiced or realized here. At the same time, the very essence of grammatical phenomena is set aside. Theoretical study of the language is replaced by "practical grammar," which can be used, for instance, for orthographic purposes.

But in the instruction in the fundamentals of the *science* of language, which presupposes an awareness of the principles of language structure, the formulation of questions has merely a decidedly auxiliary and secondary significance. In ordinary school practice, however, this technique is universally implemented [38, p. 97].

The advisability of formulating questions is extensively discussed in the literature on the psychology of methods. The opponents (A. M. Peshkovskii [241], M. N. Peterson [239], V N. Zykin [130], among others) and defenders of this technique (V E. Gmurman [92] and others) are well known. Considerations about the need for a differentiated evaluation of the role of questions at different levels of instruction are expressed (I. R. Palei [237]). A. M. Orlova has recently defended the advisability of questions – when there is a proper differentiation of the methods of stating them [233]. S. E Zhuikov [114] notes the importance of questions at the propaedeutic stage of language study and at the same time their inhibiting influence on the grammatical abstraction processes in the subsequent mastery of grammar. In our opinion, D. N. Bogoyavlenskii's position is of the greatest interest. The problem is as follows: Are specifically grammatical principles learned with the aid of questions or not? He answers this question in the negative without in any way detracting from the auxiliary role of questions. However, if they do not lead to an understanding of the essence of language but merely serve as a means of empirically identifying phenomena, then this technique itself is internally related merely to "practical grammar," and not to the instructional subject that introduces students to the principles of language itself.

If it is taken into account that the statement of questions is universally implemented in all grades in school, then a purely *empirical* technique, which does not rely on an understanding of the essence of grammar and does not require specifically grammatical thinking, serves as the basic means of identifying linguistic phenomena for practical purposes there, as a result. Empirical generalizations and the empirical skills that depend on them are "operating" here. Grammar, in essence, is not functioning as a *theoretical* discipline here. These conclusions follow legitimately from the approach to the role of questions outlined by Bogoyavlenskii.

Advocating the need for students to be taught scientific grammar, Bogoyavlenskii rightly points out that the formation of grammatical *concepts* requires *special forms* of analysis and synthesis which lead to abstractions and generalizations, to an awareness of the interconnection of the two aspects of language [38, p. 97]. This requirement permits the conclusion that the forms of analysis and synthesis, abstraction and generalization, which are cultivated by the traditional curriculum and methodology do not correspond to the goals of teaching *scientific* grammar with broad educational objectives.[11]

Let us call attention to another fact. School grammar is centered around problems of identifying linguistic phenomena. The functions of abstraction, generalization, and the concept are also treated from the standpoint of the grouping of linguistic material.[12] The empirical theory of thought is certainly expressed consistently here. "Grammatical thought" comes down to classifying and identifying words and sentences of different types here.[13] The entire teaching technique is adapted to this purpose. But it is quite typical that it *does not deal with* these very problems. The students experience considerable difficulties in recognizing linguistic phenomena, constantly confusing them.[14] The aforementioned materials indicate the basic reason for this confusion – grammatical facts cannot be defined unambiguously without delineation of the specifically grammatical objective of analysis, without a *theoretical* understanding of the relationship between form and meaning and its particular manifestations. But this sort of understanding and objective are not developed in school (particularly in the primary grades) in any systematic and purposeful way.[15] The children are accustomed to differentiating linguistic facts according to more or less *external* features which belong to large groups of facts but do not rule out certain phenomena of another kind. These differentiations become increasingly subtle but at the same time unstable as well, since there is no single, simple principle behind them that permits external differences to be "ignored" as nonessential (in grammar, the delineation of the *formal* attributes of phenomena is such a principle).

Psychological studies have clearly established the sequence for the formation in students of the means of identification (we have cited a number of facts above when describing the results of children's identification of various grammatical facts). In generalized form it is represented, for example, by S. E Zhuikov when describing the steps in students' development of the concept of an "action," which underlies the delineation of verbs [114]. At first an *action* appears in the form of a moving object (no abstraction from the concrete object itself). Then an *action* in general is meant (there is an abstraction from the actor). Finally, the abstractly interpreted *action* is even correlated with an inactive object (some fifth graders describe the verb "to be inactive"[16] as a verb in fact, for it is the "action of an inactive person"). Clearly, with every step the range of possible mistakes in verb identification grows narrower, but the lexical meaning, which is *no guarantee* at all against errors, remains the basis for differentiation itself. The real means of classification is the use of formally grammatical attributes (for the verb structure this is the root meaning and the meanings of number, tense, person, mood, aspect, and voice).[17] But their system is *not used* in identification. Zhuikov notes: "In the ordinary teaching method, the students seldom use the formally grammatical attributes of a verb in the process of identifying it as a part of speech" [114, p. 103]. The lack of a single theoretical classification principle is compensated for by the students' development of more or less subtle empirical criteria for recognition, which, in essence, cannot encompass grammatical facts in all of their singularity (these criteria can typically be extended in unrealized form even to certain formal properties of language [38], [114]). Therefore when particular "competitive" elements are included in the material, mistakes appear *again and again* in the recognition of certain phenomena.

Studies contain facts to indicate that students, in their identification analysis, do not use even the formally grammatical attributes that are known to them (we have cited appropriate facts above). This is fully explainable. In ordinary educational material the children encounter special, "provocative" cases comparatively seldom.[18] Its qualification can be managed according to the most customary empirical criteria, setting aside "cumbersome" formal attributes (thus, one can rely on questions or act in compliance with semantic analysis).[19] The practical task of identification ultimately leads to ignoring grammar as such. What is more – and this is important to bear in mind – in its "subtleties" it is meant, not for the narrow purposes of identification, but for the analysis of the principles governing language, the internal features of its structure (the identification is only a secondary feature). Clearly, when there is slow and poorly defined instruction in this sort of analysis, students do not see its real strength and begin ignoring its means, whether or not intentionally.

The child's empirical approach to linguistic material, which is cultivated by the purpose of the identification itself, is also manifested in the instances of "one-sidedness" in the analysis, which have become almost classic cases (we have described some of them above). Children consider the words *gray* and *grave* to be related, for they have the common part *gra*. They acknowledge only a combination of *three* letters to be the root, and only a *group* of words to be a sentence, and so on. And all of this is a completely natural method of grouping, since both before school and in school they are systematically taught to delineate similar external attributes of things as a basis for generalization. This initial principle of empirical theory, which is widely used in school practice, the child actively takes as a real means of orientation toward instructional material – particularly linguistic material. Moreover, he treats the latter *side-by-side* with arithmetic, geography, natural history, and other material. If he applies his means of grouping, for example, to cereals, we are not surprised for any reason. We are amazed only when it is applied to linguistic "matter."[20] Then we tell the child that it is impossible that way, for the *similarity* of the *real* meaning of the words, and the possibilities for varying the number of words and letters must still be taken into account. However, this "game" is no longer "by the rules," since the initial principle of generalization does not contain the idea of "the meaning" and "consideration of other attributes!" These features are pointed out to the child just as arbitrarily for considering future instances. The child is taken in again, since, as he takes meaning into account, he now no longer connects the words *watch* and *watchman* into a single group. The objects they designate are by no means similar. The child is again told that here it is still important to take account of the coincidence of letter groups, and there is also a certain "internal" similarity in meaning here. Both must be taken into account in their *relationship,* in a connection. Here adults, in essence, undermine the child's honestly perceived attitude of delineating the similar and only the similar: For they ask the child to combine the very dissimilar as well (for example, the object *table* and the action of *running*) if there is something of this one *relationship* in it. Adults themselves conceive of such a possibility but do not "wish" to teach children to know about this relationship in any open and consistent way – for this disrupts the goals and objectives of the propaedeutic course, presupposing a transition to the *theory* of the subject, which contradicts the canons and attitudes of "life and tradition." The child himself must overcome the contradiction and learn, from his own observations, to distinguish between situations that can be combined and those that cannot. Students do master this art – this is noted in the annals of psychological research – but over a long time, slowly, agonizingly, and at the constant risk of not recognizing what is as different as the sky and the earth, from the standpoint of theory.

On the other hand, the principle of empirical generalization is retained here since the "children themselves" are inclined to a formal unification of the objects.

Observations show that one of the main difficulties in mastering the grammatical analysis of language is the students' inclination to reproduce the semantic evaluation of each new phenomenon (we have cited examples above). But it is not difficult to notice that this tendency is supported and nourished by the entire *system* of instruction, which relies on the traditional *visual* principle. Didactics and methodology fight for visuality and the children's constant actualization of concrete conceptions as the bases of concepts. The entire style of studies, and particularly in the primary grades, the selection of material and illustrations appeals to the child's conceptions. In a certain form this principle also operates in school grammar.[21] Thus, A. M. Peshkovskii in his time believed that to master the root meanings of words the child should connect them with lively conceptions. Peshkovskii wrote as follows about the *root* of the word *village:* It "should be related as closely as possible with the so-called 'meaning' of the word – that is, in this case, with a picture of a number of cottages, barns, fences, a country road, hens and roosters, and so on" [241, pp. 65-66]. D. N. Bogoyavlenskii rightly points out that these are the ideas implemented in our school textbooks. [38, p. 94].

All of the facts about the varied negative influence of vocabulary on the mastery of grammar must be considered not only and not so much within the framework of language teaching itself as on the broader plane of application of the visual principle. The pressure, described by psychologists, of the everyday attitude toward language for grammatical concepts is implemented through the participation of the child's visual conceptions in an analysis which they in essence *contraindicate.* The nature of grammatical abstraction and generalization, from the very start – as Bogoyavlenskii rightly notes – presupposes an abstraction or departure from certain concrete conceptions that stand behind a word (in Bogoyavlenskii's terminology, this is "second-level abstraction"). Here, for example, the word "as an object of grammatical study is a group of particular morphological elements of language expressing abstract grammatical meanings" [38, p. 85]. The delineation of these elements and of their *abstract* meanings is the central goal of the very first steps in grammar.

Here the ordinary type of visuality can only be harmful. Visual conceptions, Bogoyavlenskii writes, which are related to the lexical meaning of words are in direct opposition to grammatical concepts and cannot be starting points in the process of forming them. Nevertheless, in pedagogical practice this circumstance is not taken into account at all ... The pictures that evoke visual conceptions, by riveting the students' attention to the lexical meaning of the whole word, act in the opposite direction from the operations needed in grammatical abstraction, in which one should abstract oneself from this meaning" [38, p. 94].[22] In our view, one of the main reasons for weakness in grammatical abstraction among students is indicated precisely and definitely here – and this reason is rooted in the initial attitudes of educational psychology and didactics, which implement the requirements of the empirical theory of abstraction and generalization.

Thus, application of this theory in the teaching of Russian leads in practice to a number of substantial negative consequences. First, the use of visuality that is easier to understand, constant reliance on conceptions, inhibits the children's formation of a specifically grammatical approach to linguistic phenomena and keeps the children at the stage of everyday conceptions of language. Second, reducing grammatical thought to mere identification of linguistic phenomena closes off the way for the children to study specifically grammatical principles or to master the concept of the essence of the grammatical structure of language.

Some Difficulties in Operating with Mathematical Material

In school instruction mathematics takes up considerable space, and educational psychology and didactics take part in designing it as a school subject. Treatment of the practical results of the mastery of this subject from the point of view that interests us can be a topic for broad studies at many levels, and these are a matter for the future.[23] We believe that in this work it is advisable to do this by using the example of the children's formation of a single mathematical concept that is nonetheless important – the concept of *number*, to which a particular section is especially devoted (see below). For the time being, however, we shall merely cite some facts to describe the features of mathematical generalizations in students.

It is known that problem solving presents particular difficulty for students in various grades. Instruction in techniques of analyzing the texts of problems, choosing operations, and in methods of computation in the primary grades, for example, occupies almost half of the time set aside for mathematics. In the textbooks there is a comparatively small number of *types* of problems, which are widely varied according to the external features of the subject matter, the category of the numbers, the particular features of connection among the quantities, and so on. The main purpose of the teacher's work is to use systematic solution of large series of problems of a certain type to impart to the children the ability to *identify* the type according to a series of attributes, for the purpose of applying the previously mastered technique of finding a result. There is classification of the types of conditions and of the solution techniques that are applied to them. On its basis some *new* problem is identified, then solved. But if identification does not occur (a problem of an *unknown* type), there is no solution either – or, more correctly, the series of these problems, solved with the teacher's help, leads to the concept of a new type of problem. M. V Pototskii describes this school situation in this way: "Too often we teach the classification of problems instead of teaching how to solve them at once. Who is not familiar with the declaration that is typical of many students, made when encountering a new problem: 'We haven't solved problems of this kind.' As if they must be able to solve only problems that have already been solved at some time or other!" [257, p. 142].

Many students have a poorly developed ability to analyze problems which they have not yet encountered in their educational experience but for which they have all of the necessary knowledge.[24] But this past experience, the accumulated skills, are brought to bear only in situations that are immediately identified as familiar ones. Research by V. L. Yaroshchuk. involved a special study of the peculiarities of students' mental activity in solving typical arithmetic problems [362]. There are quite typical numeric data in this research. Thus, ten problems apiece were presented to 20 fourth graders – that is, they were required to give a total of 200 solutions. The results were as follows. In 124 cases the problems were subsumed under a type (that is, identified as previously solved by a certain technique) and correctly solved. In 16 cases they were still unsolved when the problem type was identified. In 5 cases the problems were solved without identifying their type. And in the other 55 cases the absence of subsuming under a type was combined with the absence of a solution. Thus, an obvious connection between the solution of problems and the preliminary identification of their type was outlined here, and, on the other hand, the absence of subsuming under a type in only 5 instances out of 60 was accompanied by solution of the problems. As we can see, the percentage is not large (around 8.5%).

The same study made a comparison of the solution of story and number problems (problems of one type were compared which required the same solution, such as: "304 notebooks must be distributed between two classes so that one class receives 16 more notebooks that the other" and "Divide 299 into two numbers so that the second is 19 greater than the first"). Of 100 story problems, 81 problems were subsumed under a type and 73 were solved. Of 100 number problems – 59 and 56, respectively. Since every subject solved problems of both types, some students (22 of them) subsumed the story problems under a type more easily, while 17 who solved the story problem were unable to solve the analogous number problem.[25] There are materials in the work to indicate that the smaller number of instances of solving number problems is related to greater difficulties in subsuming them under a type than for story problems. V. L. Yaroshchuk also cites data to show that in a story problem the children *conceptualize* the specific objects discussed there in one way or another – and this makes it easier for them to perform the operations of subsuming under a type. Some subjects were able to do this, as soon as they made the abstract numbers concrete, independently or with the investigator's help, connecting them with certain objects.

The quantitative indicators cited in this work are certainly related to the specific conditions of instruction, which affect the students' preparation. Apparently, these figures will change for other groups of students in other grades. However, in our opinion, a definite tendency, which is directly or indirectly confirmed by other studies and observations, is expressed here, all the same. Thus, A. V Skripchenko, who studied the effectiveness of teaching primary-grade students to solve problems, notes that “if a problem does not fit one of the types of problems that are known to the students, they prove to be unable to solve it. Consequently, the recollection and reproduction of a solution method is central here, rather than independently finding a way to solve a new problem” [292, p. 85]. A. Ya. Khinchin cites some interesting opinions of teachers in one of his articles in the late 1930s. He writes:

> Once I had to find out from a number of good fifth-grade teachers about approximately what percentage of students actually learn to solve arithmetic problems that are not simple computation examples – that is, ones where the method of solution, no matter how simple it is, is to be found by the student himself ... To reach the point where a student finds the solution to a problem of a new type, even though it is a very simple type, on his own – this, in the unanimous opinion of the teachers, is a matter that is successful only in very exceptional cases [323, pp. 161-162].

Thus, students, particularly younger ones, basically are altogether successful at solving only problems of a type that is known to them, whose preliminary identification is the principal condition for reproducing a previously mastered, specific method of solution. For all of the complexity of this activity in itself, it does not extend beyond the limits *of classificational*, empirical thought.

Success in solutions also depends on the extent of the concretization of a problem’s conditions, on the potential for their visual expression and conception. Thus, N. A. Menchinskaya points out that skill in visually conceptualizing a problem’s content plays a *decisive* role in establishing the necessary correlations. “Every teacher knows that when a student cannot solve a problem, it is sufficient to change its theme, making it closer to the child’s experience, as success in the solution is assured” [207, p. 358].

According to this sort of “natural experience” on the teachers’ part and according to the traditional visual principle, many methods manuals recommend illustrating problem texts with pictures depicting certain objects discussed in problems (see, for example, the pictures recommended in M. M. Topor’s book [305]).

To be sure, children need pictures, but the question is of *what* to depict and *how, what* to single out and emphasize in them, and *how.* Since the connections or relationships among quantities emerge as the object of the children’s operations in problem solving, it is *these relationships* that clearly should be singled out for first place and be represented in symbolic form (graphically, with letter symbols, etc.). N. A. Menchinskaya notes that, along with the technique of concretization, the technique of abstracting should be applied in school, too, where the story aspects of a problem[26] are left out and the mathematical relationships are revealed.

Menchinskaya writes: “Up to now very little attention has been paid in the methods manuals to this aspect of the reinterpretation of a problem” [207, p. 359].

And, to be sure, this is not an accident. Strictly following the principle of “relying on conceptions,” methodologists basically apply the “technique of concretization,” focusing the children’s attention on specific features of a problem’s conditions. As M. E. Botsmanova has shown in making a special analysis of all types of visuality that are applied in solving arithmetic problems, most visuality is purely *illustrative* and *external*, refining the children’s conceptions of the objects treated in the text [46]. It is entirely natural that when there is a systematic use of this visuality over many years, children who have been confronted with a “difficult problem” actually require that its subject-matter and objects approximate their *own personal* experience – this helps them to *conceive* of the problem’s content.

The children’s timely and proper transition from relying on natural visuality to skill to orienting themselves in the relationships among the quantities and numbers themselves (to “abstract relationships”) is an important condition for entering mathematics. However, in practice, children are held too long at the level of conceptions of real objects around them and of aggregates of these, which inhibits the formation of specifically mathematical concepts. This feature of ordinary instruction, as well as an opinion on its genuine goals, is distinctly expressed in the following views of J. Dieudonne:

> In our times we are inclined, particularly among teachers .... to contrive to disguise or to diminish the abstract character of mathematics as long as possible.

> This, in my opinion, is a great error. Of course, it is not a matter of confronting the children with very abstract concepts from the very beginning but of their mastery of these concepts in proportion to their mental development and of mathematics' being presented in its true form. ..." [258, p. 41].

Dieudonne believes that children must *candidly* be shown the abstract essence of mathematics, that they must cultivate a capacity for abstraction – for using its *theoretical* power.

In practical work, however, there is a much more frequent reliance on established principles in educational psychology, according to which there can be extensive use of the "technique of concretization" and an ignoring of the "technique of abstraction" (if these terms are used).[27] This is ultimately a consequence of the traditional interpretation of the conditions of generalization.

Here we need to consider a very interesting question that has arisen recently in psychology on the basis of a systematic study of the features of mental activity for students who have different abilities in the mastery of mathematics. Relying on experimental data, V. A. Krutetskii has singled out *two fundamentally different* ways to generalize mathematical material which are observed in students:

> Along with the method of gradual generalization of mathematical material on the basis of variations in a diversity of particular cases (the method for most students), there is another way, in which able students, without comparing the "similar," without special exercises or hints from the teacher, independently generalize mathematical objects, relations, and operations "on the spot," on the basis of an analysis of just *one* phenomenon in a series of similar phenomena [174, pp. 261- 262].

Krutetskii links the isolation and description of the first way to generalize with the works of many psychologists:

> In Soviet psychology the position has been taken that any generalization, including a mathematical one, relies on the comparison of particular cases and the gradual isolation of the general, with a broad variation of irrelevant features being assured, while the relevant features remain constant [174, p. 261].

Here there is an altogether correct citation of the basic theses about the conditions for this kind of generalization which has been formulated most distinctly in works by a group of our psychologists (N. A. Menchinskaya, D. N. Bogoyavlenskii, E. N. Kabanova-Meller, Z. I. Kalmykova, V I. Zykova, and others).[28]

Actually, this sort of characterization of the *necessary conditions for any generalization* is widely represented in educational psychology (we have presented this fact in detail in Chapter 1). To be sure, both the scheme for this sort of generalization and its absolutization, the transfer to all instances of the formation of generalization, have their nearest sources in empirical associationist psychology, which has itself relied on traditional formal logic and the empirical sensationalist theory of generalization (these are circumstances we have treated in Chapters 2 and 3). In the previous exposition of the problem we also established that this scheme explains the formation of empirical generalizations and concepts alone, but it cannot be made absolute – cannot be attributed to any generalization, particularly to a *theoretical* one.[29]

At present there are *experimental* data to describe the different methods of generalization.[30] V. A. Krutetskii correlates his own materials with the known theses about generalization and writes:

> All of these positions are completely correct. They have been confirmed in our *work* with average and incapable students, but they apparently cannot be attributed to all students or regarded as the necessary condition for mathematical generalization.[31]

And then: "The method of gradual generalization is not the only way to a mastery of general knowledge about mathematics. . ." [174, p. 261].

Thus, the empirical way of generalizing is typical of the mental activity of children who are of average abilities and relatively incapable in mathematics, who make up the *majority* of the students. The specific features of the thought of these students, which are detected during the generalization of mathematical material, have been described in detail in Krutetskii's book [174, pp. 237-263]. We shall delineate only some of them.

Let us give a brief description of the methodology of Krutetskii's study. Special tests (observations during lessons, an appraisal of the results of special written tests, an assessment of progress in school, etc.) were used to delineate groups of students in grades 6 and 7 who had differing abilities for learning school mathematics. The tests, which were oriented toward disclosing the peculiarities of generalization, involved the participation of 96 individuals (for Series V, VI, VII, and IX). Four of them were very capable (VC), 33 were capable (C), 37 were average (A), and 22 were relatively incapable (I). Every subject solved a system of assignments that were broken down into definite series, on an individual basis (in addition to studying the capacity for generalization, there were other series for studying the ability to curtail reasoning, flexibility in thought, and so on).

Thus, Series V was meant for students who were not yet familiar with the formulas for short multiplication. In the beginning they were helped by the investigator in becoming familiar with one of these formulas and used elementary examples to learn its mathematical meaning. Then they were presented with a formula that was extremely far-removed from the original one (see below – Assignment No. 8). Whether the subject recognized the square of a sum in the expression was determined. If that recognition did not occur, Assignments 1, 2, 3, etc., were introduced sequentially, with Assignment 8 being presented again after each of them.[32] One could therefore find out when – after which assignment in the series – the most difficult assignment was solved. All assignments were as follows, in order of increasing complexity:

1. $(a + b)^2=$
2. $(1 + a^3b^2)^2 =$
3. $(-5x + 0.6xy^2)^2 =$
4. $(3x – 6 y)^2 =$
5. $(m + x + b)^2 =$
6. $(4x + y^3 – a)^2 =$
7. $51^2 =$
8. $(C + D + E)(E + C + D) =$

This series was for the study of the way in which entities are subsumed under a concept that has just been formed at base, the transfer of a developed method into similar conditions. The extent of the development of the ability to generalize can be judged by how much the student sees in common in different problems and to what extent he can move from simple assignments to complex ones.

The tests in Series VI (6 arithmetic problems and 1 geometric text) required that the subjects have skill in bringing together externally dissimilar problems (but ones that were essentially of a single type) and in differentiating similar problems (but of a different type) from them. Here they had to make an independent generalization of several phenomena, to develop a concept of problem type (we will not cite the texts of the problems – see [174, pp. 119-123]).

The tests in Series VII included the solution of problems with a gradual transformation of the data – from concrete (numeric) to abstract (letter) data. At first the subjects were asked to solve a problem with only letter data. If a subject could not manage to do so, he was given a problem in which some data were concretely numeric, and so forth [174, pp. 123-125]. Whether a student solved a problem on an abstract level right away or whether a gradual transition was needed was ascertained here.

Series IX required a system of proofs of a single type but of increasing complexity to be carried out (two algebraic, one geometric, and one logical proof). In these cases the ability to generalize the method of reasoning, to transfer a learned principle to the solution of similar but increasingly complex problems was disclosed [174, pp. 127-130].

All of these tests disclosed certain characteristic features of the mental activity of the subjects in the different groups. Thus, the *incapable* students generalized the material with considerable effort. Transitions from one level to another required help from the investigator. Reinforcement at each of the levels occurred after a considerable number of exercises, in which trials and errors were observed. For example, anywhere between 8 and 12 exercises of the type $x^2 . x^3 = x^5$ were required in order to work the example $x^n . x^m$. The problems of one type had to be similar enough for the students to combine them into a single type. They had difficulty abstracting themselves from concrete numeric expressions and only gradually passed to solving problems with letter data. It was hard for them to understand the essence of a geometric proof, which is that a proof for one particular case – a specific figure – indicates that all analogous cases have been proved. An unaccustomed or unusual representation of a figure disorganized these students, who then could no longer prove a theorem that was known to them.

The *average* students approached generalization through the solution of examples in which the nonessential attributes varied. Thus, they approached the solution of Assignment No. 8 in Series V gradually and sequentially. They did not always find the common-type similarity in externally different problems on their own, but did so successfully with help from the investigator. To attribute problems to a single type, as a rule, it was not enough for them merely to analyze their structure. Only after first having solved the problems and then having compared the courses of the solutions did they attribute them to a single type. They passed from simple to complex proof by intermediate stages.

The *capable* students had quite different generalization features. After a first acquaintance or one solution of an example on the "square of a sum" they solved all of the other examples freely, starting from the most remote one, easily singling out the common type in them (Series V). In the tests in Series VI, it was only on the basis of a preliminary analysis of the structures of the problems that they found their type similarity rapidly. They found the differences in externally similar but mathematically different problems just as easily. They became aware of the type of proof, as a rule, after solving just the first problem – that is, "on the spot" (Series IX). Confronting a specific problem, they primarily tried to discover its "essence," to distinguish the main lines by abstracting themselves from its particular features – from its concrete form. "Thus, in solving the first concrete problem of a given type, they – if one can so express it – were thereby solving all problems of that type" [174, pp. 247-248]. The mode of the mental activity of capable students differs qualitatively from the solution of problems by other children. The capable students carefully analyzed the very first concrete problem, striving to delineate the internal connection among its conditions (this is peculiar to theoretical generalization). Typically, these students' ability to generalize solution methods, their principles of approaching the problems, affects their high effectiveness in solving atypical, nonstandard mathematical problems.[33]

Krutetskii singles out the following four levels of generalization on the basis of the experimental materials:

> 1) students who cannot generalize material according to essential attributes, even with help from the investigator and after intermediate practice exercises of a single type;
>
> 2) students who can generalize material according to essential attributes under the conditions indicated in (1) but who make particular errors;
>
> 3) student who generalize material according to essential attributes on their own, but after several exercises and with insignificant errors (an error-free generalization arises when there are insignificant hints or leading questions);
>
> 4) students who independently generalize material correctly and immediately, "on the spot" (without training in solving problems of a single type).

According to the peculiarities of the solution of problems in these series indicated above, the subjects in each group were attributed to a certain level of generalization. The summary data are shown in Table 4 [174, p. 178].

Table 4. Grouping of Subjects by Levels of Generalization of Mathematical Material (as a % of the Total Number in the Group)

Group	Series	Level of Generalization			
		1	2	3	4
VC	V			25.0	75.0

	VI			–	100.0
	VII	-		–	100.0
	IX			25.0	75.0
C				30.3	69.7
	VI			27.3	72.7
	VII			1.2	78.8
	IX			24.2	75.8
A	V		73.0	27.0	
	VI		59.5	40.5	
	VII		45.9	54.1	
	IX		64.9	35.1	
I	V	100.0	-		
	VI	86.4	13.6		
	VII	77.3	22.7		
	IX	95.4	4.6		

Translator’s Note: Adapted from [174, p. 225].

Thus, the second level of generalization is typical of many students who are average in their abilities, but only level 1 is typical of most incapable students. None of the children in these groups solved the problems in any series at level 4 – that is, by “on the spot” generalization, which underlies the solution of nonstandard, atypical problems.

Let us turn our attention to the distribution of students in the A and I groups in Series VII, where the potential for passing from solving problems with numeric data to solving problems with letters was verified. On the one hand, it is in this series that the largest number of students did the assignments at the third and second levels of generalization (the “ceiling” for the respective groups) in both groups. This was disclosed particularly distinctly in the A group, where more than half of the students worked at level 3. This indicates that these sixth graders had more or less mastered the use of letter symbols, which are introduced with the principles of algebra. On the other hand, other figures are indicative along with this. Thus, 45.9% of the students in the A group did the assignments in Series VII at the second level of generalization – that is, with the investigator’s help and by gradually eliminating the numeric data. In the “incapable” group, however, 77.3% of the students (level 1) were unable to do the assignments with some letter data.

In other words, a significant number of sixth graders had trouble working on the level of letter symbols (“on an abstract level”) or did not work on that level at all, although the principles of algebra had already been introduced according to the curriculum. Krutetskii also writes directly about this, describing the features of the mental activity of average and incapable students:

> It was always very hard for our students to abstract themselves from concrete numerical expressions. Our students had difficulty (some more, others less, but all had difficulty!) understanding the very essence of algebra, which is an operation with numerical abstractions. It was hard for them to understand that letters in algebra are numbers deprived of their concrete expression... [174, pp. 253-254].[34]

As was noted above, some of the fourth graders had difficulty operating with abstract numbers – they had to imagine concrete objects. Some sixth graders (and, apparently, no small number) had trouble abstracting themselves from concrete numeric expressions in passing to letter symbols. Here a single line of difficulties experienced by children at different levels of instruction is sketched, when there is a need to use means of expressing a quantity *abstractly* to allow the designation of *any* collections of concrete objects (abstract numbers) and *any* concrete numbers (letter symbols). Is not this sort of protracted tendency to “rely on concreteness” by the students a direct consequence of the teaching methodology itself, which is based on the traditional theory of generalization?

Every stage of abstraction here relies on a large number of variable conceptions or particular cases and emerges as the result of a gradual delineation of what is similar or common in them. An understanding of this general element presupposes a repeated treatment of similar conceptions. Thus, children are obliged to be dealing constantly with concrete material even when they have apparently singled out what is general. For this general element must be illustrated; moreover, a particular feature that must be varied can always be found in the material. The students do not sense a clear-cut distinction between the concrete and the abstract. This boundary is made all the more elusive as the substance of the abstract and operation with it can also be reproduced directly in concrete material (the *number* 10 can be divided, but 10 *objects* can also be divided). In such situations it is difficult for the child to master the specific nature of an abstraction, the qualitative peculiarities of operation with it. Do not these circumstances objectively urge teachers possibly to short change to a great extent the abstract nature of mathematics, to bring about the “contrived masking” of it as indicated by J. Dieudonne?

Because the fourth grader is constantly finding himself in situations dictating such a method of learning, he might not grasp the qualitative uniqueness of abstract numbers, and the sixth grader might not understand the meaning of letter symbols.

A comparatively small group of students was studied in Krutetskii’s work (earlier we described materials pertaining to 96 sixth graders and seventh graders; but this work studied a total of 192 individuals from the age of 6 to 10th grade [174]. Studies of much larger groups of children are needed in order to reveal more precisely the basic distributions for groups according to certain levels of generalization (the criteria for these levels themselves require particular substantiation). However, in our opinion, the existing data indicate certain typical features in the generalization of mathematical material that are inherent in particular categories of students. There are grounds for thinking that the empirical approach to material that is typical of the first and second levels of generalization is one of the sources of the many difficulties experienced by students of average or low-capacity abilities in learning.

Studies in educational psychology show that a knowledge of mathematics, as well as a knowledge of anything else, is mastered slowly and is weakly transferred to new conditions if students are unable to find internal generality among externally similar things and phenomena. They single out even an external similarity by many exercises of one type when the details in the material are varied, and they are inclined to repeat stereotyped operations in well-known situations that merely require identification.

Psychologists have repeatedly observed the facts concerning “on the spot” generalization but have not attached the proper theoretical significance to them (how else to explain the small amount of research devoted to making a special study of them?).[35] These facts go beyond the framework of the established views on the formation of *any* generalization and on its *necessary* conditions. They also break down the habitual methods of organizing learning. Of course, the comparatively small number of children who have the “gift” for this kind of generalization allows it to be classed among the phenomena of “special abilities” or “giftedness,” while the school, basically, teaches *ordinary* children. But it is all the more important to study the mechanisms of the functioning of generalization of a special type, as well as the conditions of its formation among able students. In addition, it is important to try to have a more profound grasp of the internal preconditions for the formation of the ordinary method of generalization in the majority of the other students. These studies, in time, will permit the design of a kind of instruction that, on the one hand, will actively develop in children the most productive types and levels of generalization and, on the other hand, will constantly depend on them in all of the processes of organizing learning.

Features of the Traditional Method of Forming Children’s Concept of Number

Along with a general description of the mastery of school material in mathematics, it is advisable to consider the features of the students’ formation of some *one* concept. We have singled out for this purpose such an important mathematical concept as the concept of *number,* which begins the child's entry into school mathematics and which keeps its purpose throughout the mastery of mathematics in school. With this example we shall attempt to discover the details of the application of the empirical theory of generalization in the actual development of students' concepts.

Let us consider the method of familiarizing the first-grade child with number in the textbook by A. S. Pchelko and G. B. Polyak, which has long been in use in our schools, and in the corresponding methods manuals [252], [266], [267].[36]

At first the teacher establishes the scope of the information in arithmetic that the children have obtained before school: a knowledge of the number sequence, skill in counting groups of objects and in estimating result in counting. Of course, the preschool child's experience is rather multifaceted – particularly when it comes to estimating mathematical relationships.[37] But the teacher discloses only those aspects of his experience that are directly connected with counting, for it is with this that the child's entry into mathematics begins.[38]

The textbook opens with the topic called "The First Ten Numbers." First an assignment is given on distinguishing between balls and pencils according to volume and length ("more-less," "longer-shorter"). On the next two pages the child encounters problems requiring him to establish a correspondence between collections of real objects (children, trees, cucumbers) and collections of sticks or circles: "Show as many sticks as trees in the picture," "Put down as many circles as there are cucumbers in the picture" [267, pp. 4-5]. In doing these assignments, the child learns to *single out* particular objects from groups of them and to equate this group with a set of special "standard units" such as sticks or circles ("as many" of them are put down "as" the objects that have been singled out).

The next step is for the children to become familiar with concrete numbers, beginning with "one." On page 7 of the textbook [267] there is a picture of a boy, a little further down there is a mushroom, then a squirrel and a hedgehog, and alongside them a particular bead on the wire of an abacus and a particular dot (a "number configuration"). All of these are designated by the numeral "l."

The number "two" is given on the next page. Here there are pictures of boys, a pair of boot-skates, a pair of skis, a bicycle, pairs of sticks, beads, and dots. Alongside there is the numeral "2."

The other numbers up to "ten" are given in a similar way – only the specific objects change, but their sets coincide with the sets of beads and dots in the configurations, according to the number of individual items. In studying each number the child must form it by connecting one unit to the preceding number studied before, as well as

> considering the natural groups of objects that are characterized by the given number: for example, in studying the number "four" he should be considering four legs on a chair or table, four legs on a horse, a cat, etc., four dots in the number configuration, four panes in the window frame. This will be the first level in the abstracting of number, the delineation of its *identical quantitative aspect* in various groupings of the number [266, p. 146].

Then the child learns to do direct and reverse counting (he masters the sequence of verbal designations for the numbers), finds out the relationships among the numbers ("Five is greater than four but less than six"), becomes familiar with the composition of the given number ("Six is two, and two, and two more"), and learns to write the numerals.

This is the general design of the work that is presented in the textbook. It is implemented in teaching practice on the basis of certain methodological techniques. We shall point out the basic ones. The teacher sets up assignments in doing which the children themselves create certain groups of objects by adding them one by one (one *unit* at a time). If "one" more chair is added on to "two" chairs, a row of "three" chairs is obtained. In doing these exercises using various objects, the child comes to a general rule: when another "unit" is added to "two ... .. three" is obtained; another "unit" yields "four," and so on. The names "two," "three," and the rest are given for all of the group as *a whole*. With each number name, the child should develop a proper conception of the group of objects designated by that number. For this purpose it is important to ask the children this question: "How many objects were obtained?" as soon as they make a group. The answer – the number's name – is *associated* with that group.

> From this, the name of the new number gets an altogether definite and concrete content. The size of the number is made concrete through the size of the collection of objects whose designation it is [266, p. 144].

Here it is important for the children to keep in mind the group of objects as a whole. Counting aloud helps (counting claps or strokes), where every sound vanishes and if there is a mistake it is impossible to start counting from the start, as is possible when a row of objects can be counted and recounted. The child gets the clearest and most correct conception of number when the group is given in an easily visible form. This is aided by the use of assorted number configurations that are used to form visual numeric conceptions. For example, the textbook shows a collection of objects, a number configuration to correspond to it, and the numeral that is associated with them, designating the number "four" [266, p. 148]. The number configurations "are a means of forming concrete conceptions about numbers" [266, p. 145]. They assist in mastering the relationships between numbers (every successive number is *larger than* its predecessor, and so on).

The following internal features are typical of this scheme for familiarizing the child with number. In *comparing* many things having different qualities, the child singles out something similar or common in them – there turns out to be a *separateness* of every object from another, a certain spatial or temporal restrictedness about them. There is an *individual* object – and each object contains this sort of *externally perceptible* individuality or separateness. If this separateness is singled out and detached from the other properties of an object (and this is just what occurs when the students' thought gradually passes from the "real boy" through the "real mushroom" to any *one* stick), we obtain a *unit.* Every *individual object* is a unit. A group of objects is a *set* of units (a collection of "individuals"). Above all, the child learns to single out in any observed object this peculiarity it has of being a separate entity, and of approaching groups of objects only as sets of units. In this way an abstraction of quantity is formed. The child's skill in discovering a certain quantity of units in any objects ("boys," "wheels," "sticks," etc.) and in designating it by a number indicates the presence of a *concept* of that quantity, that number. In this way the concept of the number "one," of the number "two," and so on, is formed.

As is emphasized in one methods manual [266, pp. 144-145], the content of every such concept should be visually conceivable for the child – behind every concrete number word there should stand a notion of an appropriate collection of objects. Since these can be any objects, the notions can best be developed by using special "number configurations" consisting of easily seen "dots."

An important step in forming the concept of number is being "freed" from its visual supports. How does this become possible? Unfortunately, the textbooks, methodologies, and works on psychology do not give a definite answer to this question. In essence, everything comes down to the fact that children begin *memorizing* the verbally expressed results of the operations of *adding* and *subtracting*, with which they become familiar after counting: "One and one is two, two and one is three; one and two is three," and so on [266, pp. 147-149].

In the previous chapters we have considered in detail the epistemological prerequisites of the empirical theory of generalization and concept formation. The established method of forming students' concept of *number* can serve as a highly typical illustration for what we have said.

Thus, the quantitative aspect of objects is delineated by *comparing* very different object groups and expresses their similar, formally common property – that of being a "group of individual things," the elements of which are not really connected with one another, do not depend on one another, and do not constitute a real unity. Every such element loses nothing if it is removed from the group and considered as an independent unit. The unity of such independent units is possible only in a concept, on a mental plane, in a "verbal system." As we can see, this approach to the concept of number, which is intrinsic to the traditional teaching methodology and its psychological substantiation, has a distinct and frankly expressed *nominalist* character.

The method of singling out a unit is that of abstracting and generalizing a sensorily given, external property such as its individuality or separateness. The content of the concept of a unit and of a set of units includes only that which was directly observed in the beginning. Even number relationships can be *contemplated* when operating with number configurations, for instance. The difference between a concept and a conception consists primarily in operating with number without visual means, in a "verbal system." The function of the concept involves a clear-cut differentiation of the different sets of units with a precision of up to one unit. The one-sided *sensationalist* attitude is clearly seen in this sort of interpretation of the sources of a concept, an interpretation that has been adopted in the methodology and psychology for teaching arithmetic.

Every set of units that is to be differentiated gets a particular *mark* on the verbal level; it is linked with the numeral word by association. To understand such a word means to have a clear conception of the concrete collection of objects. The term "association" here has precisely the meaning that is attached to it by adherents of the *associationist* nature of intellectual activity. If it is taken into account that associationist psychology has represented every abstract idea as the expression of what is similar or general in a group of sense impressions, then the connection between traditional methodology and this psychology can be interpreted as by no means accidental.

According to the conceptualism of this theory, the methodology lacks the task of forming in children the particular, specific operation that reveals to them the object of the concept of number (this operation is replaced by a formal comparison of groups of objects). As a special analysis shows (see its results in the series of our works [424], [4281, [429]), finding *the relationship of the multiple* for quantities where one of them is a *measure* for expressing the other is such an operation. The need to determine this kind of relationship and to record it in number form arises in a situation of mediated equalization of quantities [424]. Here the choice of a measure for counting or measurement that leads to a certain numeric description of the quantities depends on the existing situation, on common experience, and so on. In any event the measure ("unit") of counting or of measurement does not have to coincide with the individual object in its physical properties (this measure can be *composite*).

The relationship between one quantity and any other that is taken as a measure is recorded in the form of a number – that is, in the units of a standard grouping. Therefore the units included in a number do not coincide with the parts of an object that are singled out by the measure and that are able to consist of the elements proper. In the traditional methodology for familiarizing children with number the units of a number and the physical, individual objects are precisely what are identified. The child does not clearly differentiate between the counting object itself and the means of recording the result. This is an essential defect in the concept of number. It will show up when the child cannot count or measure using arbitrary measures specified in advance. Moreover, he will identify the elements of an object with the units of a number.

To check this hypothesis, we conducted an investigation of the features of the concept of number among first graders mastering it by the accepted methodology (in grade 1A the investigation took place from the end of January to the first half of February, and in grade 1B – from the end of February to the first half of March, 1961). The children freely added and subtracted the first ten numbers, were well oriented in constructing the number series (what number is 1 or 2 less than or greater than a specified one, and so forth), correctly and rapidly counted groups of objects (sticks, corn kernels, tables), and compared groups according to their numerical characteristics. The students were familiar with particular units of measure (the meter, the centimeter, the kilogram, the liter). They had already repeatedly observed instances of the use of these units to measure length, weight, and volume.[39] All of the students had a *thorough mastery* of the part of the curriculum that prescribes the scope of information needed for deliberate counting (according to the usual requirements for it) as well as for understanding the meaning of measurement.

Every student *individually* was to perform five assignments that were substantially different from the ones that he had done in class but that presupposed the use of the concept of number.

Assignment 1. The investigator gives the student a wood panel (50 cm) and asks him to bring a panel of the same length from another room. But it is impossible to bring the model with him – only a small stick (10 cm) can be taken. *Purpose of the assignment:* to find out whether the student is able to produce a mediated equalization through number.

Assignment 2. There are 12 blocks that have been divided into 4 parts lying on a table (three blocks in each part). The investigator asks: "How many are here?" without indicating the unit of counting ("row" or "block"). This assignment clarified whether the student had grasped the question's vagueness and whether he would require a specification ("How many of *what*?") or would himself choose a unit.

Assignment 3. The student is given a row of 20 blocks and a unit of counting is indicated – part of a row which consists of four blocks (it is demonstrated, but the number is not named): "How many of *these* are there here?" (The part of the blocks is detached and exhibited.) After counting and responding ("There are *five* of these here!"), the student does additional tasks: "Give me one of *these* five," "Make it one more (or less)." *Purpose of the assignment:* to discover skill in finding the relationship between an object and a counting unit given in advance (a "group element") and skill in singling out "one" when correlating part of an object and the unit.

Assignment 4. Two panels that have been combined (20 cm each) and a measure (10 cm) are shown to the student. The question: "How many of these (measures), in length, will go here (into the two panels)?" After the answer ("Four"), there are questions: "Where will these four (measures) go?", "What are the four (measures)?", "Show where *two* of these four (measures) will go." *Purpose of the assignment*: to discover skill in correlating a number with an object to be measured, through a measure that was used.

Assignment 5. A row of jars (two "big" ones and two "little" ones, each of which is equal to *half* of a "big" one) are put in front of the student. The investigator explains: "Two of these little jars will go into this big one" – this circumstance is demonstrated by pouring water. Then an assignment consisting of two parts is given: 1) "How many of *these* jars of water can be poured here (the whole row of jars is shown) (if the measure is the *little* jar)? You know that two of these little jars go into one big one," 2) "How many of *these* jars (the *big* jar is shown) will go here (the row is shown)?" *Purpose of the assignment*: to reveal the child's skill in using a unit that does not coincide with the particular elements in the series when counting.

These assignments were presented with material and in a form that "coaxed" the child to count the *particular* blocks (jars) and to identify the units in a standard grouping ("one") with an individual block (jar) To overcome these "coaxing" influences presupposes the ability to make a clear-cut connection between the question of "How many?" and an indication of the appropriate counting unit (measurement unit) and an ability to single out "one" in correlating part of an entity with the specified unit.

According to the performance of each assignment, we subdivided all of the subjects into three groups: 1) some students did the assignment independently and correctly at once, 2) others first did it incorrectly, but then, with a certain amount of help from the investigator, corrected their mistakes, 3) finally, still others did not manage the assignment, even with help from the investigator (leading questions, explanations of the situation, and the like). Table 5 shows the data on the number of students assigned to these groups during the performance of each assignment (28 in one class and 25 in the other).

Table 5.

Assignments	Number of subjects					
	Doing assignment independently		Making mistakes and doing with assignment investigator's help		Not doing assignment	
	1A	1B	1A	1B	1A	1B
1	7	2	12	21	9	8
2	7	5	4	3	17	17
3	6	7	13	16	9	2
4	13	15	10	9	5	1
5	8	12	11	12	9	1

Note: In Assignment 2 the subjects were divided into groups: 1) those requiring specification of the counting unit, 2) those immediately counting the groups of blocks, 3) those immediately counting the individual blocks.

The results for grade 1B, which was tested a month later, are better than the results for grade 1A (basically for the number of children getting help from the investigator). It is advisable to combine the data from the two grades for further consideration. A total of 265 assignments was received by all 53 students. Of these, 82 assignments (31%) were done independently and without mistakes, 111 (42%) were done with mistakes and with help from the investigator, and 72 (27%) were not done at all. Only 2 students did all five assignments independently and without mistakes, 1 student did four assignments in this way, 8 students did three assignments, 16 students each did two and one assignment, and 14 students were unable to do any assignment on their own. Thus, most of the subjects (42) either did not manage the assignments at all or could do only one or two of the five.[40]

The last three assignments (the third, fourth, and fifth) used relatively similar material and had similar goals (they differed somewhat from the first two assignments). Moreover, the "sharpest" conditions for singling out a unit were created in them. Let us cite the data on the performance of these three assignments separately. The subjects received 159 of these assignments. Of them, 61 assignments (38%) were done independently and without mistakes, 71 (45%) were done with mistakes and with help from the investigator, and 27 (17%) were not done at all. Nine students did all three of these assignments on their own and without mistakes, 5 students did two assignments, 21 did one assignment, and 18 did no assignment. Thus, most of the subjects (39 of them) either did not manage at all or did only one of these three assignments on their own.

The numeric data show that when performing these assignments, many first graders experienced significant difficulties. Of all of the five assignments, 31% were done independently and without mistakes, and 38% of the group of three assignments were done in this way. Only a small number of children did 5 or 4 assignments without mistake (of all five) and 3 or 2 assignments in the special group.

Let us briefly consider the features of the subjects' operations during the performance of the particular assignments and the character of the mistakes observed here (a detailed presentation of the appropriate materials is contained in another work of ours [424]). In doing the *first assignment* some of the subjects (9 persons of 53 in the two grades) measured the model panel with the small stick, and then found the other needed panel in the other room with the aid of the resulting number and the same stick. These children, in their account of the method of operation, as a rule, used the words "measured," "laid off," and the like. They evidently had a good understanding of the meaning of measurement, although their skills in this operation (in measuring length) were still only weakly developed. The children in the second group (33 of them), after receiving the assignment, immediately "darted off' and tried to find the needed panel by sight. The investigator pointed out the possibility of using the stick, but they paid no attention to this. Only after a number of leading questions or even a direct indication of the need to measure did these children use the stick as a unit of measure and obtain a certain number. Later, however, they often forgot to take the measuring device with them into the other room. Finally, the third group of children (11 persons) did not understand the point of the situation at all. And even after measuring the model panel – when the investigator directly requested this – these children did not know what to do next, how to apply the resulting number.

In the *second assignment* 12 persons asked the return question at once: "How many of what? Blocks?" and, having received confirmation, counted them. Seven others, without this retort question, counted the *groups* of blocks ("little lines," "little rows") immediately, from their own perception, and only with the investigator's help did they find another possible unit of counting. The other 34 immediately began counting the *individual* blocks without any hesitation, without "being put off" by the presence of clearly delineated rows.

In the *third assignment* almost all of the students made proper use of the indicated counting unit (the group of four blocks) and got the number "5." But then, at the request to "give one of *these* five" and to "make it one more"[41] only 13 persons first moved aside part of the row equal to the counting unit and then increased it by the same part (some called it a "pile" or a "little row"). For 29 persons in the second group there were mistakes initially. Three students, when singling out "one," immediately set aside the necessary number of blocks, but when increasing by "one" moved a *single* block to that part. Only with supplementary hints from the investigator: "Is that right? Of what did we have five?" – did they single out "one" in accord with the counting unit. Another 26 persons of these 29 set aside a single block from the very beginning.

Only with the investigator's help, who at times directly demonstrated the previously used counting unit, did these children begin to single out "one" properly in the conditions as presented. The third group of subjects (11 of them) made mistakes even with very persistent aid. These children singled out only a particular block, although the investigator clearly and repeatedly demonstrated the real counting unit to them.

In the *fourth assignment* all of the children did the measurement correctly and indicated both its object and the measure. Then, when requested to single out in the object the part equal to two measures, 28 persons immediately gave the investigator one of the panels (it was 20 cm, and the measure was 10 cm). Another 19 persons made a mistake at first – they brought both panels that made up the object of the measurement. But with the investigator's help in demonstrating the measure, they were able to do this assignment correctly. The other 6 still gave both of the panels at this request, even after a clear delineation of the fact that both panels contain four measures in length.

The *fifth assignment* was done independently and correctly by 20 students (the answers "six" and "three" were according to the counting units). Most of the children did the first part of the assignment (the unit was a small jar) by addition: "Here there are two, another two, another one and one – six." Almost all of these students did the second part of the assignment (the unit was a big jar) by relying on the notion of a "half": "Here there is one, here there is one, here there is a half, another half – three in all." Thus "one" was singled out here, not through a direct relationship to the counting unit, but in a roundabout way (and it was efficient). One subject still used the measure directly. He took the big jar in his hand and first applied it to each big one, then to the two small ones ("One, two,... three").

The second group of children (23 of them) did the first part of the assignment independently and correctly. Most of them acted as follows: they touched their fingers to the upper part of the big jar, then to the lower one ("One, two"), repeated the same thing on the second jar ("three, four") and finished counting with the little ones ("five, six"). But in the second part of the assignment they made a mistake – they took each small jar to be "one," like the big one (an answer of "four" instead of "three"). The investigator's help was needed and, for some students, quite essential so that they would take the two small jars as "one." Finally, the remaining 10 subjects were never able to do this assignment properly, although the investigator demonstrated to them several times that the big jar held two little jars of water.

Let us give a general summary of the execution of all of the assignments. For most of the children a situation requiring a mediated comparison was unexpected – and they were unable to resolve it on their own. Typically, only 12 students (of 53) grasped the vagueness of the question "How many?" But many children (34) immediately turned to counting *single* blocks, although the "little rows" were also clearly delineated in the material. All of the students operated freely with the counting unit consisting of several blocks, when it was "superimposed" *directly* on the row – here "one" meant the result of the correlation of this unit with part of the row (Assignment 3). However, 40 persons made a mistake in delineating "one" without this external "superimposition." For the number "one" they were oriented toward a *single* block, although they had just obtained the number "five," working with "group elements." A similar difficulty in singling out part of an object through comparing it with the unit of measure, and the number was observed in the fourth assignment as well (here 25 students made a mistake).

The results of the execution of the fifth assignment are of particular interest. All of the children operated freely with the measure that was equal to the small jar. They did not forget that a large jar was equal to two small ones. Many touched the large jar twice with their fingers in order to delineate its parts and designate them by numbers ("One, two").

But the situation changed substantially with a different measure: 33 students made a mistake in taking *each* small jar as "one," seeming to forget that a small jar was not equal to a big one. The *individual* elements in a row were again designated by numbers without correlation with the counting unit.

Thus, many of the first graders we investigated showed a distinct tendency to count only particular objects, to identify the units in a standard grouping ("one") with a particular object in the counted grouping itself, as well as difficulties in singling out the parts of the grouping through correlation with the actual unit of counting and measurement.[42]

These actual features of the concept of number which children form are a consequence of the basic aims of the teaching methodology that has been adopted, aims whose theoretical meaning has been considered above in detail. In situations requiring an understanding of the meaning of the unit of a standard grouping, many children did not take account of the circumstance that such a unit designates the *relationship* between any physical part of an object and any measure that has been specified in advance. At the same time it is this understanding that characterizes, in particular, the thoroughness of the child's orientation in quantitative relationships using numbers.

Typical Difficulties In Mastering Material in History and Certain Other Subjects

As has been shown above, some substantial difficulties in mastering the concepts of grammar and mathematics are internally related to a method of selecting and developing educational material which relies on the empirical theory of generalization. Apparently, in other instructional subjects as well, a more or less distinct expression of this connection can be discovered. It appears most clearly in the propaedeutic courses in the primary grades. But a number of materials show that its influence is also detected in more advanced grades, particularly in the work done by students of average or less-than-average abilities. In many psychological and educational studies there are facts to indicate difficulties in the mastery of concepts in *history*, *botany*, *geography*, etc., due to a protracted negative influence of the children's everyday experience and to the absence of internal criteria for coordinating the particular attributes of the concepts, leading to a confusion of them.

In a study by A. Z. Red'ko [268], [269], mastery of *historical* concepts by students in grades 5-7 was investigated. It was established that, in the first place, they master visually presented attributes of objects that are reflected by certain concepts. For example, in the concept of a "slave" there is an initial grasp of such attributes as heavy work (this is illustrated by pictures), a humiliating position in society, and only considerably later is such a significant attribute as the slave's attitude toward labor, which affects his low productivity, mastered. At the initial stages in the mastery of the concept there are combinations of attributes that are as random and particular or as general as possible, or both, but without an inner connection. Red'ko speaks figuratively of such concepts: "The concept either has only a base, or only a peak, or a peak and a base at the same time, but its 'middle' is empty" [268, p. 111]. These concepts are one-sided; their attributes are not ordered.[43] Only slowly and *gradually* do the children arrive at a delineation and proper coordination of the essential attributes. A protracted absence of such a systematization of attributes in most students occurs because the children do not yet proceed from the basic law explaining the development of society by the material conditions of its life and, above all, by the means of production. In grades 5 and 6 this law is not yet generally significant and essential; therefore the students explain many historical events by subjective causes. Surmounting explanations of this kind, delineating and systematizing the essential attributes of concepts becomes possible, as Red'ko stresses, "only at the level of high development of a concept of formations and mastery of the basic principles governing the development of human society" [268, p. 112].

Thus, as the students pass through a number of courses, they learn many assorted facts about particular historic phenomena and events, with these facts often poorly interrelated and not representing systematized knowledge, which leads to a confusion of the phenomena and to an improper explanation of the causes. These defects are overcome later on and only on the basis of a sufficiently profound mastery of the concepts of the principles governing the development of society.

These factual materials[44] enable the following question to be raised: To what category of knowledge can we attribute the historical facts that students in grades 5 and 6 have if they are not yet relying on basic scientific concepts in their thinking?

In our opinion, both in the method of their formation and in the resulting features these facts can be attributed to *empirical* concepts and descriptions. Their vital and developmental value is clear. They can be sufficiently correct, distinct, and clear – and still they can be knowledge about the external features and characteristics of historic phenomena.[45]

This knowledge often pertains to formally general, identical properties of many similar historic facts but does not express their genuine specificity, their qualitative uniqueness, which is particularly important for the conceptual level of cognition. This feature of empirical knowledge is well expressed in Red'ko's work:

> ... The students' delineation of the attributes of the concept of feudalism – oppression, servitude – is essentially an abstraction of them as a result of the fact that the students, as they studied the history of a number of nations, have perceived one attribute of the relationships among people that is common to them, at first still a very extensive attribute, with which it is still impossible to differentiate or distinguish one epoch from another, since there might be oppression under both a slave-holding system and a capitalistic one [268, p. 108].

Observations and special tests of the students' knowledge in the different grades indicate that an orientation toward external, similar but not specific features of phenomena is the source of many mistakes and superficial explanations. Here are a few examples. When asked: "Were the scribes slaves or slave-holders?" the fifth-graders answered: "The scribes were slave-holders, too, for slaves did not know how to read and write." When asked: "Were the overseers slaves or slave-holders?" answers of this type ensued: "The overseer was not a slave because the slave would not kill his comrades, but he is not as rich as a slave-holder" [173, p.84]. These answers are based on an assessment of purely *external* properties of "scribes," "slaves," and "slaveholders."

The fifth graders were to read an account of the staunch resistance by a Central Asian people (the Sogdians) to the troops of Alexander of Macedon, and to respond independently to this question: "Why did the Sogdians battle the Macedonians staunchly for a long time?" (The reasons for the struggle were not treated in the account.) The answers were as follows: "They were fighting for independence, but every country wants to be independent," "They loved their native land," and so on. As Red'ko notes, the students' knowledge about the ancient Greeks' struggle with the Persians, about the Russians' struggle with the Swedes, and so on, came into play here. Now, however, "accounts of events that are *similar in very general attributes* and remote from one another in time activated the students' knowledge about *analogous* causes of these events" [269, pp. 50-51] (emphasis ours – V. D.). Clearly, in the "very general attributes" and by the external analogy such an "explanation" is suitable for all historical epochs and peoples, without disclosing the distinctive nature of the causes and conditions of the struggle for independence by various peoples. However, history is called upon to make an analysis of this sort of uniqueness. Here is an example of a good student's response (eighth grade) when asked what a social class is: "... A class is ... people.... They act jointly, together... workers, say, were all working together, doing things together, fighting together. They have common interests .... But that isn't all, I think... They have the same material conditions .... A class is some people with common interests, and (they) live in the same material conditions" [269, p. 46]. A complex concept has been chosen for definition here. But a great deal has been said about it before eighth grade – and, for all that, even a good student has difficulty singling out a specific attribute of a class in its theoretical formulation. Red'ko points out that in such conditions the students usually turned to concrete illustrations [269, p. 46]. This is evidence of the difficulties experienced by the students even in the upper grades when moving on to work with concepts, to work on an abstract level.

Historical reality is highly complex, contradictory, and dynamic. Analyzing and explaining its particular events presupposes consideration of many factors in their internal interconnection, in their development. Here as nowhere else, there is a divergence of essence and phenomenon, internal and external, real and apparent. Cultivation of techniques in this kind of analysis, of skill in operating with historical concepts during the independent solution of historical questions is a protracted and complex matter, one that is apparently largely still poorly determined. As a study by G. E. Zalesskii has shown, even tenth graders have difficulty in analyzing historical events that are well known to them in general (for example, independently determining the real significance of certain events was possible for only 46 of 283 who were interrogated). Zalesskii writes: "Many students do not master the method of scientifically analyzing factual material, and therefore are guided in their independent evaluation of events chiefly by their senses, by an emotionally personal treatment of various historical events.

"As a result, in instances where the attitude toward an event does not coincide with its real significance, the students' assessment of the events proves erroneous" [119, p. 177]. Difficulties in forming theoretical thought in the realm of history have many causes. But some of them, insofar as can be judged by the facts cited above, are rooted in the protracted retention of the empirical level of mastery of historical knowledge that is typical of our schools.

Botany as a school subject presents students with material that is largely descriptive. A necessary condition for proper orientation in it is clarity in classifying and coordinating the attributes of plants. In learning botany, as is shown particularly in a study by E. M. Kudryavtseva, sixth graders make characteristic mistakes, the reason for which is a discrepancy between the habitual external similarity in any plants and the real basis for classifying them. Thus, some students do not attribute bamboo and reeds to grains, since a dissimilarity between their woody stem and the grassy stem of other grains is observed here. It is interesting that erroneous generalizations in the naming of parts of plants arise chiefly with respect to atypical parts whose external similarity does not correspond to their internal kinship. Students at times suppose that a root's main attribute is its occurrence in the ground. This attribute is visual and corresponds to the children's everyday practical experience (therefore, from their point of view, all of the parts of a plant that are underground are roots). A root's essential attributes – its structure and function – are much harder for them to master [178, pp. 192-194].

E. N. Kabanova-Meller has described the incorrect generalization developed by certain fifth graders when forming the geographic concept of a "watershed." There is a drawing in the textbook that is a model of a watershed. It shows a slight elevation from which rivers are flowing in two directions. The students relied on this model when learning the concept. Then they were asked the question: "Is the Central Caucasian mountain range a watershed?" The poorer students answered it negatively since, from their point of view, "a watershed is an elevation, but the Caucasus are large mountains." They relied on an elementary visual generalization that arose when considering a picture-model of a single type in which a nonessential attribute (a "slight elevation") was regarded as necessary [143, pp. 129-133].

Facts that are analogous in a psychological sense were found among sixth graders in forming geometric concepts (study by V. I. Zykova [131]). Thus, the teacher might give a verbal definition of a right triangle with respect to a specific variant of a drawing of it in which the right angle is at the base. Later on a number of students (20 of 36), when giving a proper definition of this triangle, did not find it in the drawing where the right angle is located on top (they called it acute). Thus, the particular position of the right angle in the drawing for them became the identifying attribute of triangles of this type. Similar facts were also found with respect to other concepts (for example, some students called only wavy-shaped curves "curved lines" and did not identify an arc-shaped curve as a curved line). These materials and other similar ones (see, for example, [301]) indicate that the thinking of sixth-grade students is still too riveted to visuality. They are inclined to correlate the attributes of verbal definitions only with the concrete figures that have occurred in their direct experience. Earlier we cited Krutetskii's data indicating that these "inclinations" are intrinsic, basically, to students who are average in mathematics and particularly to those who are mathematically inept.

The facts concerning erroneous generalizations of geographic and geometric material are interesting in disclosing the illegitimately large role of visual attributes even in the thinking of fifth graders and sixth graders. But another psychologically significant feature of these students' thinking is also found here. It is known that the method of considering and applying any representations, particularly drawings and diagrams, is essentially different from the real things. Drawings and diagrams (like other "models") have an altogether definite purpose of representing only certain aspects of real things – and these aspects are specified "in pure form." Therefore it is necessary to have a particular *cognitive relationship* to drawings and diagrams, special methods of "reading" them, in order to be able to see in them the "abstractions" represented, the symbols of concepts. In this instance the person inevitably abstracts himself from many specific material features of a drawing, paying no attention to them. Thus, a theorem can be proved if one has some "parallel lines" which actually – by sight – converge on the blackboard (a poor illustration). Many particulars are important for a real thing and for actual operation with it, but they can lose their significance when this thing is being represented and during cognitive operations with it.

The students who "took into account" the height of the elevation in the diagram of the watershed and the location of the right angle in the diagram of the triangle possessed, to be sure, excellent powers of observation, but did not understand the functions of representations, the functions of conventional diagrams and geometric drawings. They approached them as distinctive but nevertheless real objects in a series of other objects ("natural visuality"). If these students had been able to read diagrams and drawings, they would have singled out the *boundary* in the watershed, having mastered its abstract essence even though using an imperfect diagram, and they would have singled out only the *size* of the right angle in the right triangle. The way out for these students should consist in acquiring general methods of reading drawings as representations of spatial relationships, and not merely in observing a series of varied triangles. It should be observed that the introduction of geometric drawings in the primary grades is apparently not accompanied by the children's instruction in such methods – the drawings are given here as ordinary picture-copies of "real" triangles, squares, circles, etc. This tendency to "naturalize" symbolic visuality is also retained in the intermediate grades, which undoubtedly inhibits mastery of geometry (many students' thinking remains riveted to visuality).

In ending our survey of experimental materials, we consider it advisable to cite the results of R. G. Natadze's tests [220], which ascertain certain difficulties in concept formation among younger students. In some special experiments the children were made familiar with the essential attributes of mammals, fish, birds, and insects, then with the external appearance of their typical representatives. These attributes were memorized and reproduced precisely. Then the children received some pictures of animals that belonged to one concept in their external appearance but to another in essence (for example, pictures of a whale, a bat, etc.). They were to attribute them to some known class. Then they received assignments in which the animals were to be classified according to an indirect requirement (for example, they had to answer the question: "Which mammal is the strongest?"). The first graders identified the animals only by external appearance, without noticing that it might differ from the known essential attributes (*whale—fish*). The second graders likewise were primarily oriented toward external appearance, but with leading questions from the investigator were able to rely on known attributes in their classification. But in situations requiring classifying indirectly, they again proceeded from visual properties ("The strongest mammal is an elephant," rather than a whale). The third graders often tried to combine both series of attributes (*whale—mammalian—fish*). In grade 4 the students took essential attributes into account when directly classifying conflicting animals but often relied on external attributes in indirect assignments.

These materials show that students in the primary grades have a good grasp of the visually similar attributes of groups of objects. The essential attributes that are given in the verbal description of objects can be well known to the children, but if the grounds for classification diverge they orient themselves primarily to visual similarity, ignoring other important known facts.

Earlier we cited some examples of improper generalizations in botany that have been observed among sixth graders. In essence, they acted in the same way as did the younger students, orienting themselves, for example, only in a *visual* attribute (being found in the ground) when singling out roots and ignoring their genuine functions. Still earlier we described materials that indicate that students in grades 5 and 6 singled out the parts of a sentence in Russian assignments according to their immediate significance, "forgetting" certain attributes of formal grammar. Orientation toward random visual attributes is also encountered in working with geometry material. All of these data show that the method of resolving "conflict" situations that is observed in primary-grade students is not alien to a certain number of students in more advanced grades, either – ones who depend only on the external similarity of the objects and phenomena to be classified when solving certain problems.

5

The Absolutization of Rational-Empirical Thought in Educational Psychology and Didactics

The Detachment of School Instruction in Concepts from Their Origin

In the preceding chapters we described the basic consequences of the application of the empirical theory of generalization to the solution of some fundamental questions in educational psychology, didactics, and special methodologies. Concrete material was used to establish that in school practice this leads to a number of essential difficulties experienced by students in mastering grammar, mathematics, history, and other subjects. Now we must sum up the results of the treatment of the problem of generalization and include it in a broader context connected with the very nature of thought.

In the established system of instruction for children, the differences between nonessential, merely formally identical properties and the content-based general properties of the subjects that are studied often turn out to be hidden, undisclosed. This is found in a particularly clear-cut way in the teaching of grammar and history. We found an orientation toward the nonessential attributes of number (incidentally, very subtly "slipped beneath" an orientation toward its content-oriented properties) in first graders. In our opinion, these and other similar facts cannot be attributed to the results of shortcomings of individual teachers. Their reasons are included in the circumstance that traditional educational psychology and didactics, which proceed from the empirical theory of generalization, do not have the means for a clear-cut distinction between the identifying attributes of objects and their really essential properties. To solve many immediately practical problems, of course, it is sufficient to have a knowledge of the external identifying attributes of customary objects (for example, in spelling – distinguishing between word categories on the basis of "grammatical questions," in adding and subtracting abstract numbers – notions of number as a collection of "abstract units"). But for a theoretical understanding of the difference between objects one must rely on a knowledge of their essential properties, on the ability to observe the "conversion" of these properties into particular and external features. Thus, only a knowledge of the grammatical attributes of a word, as a unity of meaning and form, permits an unambiguous distinction, for example, in the parts of speech, and permits the word "running" to be consciously classed among substantives.

The identification of external identifying attributes with the content of a concept (this is a typical consequence of the narrowly sensationalist attitude) means that the concept's real object sources and preconditions remain unrevealed in instruction. The absolutization of comparison as a method of singling out general attributes (this is a direct consequence of conceptualism) is related to an ignorance, in instruction, of the specific operations by which children might discover, delineate, and establish the essential properties of objects. All of this impedes the students' detailed introduction both to the subject of the respective discipline and to the genuine content of the concepts that constitute it. As a result the students often do not obtain means for a properly grammatical, mathematical, historical, or any other approach to the corresponding aspects of reality, which, in turn, complicates the mastery of the concepts in a certain educational discipline.

With respect to mathematics, A. N. Kolmogorov has especially pointed out this circumstance:

> ... At different levels of instruction, with different levels of boldness, the same tendency appears unalterably: to have done with introducing numbers as soon as possible and then to speak only of numbers and the relationships between them....
>
> That the generally accepted system is imperfect from a pedagogical aspect is evident if only from the difficulties that arise in the students' mastery of the independence of the meaning of geometric and physical formulas on the choice of units of measure and the concept of "dimensionality" in geometric and physical formulas.

> The point, however, is not in the particular defects but in the fact that in school instruction the separation of mathematical concepts from their origin leads to a complete lack of principle and logical imperfection in the course [164, p. 10].

In the preceding chapter we have shown how the accepted teaching methodology for arithmetic strives to "have done with introducing numbers as soon as possible." The concept of numbers is given to the children in ready-made form without revealing its object content. Hence the difficulties in further mastery of mathematics, which, as a school subject, suffers from "lack of principle and logical imperfection."

These features, in essence, can describe the school grammar course, too, in which – as has been shown above – a tendency to ignore the specifically grammatical preconditions of concepts is also observed.

Other school courses – history, biology, and literature – suffer from similar deficiencies. In these disciplines an ignorance of the origin of concepts is one of the sources of an excessive descriptiveness in the instructional material, the intellectual work with which often amounts to children's mastery of classifications of phenomena and events, to their memorizing verbal descriptions and characterizations. This feature of the school biology course is noted, for example, by N. M. Verzilin:

> Students do not like biology because its content is descriptive, not providing material for deductions – that is, food for thought.... In all of the biological subjects in grades 5-9 the students are given very simplified scientific material, intended only for memorizing, rote-learning, without an understanding of the reasons or consequences, without broad generalizations [56, p. 25].

In the teaching of literature the disclosure to the students of the specific nature of the means of reflecting reality in literary artistry has primary significance. But, as the treatment of school curricula and methodologies shows, the approach to these means itself has a manifestly formal-logical character – it is merely a classification and description of literary phenomena, their distribution by rubrics. The teaching of literature has hardened at this level of "taking inventory," where the students, on the whole, are taught to speak only in "classifying language," without discovering a broad outlet to understanding the essence of literary form.

All of this is a consequence of the separation of the teaching of mathematical, grammatical, and other concepts from their origin – a separation that proceeds naturally from the aims of the empirical theory of generalization.[1]

At the same time it is well known that the overwhelming majority of modern works on educational psychology are aimed at the study of the "development of concepts," toward the revelation of the "origin from concepts of sensory data." Of what kind of "detachment" can we speak, then? Let us note the following. In the first place, the term "development" in many investigations is taken "on hire," as it were, losing its specific epistemological content. Within the limits of traditional formal logic (and we are speaking only of the orientations in psychological didactics that assume these attitudes) there is no problem with the "development of concepts" – logic was abstracted from the problem and did not have the cognitive means either for posing it or for studying it. This problem can be raised only within the framework of dialectical logic and is internally related to its general approach to cognition or thought.

Second, for empirical theory the content of concepts is identical to what is first given in perception. Here the process of changing the subjective form of this content is considered – the transition from its direct perception to "implication" in verbal descriptions. The problem of the origin of the content of concepts is simply absent. Thus, "numbers" are taken as given and "ready-made," having representation in "number configurations." How and from what "nonnumeric" preconditions they have emerged, how the substance of the concept of number took shape and developed historically – all of this remains behind the scenes. The child begins to become familiar at once with the results of this process, which have occurred in the history of cognition (at best, he is then told this history). In other words, the study of the origin of the concept from "sensory data" is not equivalent to the problem of the "origin" of a concept from its objective, material preconditions. In the latter case these preconditions do not coincide with the properties that function in the concept as the product of some historical process of development of cognition. It is from this process that the teaching of concepts in school is detached.

The Principles of Rational-Empirical Thought as the Basis of the Traditional System of Instruction

The results of the preceding analysis permit a description of the type of thought that is projected by a system of instruction that relies on traditional educational psychology and didactics. Insofar as the accepted system of instruction succeeds in deliberately cultivating a certain type of thinking in children, it inculcates empirical thinking in them.

Its characteristic feature, according to the theory of cognition, is that it reflects objects from the standpoint of their external connections and manifestations that are accessible to perception. Theoretical thought, which reflects the internal connections among objects and the laws of their movement, is usually opposed to it (see, for example, [159], [169]). In this case it is important for us to consider those features of empirical thought that make it related to the intellect. Ever since antiquity a distinction between two levels of thought has been drawn in the history of philosophy. On the one hand, there has been a delineation of mental activity that is oriented only toward articulating, recording, and describing the results of sensory experience, and on the other hand, there is thought that discloses the essence of entities, the internal laws of their development. This distinction was first made and substantiated particularly clearly by Hegel, who called these types of thought *intellect* and *reason*.[2]

Hegel wrote:

> The activity of the intellect means, in general, that it conveys to its substance the form of generality, and the general, as the intellect understands it, is an abstractly general, which, as such, is established in opposition to the particular ... Since the intellect acts in a divisive and abstracting way in relation to its objects, it is consequently the opposite of direct contemplation and sense, which, per se, deal exclusively with the concrete and stay within it [79, pp. 131-132].

"Division" and "abstraction," leading to the "abstractly general" (or to an "abstract identity"), which is the opposite of the particular – such are the functions of the intellect, from which rational cognition begins. By virtue of the intellect the objects at hand are grasped in their definite differences and "independently established in this isolated state of theirs" [79, p. 132]. Both in the theoretical and in the practical domains the intellect permits the person to achieve solidity and certainty in his knowledge. But at the same time "thought, like intellect, does not go farther than fixed certainty and the difference between the latter and other certainties" [79, p. 131].

At this initial stage in rational cognition, by means of division, comparison, and abstraction, knowledge about abstract identity, about the abstractly general, as established in a concept, is engendered.[3] The intellect is "merely the capacity for a concept in general" [82, p. 31]. "When it is a question of thought in general or, in particular, of understanding in concepts," Hegel notes, "it is often merely the activity of the intellect that is meant" [79, p. 131].

Hegel regards as typical of the initial level in all disciplines and of daily activity a "naive image of thought," which reproduces the content of sensations and contemplation without yet realizing the "opposition of thought within itself" – that is, without internal reflection. One-sided, abstract definitions (abstract generalities) are created along this route, without going beyond the limits of the intellect.[4] In this way it is possible to arrive at very lean abstractions, which have lost all the concrete content, completeness and richness of contemplation [79, pp. 64-70].

The need to retain such content leads to empiricism, which also raises perceptions to the form of universal ideas and laws but which attaches no other significance to them except for that contained and justified in perception. By virtue of the dismemberment (analysis) of properties that have "formed by accretion" in the perceived object itself, one can pass from the spontaneity of perception to thought, attaching the form of universality to these properties ("definitions"). Empiricism reserves for thought "only abstraction, formal generality and identity," but strives to hold within them the changing concrete content of contemplation, appealing to its varied, direct "definitions" and relying on conceptions. Such thought again stays within the limits of the intellect [79, pp. 78-80].

Thus, the intellect is aimed primarily at dismembering and comparing the properties of objects for the purpose of abstracting formal generality – that is, attaching the form of a concept to it. Because of this objects can be clearly divided and differentiated. This thought is the initial level of cognition, at which the content of contemplation takes on an abstract, formal generality. With an excessive extension of such generality, the abstraction becomes quite meager and empty. This tendency can be overcome by retaining the images of contemplation and conception that underlie the abstractions. Visual images attach concrete content to rational thought.

These characteristics can entirely be attributed to the type of thought which we described as *empirical*. The principle of the latter is also formal generality in the objects under consideration (with all of the consequences that follow from this). Such thinking can be called rational-empirical,[5] and its basic function is to classify objects, to construct a solid scheme of "determinants." This type of thought presupposes two ways, which were discussed above – the route "from the bottom up" and the route "from the top down." In the first, an abstraction (concept) of the formally general is constructed, which in its essence cannot express the specifically concrete content of an object in mental form. On the route "from the top down" there is a saturation of this abstraction with visual images of the object – it becomes "rich" and meaningful, but not as a mental construction – rather as a combination of the descriptions and concrete examples that illustrate it.

In Chapter 1 we cited some theses borrowed from works on educational psychology that asserted, for example, that the development of the abstract depends "on an accumulation of conceptions and perceptions" [41, p. 130], that abstract thought is the more meaningful, "the richer the range of the person's conceptions that have been developed on the basis of sensations and perceptions of reality" [234, p. 115], and so on. This idea is clearly expressed in the following thesis as well: To master the concept of an animal, for example, is to be familiar with the diversity of all types of animals and to have visual images of this – that is, to master the entire totality of knowledge about this. The development of a concept is included in the extension of images and knowledge [263, p. 252]. These theses that dominate educational psychology and didactics reproduce consistently the requirements of rational-empirical thought, although they also pass for requirements of "thought in general."

Indeed, as Hegel has shown, "although thought is rational thought first of all, still it does not stop at this, and a concept is not just a definition of the intellect" [79, p. 131]. Passing beyond the limits of rational thought is accomplished by reasoning or dialectical thought, which reveals the truth of an object as a concreteness, as a unity of various definitions, which are acknowledged to be true by the intellect only in their separateness. Hegel writes: "This reason [element], although it is something mental and, moreover, abstract, is at the same time also something *concrete*, because it is not a *simple, formal* unity, but a unity of *differentiated definitions*" [79, pp. 139-140]. If the principle of the intellect consists in abstract identity, formal unity, then concrete identity as a "unity of differentiated definitions" is the principle of dialectics or reason. This sort of unity is the "immanent passage of one definition into another, in which it is found that these definitions of the intellect are one-sided and limited ..." [79, p. 135].

Dialectical thought reveals transitions, motion, development. Therefore it can consider things "in themselves and for themselves – that is, according to their own nature." The real significance of dialectical thought for science is included here.

Dialectical thought has its own methods of generalization and of forming concepts, of which more will be said below (Chapter 7). For the time being, however, we note once more that our educational psychology and didactics have bypassed the ideas of dialectics about the place and the role of concrete unity in thought, on the real significance of this "unity of differentiated definitions" in any "scientific development of thoughts." In any case up to now the actual teaching "techniques," the techniques of developing instructional material and of forming students' concepts, have been constructed, as a rule, on the basis of the principles of rational-empirical thought.[6]

It is known that the Hegelian distinction between "intellect" and "reason" has been positively appraised by F. Engels: "This Hegelian distinction, according to which only dialectical thought is reasoned thought, has a certain point" [6, p. 537]. Then Engels notes that people "have in common with animals all types of rational activity:" induction, deduction, abstraction, analysis, synthesis, experimentation. Engels states:

> In type, all of these methods – consequently, all means of scientific investigation that are acknowledged by ordinary logic – are altogether identical in man and in

> the higher animals. Only in degree (according to the development of the respective method) are they different. ... On the other hand, dialectical thought – precisely because it has as its prerequisite the investigation of the nature of concepts themselves – is possible only for man, and for him only at a comparatively high level of development (the Buddhists and the Greeks), achieving its full development only significantly later on, in the latest philosophy... [6, pp. 537-538].

The following ideas are particularly important for us here. "Ordinary logic" – and this meant traditional formal logic – acknowledges only the methods of rational thought. Reasoned thought is specific to the mature person. A prerequisite for it is "the investigation of the nature of concepts themselves."

The description of analysis, synthesis, abstraction, and other mental processes that exists in traditional educational psychology does not express the specific nature of human thought, nor does it characterize the process of generalization and concept formation that is internally related to the investigation of their very nature. A consequence of this is precisely the fact that the teaching of concepts in school is divorced from their origin. The investigation of the material-object sources of concepts, of the process of representing them in different symbol systems, etc. – that is, of all of that which permits the origin, the nature of the concepts to be known – simply does not correspond to the potential of educational psychology, which is restricted to describing rational-empirical thought.

The accepted system of instruction, in its epistemological and psychological purposes, is aimed at developing just this type of thought among the students. This is an exceptionally important and mandatory goal for any instruction, since "intellectuality" as a feature, of necessity, enters into the more highly developed forms of thought, attaching solidity and certainty to its concepts. Hegel, who decisively revealed the fundamental limitations of the intellect, at the same time stressed its irreplaceability in man's total mental activity:

> ... The intellect is, in general, an essential feature in education. The educated man is not content with the vague and indefinite, but grasps objects in their clear-cut certainty [79, p. 133].

But now the problem is to find ways of instruction in which the intellect might become a "feature of reason," rather than acquiring a dominant and independent role, a tendency towards which is incorporated in conceptions of intellect as "thought in general." Practical implementation of this tendency in education is fraught with very negative consequences at present. The main one is the retention of spontaneity and poor controllability of the conditions in which the components of "reasoned thought" develop in a person of school age.

It is advisable to cite Lenin's remarks when he was reading and briefly recapitulating that part of Hegel's "Science of Logic" where the cognitive potential of "ordinary conception" (the intellect) and "reason" are compared. Lenin writes: "Ordinary conception grasps difference and contradiction, but not the transition from one to the other, but this is *highly important*. ..."

"The thinking reason (the mind) sharpens the dulled difference of the different, the simple diversity of conceptions, to an *essential* difference, to an *opposition.* Only when raised to the peak of contradiction do diversifies become mobile (*ragsam*) and alive with respect to one another – they take on that negativity that is the *inner pulse of self-movement and vitality*" [17, p. 128].

Considering objects "according to their own nature" (in Hegel's expression) is typical of scientific thought. The "self-movement" category expresses this "nature" precisely, which can be known only through establishing transitions (unities) of opposites from one to another – this is precisely the function performed by reasoned thought.

At present in school education there is an increased volume of specifically scientific concepts being outlined (particularly in mathematics, physics, biology, etc.). The so-called "information explosion" and the swift "obsolescence" of the scientific knowledge that is obtained are changing the goals of education in a decisive way. Under these conditions, as A. N. Leont'ev has noted [193], cultivating students' abilities to master ever more recent scientific concepts on their own and creatively is becoming the primary task of the school. Naturally, this ability presupposes a high development of scientific and theoretical thinking, which, in the modern world, is essentially dialectical (see, for example, N. N. Semenov's work [287], etc.).

However, the practice of developing instructional material has traditionally been oriented primarily merely toward the principles of rational thought, without providing for the proper, well-developed conditions for students to develop the components of theoretical thought. But the "undeveloped quality" of such thinking on the students' part functions as a factor that hinders a rise in the scientific level of the content of education and creates an obstacle on the way to consistently implementing the principle of the scientific nature of education as promulgated by our didactics. In these circumstances scientific concepts in their "school interpretation" can become merely a surrogate for scientific knowledge.

But is theoretical thinking really not being developed in today's students, particularly the older ones? Where do the "scholarly person," the "scientific talents" come from? We answer at once: Yes, it does develop! But, in the first place, not for all students; second, with significant flaws; and, third, often spontaneously and running counter to the aims of traditional educational psychology and methodology. It should be kept in mind that a multitude of uncoordinated elements still arise between these established "norms" and the actual practice of modern instruction, even when there is a general one-to-one correspondence. This practice is broader and more comprehensive. In it there are features that are lacking in traditional pedagogy, which developed under different historical conditions for mass education, but which continues to affect instruction in a substantial way.[7]

Mastery of the fundamentals of the sciences, whose teaching methods are far from perfect from a certain standpoint, in itself creates a number of objective conditions for developing students' theoretical thought. The content of certain links between instructional disciplines allows children to grasp both the opposition and the unity in a phenomenon and an essence, for example, or in a foundation and a consequence, or in the particular properties of an object and its integral nature. But in following "normative" methodologies, the teacher very frequently cannot delineate and reinforce in an opportune way children's distinctive movements of thought in contradictory definitions. In principle this is possible, but special, unusual methods of developing the instructional material and of students' work with it are required for the purpose (some features of these methods are demonstrated, for example, in the book by I. Lakatos [182]).

The accepted teaching methods cannot overcome spontaneity in the formation of children's theoretical thought, a consequence of which is inevitably a very different level and different quality of the extent of its real development in certain students. Many facts in school practice indicate this (there are also such facts in higher educational institutions, however; see, for example, N. D. Skorospeshkina's work [291], etc.). Thus, one of the characteristic attributes of theoretical thought is a sort of analysis which, although it is done on some one concrete event or on one problem, still reveals an inner connection that underlies many of the particular manifestations of the event or problem (a description of this kind of analysis is found, for example, in the works by S. L. Rubinshtein [277, pp. 143-144], [279, p. 89, etc.]). Because of this, a person seems to generalize a certain range of events and problems "on the spot." But, according to Krutetskii's data using mathematical material [174] – as presented in detail in Chapter 4 – this type of generalization is observed only in children who are highly capable of mastering mathematics (and they are in the minority among students). For the others, generalization by a protracted comparison of similar facts and by gradually combining them into a class – that is, operations of the rational-empirical type – is typical.

Students' thinking is formed under the influence of many circumstances, including ones that are not monitored and even not yet presupposed in any deliberate way by organized instruction. Here the students themselves are exceptionally active. They often discover connections and relationships among objects that are not generally included in the range of facts outlined by the accepted curricula and teaching methodology.[8] All of this, in one way or another, favorably affects the development of the children's theoretical thought.

However, in our opinion, under the established teaching system, only rational-empirical thinking is developed and cultivated among students. The "model" for it has been thoroughly studied from the logical, psychological, and didactic aspects. The model is deeply rooted in the "techniques" of particular methodologies.

The further improvement of education, bringing it into correspondence with the scientific and technical achievements of this century, presupposes a change in the type of thinking that is projected by the instruction system. Dialectical, theoretical thought should become the new "model."

Creating such a model with respect to the goals of education now requires conducting long-range studies at a different level. Developing this essentially complex problem includes at least three "layers" of scientific problems. First, there is the careful logical and epistemological description of the content, forms, and principles of dialectical thought, of its contemporary level. Second, there is the study of the psychological mechanisms for forming this type of thought in students, a description of the children's activity that enables them to appropriate the basic means of theoretical thinking. Third, there is the creation of didactic-methodological aids, by working with which students might master the fundamentals of theoretical thinking, its components, as they are learning a certain system of concepts. Each of these "layers" has its own particular problem areas, but all of the layers are interrelated.

6

Criticism of the Empirical Theory of Thought in Psychology

On the logical and epistemological level the empirical theory of thought has long been subjected to serious criticism. In addition, some educators and psychologists have noticed its essential limitations with respect to the problems of children's intellectual development.

Thus, the prominent German educator F. Froebel tried to overcome this theory in determining methods of designing educational subjects; he attempted this on an idealistic, Schellingian basis [319]). It is noteworthy that the eminent Russian educator and psychologist K. D. Ushinskii, who adhered to this theory on the whole, differentiated between "intellect" and "reason," following Hegel. He attributed the former to purely formal abilities to process external sensory impressions (intellectual concepts are "accumulations" of conceptions which are clothed in words [31], p. 629]). But reason has for its content *general ideas* that allow objects to be seen in their authentic reality, comprehensively. Reason must be cultivated in man as a regulatory and guiding element of the intellect ("*Mind* without *reason* is trouble"). Ushinskii has written: "Reason is the result of the soul's realization of its own intellectual processes ..." [31], p. 678]. Criticism of the empirical theory of thought in the light of the general features of mental activity is contained, for example, in works by C. Buhler [52], C. H. Judd [383], and others. Of particular interest are the views of psychologists who, when creating theories of the evolution of thought, especially singled out the problem of generalization and concept formation in children and, in this connection, clearly formulated their own attitude toward the different positions in these questions. From this standpoint the works by L. S. Vygotskii, S. L. Rubinshtein, J. Piaget, as well as by other contemporary psychologists, have considerable significance.[1]

The Problem of Generalization in the Works of L. S. Vygotskii

One of the points in the psychological theory of L. S. Vygotskii (1896-1934) which retains its significance as a genuine scientific problem to this day is his treatment of the structure, function, and formation of generalization as a particular method of reflecting reality in a person's consciousness. Many of the central theses in this theory, concerning such issues as the role of symbols in the formation of the higher mental functions, the hierarchical structure of consciousness, and the connection between instruction and development, have found their own concentrated expression, refinement, and long-range view in the interpretation of generalization developed intensively by Vygotskii in the last years of his life.

Vygotskii expressed a specifically psychological interpretation of man's social essence in his concept of the mediated quality of the mental functions through systems of material and verbal symbolic formations. A "sign" as a means is a sign of *something*, which becomes its *meaning* in the process of organizing the combined activity of people. For Vygotskii the "sign—meaning—communication" system was a unit of human behavior and of all of the mental functions that implement that behavior. But in the beginning this was merely an abstract unit of any function, not expressing the specific nature of each of them and not leading to an understanding of their concrete features. Therefore Vygotskii tried to find a *particular* object of analysis which, on the one hand, would be essentially significant in human activity and, on the other hand, might represent a variation of the structure that had been found, in the most detailed form.

He did find such an object – it was *spoken thought* as a comprehensively developed and constantly operating function of man as a social being. The centuries-old experience of philosophy, psychology, and pedagogy put into the hands of the investigator some voluminous information about this function, on the basis of which it was possible to delineate its specific *product-generalization*, which is fixed in a concept. According to the features of this sort of product, one can make an objective judgment about the process of "producing" it, about spoken thought itself.

The initial theses were as follows: "... The unity that we call *spoken thought* is bound up in the meaning of a word"; "... From a psychological standpoint a word's meaning is above all generalization. But a generalization, as is easy to see, is an extraordinary *verbal act of thought*, which reflects reality in an entirely different way from the way in which it is reflected in immediate sensations and perceptions" [65, p. 49]; "*... Communication necessarily presupposes generalization and development of verbal significance* – that is, generalization becomes possible with the development of communication.... There is every reason to regard a word's meaning not only as the *unity of thought and speech*, but also as the *unity of generalization and social intercourse*, communication and thought" [65, pp. 51-52].

Vygotskii enthusiastically formulated these theses, directing them against naturalistic and biologizing trends in psychology. It must be said, however, that these theses in themselves were well known in classical philosophy and in "philosophical psychology." At the beginning of our century, as well, experimental psychologists (Piaget, W. Stern, L. S. Vygotskii *et al*.) comprehensively revealed their meaning, using considerable factual material. The novelty of Vygotskii's position was elsewhere. After having rapidly assimilated the experience of previous investigators, he passed to a *causal-genetic analysis* of thought and speech, to a study of the formation of verbal significance and its higher forms. He oriented himself toward investigating highly *diversified* types of meaning. Traditional psychology differentiated them only weakly; it did not detach verbal significance from other notions, thereby closing off the path to the origin of its higher forms.

Thus, Vygotskii faced a complex investigative problem: it was necessary to find the genetic continuity of the varied forms of verbal meaning and of the generalizations concealed in them.

The work by Vygotskii and his associates made an experimental study of the processes of forming so-called artificial concepts in children of various ages, as well as conducting a comparative investigation of the formation of everyday and scientific concepts.[2]

"Artificial concepts" means verbal meanings that children develop in an experimental situation with respect to previously meaningless sound combinations. Thus, for Russian children the combinations *bat, dek, rots,* and *mup* can take on a certain meaning, including a connection with certain attributes, when solving special problems on grouping solids (for example, *bat* means small, short figurines, regardless of their color and form). The type of grouping done by the children (the features of the attributes that are delineated, the stability of the orientation toward them when groups are being compared, etc.) allows a judgment to be made about the *generalization* that is formed in this process and that is introduced by the child into the word's meaning, as well as about the intellectual operations that lead to it. For such problems to be solved, no special knowledge is required of the child of any age; therefore the nature of the generalization-meaning depends only on the children's intellectual potential.

This methodology of L. S. Sakharov and L. S. Vygotskii assures creation of an objective situation that obliges the child to operate with the verbal sign to generalize a variety of objects. But Vygotskii attached no self-contained significance to this methodology and believed that only along with other methodologies of investigation can it be used to make a comprehensive evaluation of the level of the children's intellect at a certain age (see, for example, [65, p. 183], etc.).

The formation of artificial concepts allows a probing of the "length and breadth" of the children's intellectual processes at different ages. After analyzing the entire collection of experimental data, Vygotskii singled out three basic levels of generalization, which are qualitatively distinct and at the some time genetically related: *syncretisms* (1), *complexes* (2), and *concepts* (3).

Typical of the first level (early childhood) is an "incoherent coherence" of the group of objects, which are unified without a sufficient basis, according to a random impression, which sometimes catches but usually does not single out some of the objective connections using these objects (unification according to purely external spatial proximity, according to a vivid or garish attribute, and so on). The child does not compare such subjectively significant relationships with the actual connections among the objects and transfers his own random impressions onto them.

The complex-generalization has several different forms. What is similar about them is that the child combines objects in conformity with *actual* connections, although on the basis of direct sensory experience. Here any connection can serve as a basis for including an object in a complex – just so it is present. During the emergence of a complex these connections, as the basis for grouping, are constantly changing, seeming to "slip away," losing their outlines, continuing to have in common only that they are discovered through some one practical situation. At this level the children are not yet able to consider an attribute or a relationship of objects apart from a "visible" situation that is at hand, a situation in which these objects betray an abundance of mutually intersecting attributes; therefore children also slide from one feature to another, then to a third, and so on. All of the attributes are equal in their functional significance; there is no hierarchy among them. A specific object is included in a complex as a real, visual unit with all of the "inalienable" actual attributes.

The verbal sign has a primary role in the formation of this kind of generalization. It functions as a *family* designation of objects that are combined on some actual basis.

A special place among complexes is occupied by one form – the *pseudo-concept*, which constitutes a "highly widespread form of a child's complex thought, one that prevails over all the rest and is often almost exclusive, in the preschool years" [65, p. 177]. In the external features of the generalization that is produced, it is a concept, but in the type of process that leads to the generalization, it is a complex. Thus, the child can freely select all triangles and combine them into a group independently of their color, size, and so on. But special analysis shows that this combination was made by the child on the basis of a visual grasp of a characteristic visual attribute of "triangularity" (closure, the characteristic intersection of lines, etc.), without any delineation of the essential properties of this figure as a geometric one – that is, without an "idea" of a triangle.

The description and theoretical interpretation of complex-generalizations, particularly pseudo-concepts, is the major scholarly contribution by Vygotskii. Traditional psychology treated as a concept any generalization expressed by a word or by any grouping of objects. But some psychologists long ago showed that a generalization, analogous to a concept, can even occur in the sphere of purely visual thought (Iensh *et al.*). This gradually destroyed the prejudice that generalization in thought appears only in its most highly developed form – in the form of a concept. Vygotskii, describing a pseudo-concept as a highly subtle mimicry of a concept, summed up the struggle against this prejudice.

Above all he stressed that pseudo-concepts are not just the exclusive property of the child. "Even thought in our ordinary life extremely often occurs in pseudo-concepts" [65. p. 196]. "Although formation of concepts and operation with them is accessible to the thought of an adult, by no means all of his thought is filled up with these operations" [65, p. 196]. "... The higher forms of complex thought in the form of pseudo-concepts are a transitional form over which our everyday thought lingers, relying on ordinary speech" [65, p. 197]. But what are the mechanisms for the emergence of pseudo-concepts that determine their stable preservation?

A *spoken contact* between adult and child arises very early, and this is unthinkable without a mutual understanding. The latter, in particular, can be founded on a coincidence in the specific range of objects to which adult and child attribute their words. The child himself does not create his own speech, his own verbal meanings, and does not determine the range of their object attributions – he masters the speech of adults and receives a number of specific objects from them, which are designated by these words. But the adults cannot immediately transmit to the child their own method of thought, on the basis of which a generalization has been made. The child is obliged to combine the objects that are indicated to him into groups (that is, generalize them) by a method that is different from that used by adults; only the creation of complexes that encompass the same range of objects as concepts is accessible to him. By virtue of this, a mutual understanding between the child and adults becomes possible. But a complex-meaning provides only the outlines of a concept. It is constructed by different intellectual operations than is a concept. It is a *pseudo-concept.* The meaning of a word differs from its object reference; it is something larger than the latter.[3]

From childhood a person masters the ordinary, "living" speech of those around him and the names that occur within it. Vygotskii writes:

> If we trace the law by which word families are combined, we see that new phenomena and objects are ordinarily named according to one attribute, which is not essential from the standpoint of logic and does not express logically the essence of that phenomenon. A name is never a concept at the beginning of its emergence [65, p. 193].

Naturally, the mastery of living speech leads the person to pseudo-concepts and to operating extensively with them in practice.

Vygotskii has shown the inadequacy of the psychological description of generalizations – including conceptual ones – according to their specific object attribution alone: the latter can be formally identical both in a complex-generalization and in a concept-generalization (a genetic analysis is necessary to disclose the various intellectual operations that lie behind these types of generalizations).[4] But Vygotskii has taken another step – he has revealed the inner source of the kinship between the pseudo-concept and the concept.

We find a vivid description of the treatment of concept formation in *traditional* psychology in the following words by Vygotskii:

> A number of concrete conceptions underlies a concept.... Concept formation occurs by the same method as a family portrait is obtained by a group Galton photograph.... Images are imposed on one another so that the similar and frequently repeating features that are common to many members of the family appear in sharp, emphatic relief, while the random, individual features that are different in particular individuals, when superimposed on one another, blot one another out and conceal one another.
>
> A delineation of the similar features is obtained in this way, and the totality of all of the common attributes delineated in a series of similar objects and features is, from a traditional standpoint, a concept in the proper sense of the word. It is impossible to conceive of anything more false from the standpoint of the real course of concept development than this "logicized" picture... [65, pp. 206-207].

If this "logicized picture" is false, then along what route can the *real* processes of concept formation be sought? The problem is agonizing and difficult, and its treatment by Vygotskii was not smooth, much less definitive. But by analyzing it he showed the force of his own psychological intuition and the depth of his philosophical thought.

The "general," characterized in traditional psychology only as something *similar* or *identical* in objects, can be the content, not only of a concept, but of a pseudo-concept (complex) as well. "... Constructing a complex," Vygotskii wrote, "presupposes *delineating a known attribute* that is common to different elements [65, p. 202]. To be sure, this common attribute is not yet privileged or stable here. Complex thought connects the perceived objects in groups, "takes the first steps along the way to generalizing the uncoordinated elements of experience" [65, p. 198]. The *initial phase* of the ontogenetic process of forming thought in concepts

> ... is extraordinarily close to a pseudo-concept. This combination of various concrete objects is created on the basis of maximal similarity in its elements [65, p. 198].

"This generalization, which is created by the child on the basis of maximal similarity, is at once both a poorer process and a richer one than the pseudo-concept" [65, p. 199].

The next phase – potential concepts – is a delineation of a group of objects according to one common, customary attribute by means of isolating *abstraction*. Here the concreteness of the situation is destroyed; the preconditions are created for combining abstract attributes into a concept. The latter is not only a unification and a generalization, but also a delineation, an abstraction, an isolation of particular elements, a treatment of abstracted elements "apart from the concrete and actual connection in which they are given in experience" [65, p. 202]. A concept arises when a number of abstracted attributes are newly synthesized. "... *Abstract synthesis becomes* *the basic form of thought,* by which the child comprehends and interprets the reality around him" [65, p. 202]. The word has a decisive role here, as a means of directing attention toward the appropriate general attribute, as a means of abstracting. Here the word-sign has a different function in complex thought.

Thus, having previously established the identical nature of pseudoconcepts and concepts in their object attribution, Vygotskii then indicates the objective basis for this phenomenon – a *generalization of a single type* underlies both of them. It is obtained in different ways (different intellectual operations), takes on a different form (merging with the real object in the complex, and an abstracted nature in the concept), but, in principle, reflects the *same content.*

Having detected this circumstance, Vygotskii has actually revealed the unsoundness of his initially adopted method of analyzing the nature of a concept. Along this route the *specific nature* of real concepts as a distinctive type of generalized reflection of reality in human consciousness remained undisclosed; the false, "logicized picture," which Vygotskii sharply criticized, has turned out to be unsurmounted.

He himself demonstrated the reason for such an unsatisfactory result when, at a certain moment in the theoretical analysis of the problem, he approached the concept from positions in cognitive theory that were essentially different from those on which traditional psychology has stood. Thus, he has written:

> But even the concepts themselves, for both the adolescent and the adult, since their application is limited to the sphere of purely everyday experience, often do not rise above the level of pseudoconcepts and, possessing all of the attributes of a concept from a formal-logic point of view, are still not concepts from the standpoint of dialectical logic, remaining no more than general conceptions – i.e., complexes [65, p. 204].

From the standpoint of dialectical logic, concepts, as they are encountered in our everyday speech, are not concepts in the proper sense of the word. They are, rather, general conceptions of things. But it is indisputable that they are a transitional stage from complexes and pseudo-concepts to true concepts in the dialectical sense of the word [65, pp. 196-197].

The problems in concept formation lie within these ideas. A picture that relies on the traditional, formally logical point of view is false. Its falseness is that only a particular case of generalization stands out here as the only allowable and all-encompassing one. Moreover, this case of generalization does not single out the specific nature of the concept in its most highly developed form. This type of generalization, which even becomes a verbal abstraction, still does not go beyond the framework of the *general conceptions within* whose limits a "formal concept" is internally allied to a pseudo-concept and a complex. Attempts at finding the specific nature of a concept in its "abstractness," such as Vygotskii was originally asking, do not go beyond these limits, which are specified by the *content* of the generalization itself, as though it had not changed in external form and was realized by means of any of a variety of psychological processes.[5] Along this route it is impossible to lose touch with the traditional picture, no matter how false and inadequate it has seemed to be. The way out is to alter the point of view of the concept itself, to pass to an analysis of its *dialectical nature.* This is the most important result of Vygotskii's theoretical study of the different forms of generalization.

Vygotskii gave concrete form to the problem of the difference between formally logical and "true" concepts on a psychological level as a problem of the difference between ways of forming "everyday" (spontaneous) and "scientific" concepts in children. Here he perceived the key to the entire history of the child's mental development [65, p. 213]. The research done by Zh. I. Shif [342] under Vygotskii's guidance had the following results; "What is new in our research ... is the revelation of a distinctive way to *develop the child's scientific concepts,* in comparison with his spontaneous concepts, and the ascertainment of the basic laws of that development" [65, p. 41].

Vygotskii presents the data showing the contrast between ways of forming everyday (spontaneous) and scientific concepts as paradoxical, from a traditional standpoint, and yet based on profound principles, in essence. Spontaneous concepts arise when the child encounters real things, their specific properties, among which he finds – after lengthy comparison – certain similar features and uses words to attribute this to a certain class of objects (he forms a "concept," or, more precisely, a “general notion”). This is the route from the concrete to the abstract. Having such a concept, the child becomes aware of the object represented in it but is not aware of “the concept itself, of his own act of thought, by which he represents the object” [65, p. 286].

In contrast to this, the development of a scientific concept begins with work *on the concept itself* as such, with a verbal definition, with operations that do not presuppose a spontaneous application of these concepts [65, p. 286]. This concept begins to arise, not with a direct encounter with things, but immediately with a mediated relationship to an object (through a definition that expresses a certain abstraction). From the first steps in instruction, the child establishes logical relationships among concepts, and only on this basis does he then force his way through to an object by coming into contact with experience. From the outset he is more aware *of the concept itself* than of its object. Here there is movement from the concept to the thing – from the abstract to the concrete. This route is possible only within specially organized instruction in scientific knowledge for the children and is a specific result of it.

Vygotskii singled out three basic psychological features in the formation of children’s scientific concepts. First, there is the establishing of relationships among concepts, the formation of a system for them; second, there is an awareness of one’s own mental activity; and, third and finally, by virtue of both of these, the child acquires a particular relationship to the object, which permits it to reflect that which is accessible to everyday concepts (penetration to the object’s *essence*)”

> ... The very essence of a concept and a generalization presupposes, despite the teachings of formal logic, an enrichment rather than an impoverishing of the reality presented in the concept, in comparison with the sensory and direct perception and contemplation of that reality. But if generalization enriched the direct perception of reality, this clearly cannot occur in any psychological way other than by establishing similar connections, dependencies, and relationships among the objects represented in the concept, and the rest of reality [65, p. 295].

A particular concept can exist only by means of a system of concepts. But the presence of the latter is inseparably connected with an awareness of one’s own mental activity. “*Awareness and a systematic quality are completely synonymous with respect to concepts* ...” [65, p. 248]. An awareness of mental operations is a re-creation of that in the imagination for verbal expression, which is necessarily connected with the generalization of one’s own mental processes. It is this reflection, the use of consciousness for its own activity, that engenders the particular type of generalization that is present in a scientific concept, in the higher forms of human thought. “Abstraction and generalization of one’s thought are fundamentally different from abstraction and generalization of things” [65, p. 304].[6]

Vygotskii saw the uniqueness of the generalization of thought in the creation of a “pyramid of concepts,” which permits a *mental passage* from one particular property of an object to another through a *general* concept. Such a concept emerges in children earlier than its particular “applications.” Vygotskii attached an exceptional significance to this *actual* phenomenon of children’s thought (unfortunately, it was not then adequately studied in child psychology). Thus, he wrote the following:

> Thought, in Vogel’s figurative expression, almost always moves up and down in the pyramid of concepts, and seldom in a horizontal direction. This situation, in its day, meant a regular revolution in the traditional psychological teachings about concept formation. In place of the former notion, according to which a concept emerged by a simple delineation of similar attributes from a series of concrete objects, the process of concept formation began to be conceived by investigators in its real complexity as *a complicated process of thought in a pyramid of concepts,* always passing from the general to the particular and from the particular to the general [65, p. 207].

One more observation by Vygotskii: “The process of concept formation develops from two aspects – from the aspect of the general and from the aspect of the particular – almost simultaneously” [65, p. 208].

At the same time the psychological investigation of thought in a “pyramid of concepts” with *two-sided movement* is a problem of considerable difficulty. Vygotskii himself designated it as the most “far-reaching, conclusive” problem in his investigation [65, p. 296]. And one that is by no means developed – it might be added – one that has merely been indicated in outline as a task for future studies.

By fitting the entire structure of his theoretical doubts to the need to articulate the particular content of the “generalization of thoughts,” Vygotskii did not succeed in establishing and precisely describing what the content is. To explain its peculiarities he promulgated the concept of “commonality relationships.” But, in the first place, its superficial characteristics bore a metaphorical sense, and, second, by Vygotskii’s own evaluation, this point in his theory was too general and summary and remained underdeveloped [65, pp. 317-318]. The hypothesis itself that was advanced apropos of this is remarkable in exposing the nucleus of Vygotskii’s theoretical aspirations in solving the problem of generalization.

A “commonality relationship” is a relationship of concepts vertically, so to speak, according to the potential for expressing one by another *(plant, flower, rose*). Within a single structure of generalization (syncretisms, complexes, pre-concepts, concepts) there can be different types of commonality, and in different structures there can be commonalities of a single type (for example, *flower* can be a general meaning and can pertain to all flowers both on the level of complex thought and on the level of conceptual thought). There are complex relationships here. At the same time a *general law* is also established to connect commonality relations with levels of thought, structures of generalization. To each of them there corresponds its own specific system of commonality and of relating general and particular concepts, its own measure of the unity of the abstract and the concrete. One real object can be reflected in different systems of commonality. Here Vygotskii’s idea is directed against making some already-known type of relationship absolute, against the striving on the part of certain psychological schools to reduce the wealth of forms of thought to some formally unambiguous description in which all cats are gray.[7] He asserts the qualitative diversity and the genetic continuity of measures of commonality:

> ... The movement from the general to the particular and from the particular to the general in the development of concepts proves to be different at each stage in the development of meanings, in relationship to the generalization structure that is predominant at that level. In the passage from one stage to another, the system of commonality changes, and the entire genetic order for the development of higher and lower concepts changes [65, p. 298].

We call attention to the last sentence – the “entire genetic order for the development of higher and lower concepts changes.” Thus, the dominance of the particular over the general, of the concrete over the abstract, is a particular order that is intrinsic to complex thought and to the development of everyday concepts. This relationship changes to the opposite in the structure of the generalization of another type – during the “generalization of thoughts,” in scientific concepts the general dominates over the particular.

This, in essence, was the introduction of the principle of development into the realm of specifically psychological investigations, an orientation toward concrete analysis of the origin of higher and “better” forms. Such an aim differed essentially from the principles of traditional psychology, which, in almost every instance, studied the problem of concept formation in childhood by using the example of everyday concepts, and then extended it without any verification to other spheres of thought, including scientific concepts [65, p. 221].

A typical feature of specifically conceptual thought properly speaking – the possibility of designating any concept by an infinite number of methods by using other concepts (the law of their *equivalents*) attracted Vygotskii’s attention. For example, a “unit” can be expressed as the difference of any contiguous numbers, as the ratio of any number to itself, and so on. The equivalence of concepts depends on the relationships of commonality, its “measure” which, in turn, is determined by the structure of the generalization. Therefore the level of development of children’s thought can be judged *objectively* by the breadth and freedom of the equivalent mutual expression. “Concepts are connected, not by the type of aggregate, by associative threads, and not by the principle of the structures of the images perceived or conceived, but by the very essence of their nature, *by the principle of the relationship to commonality*” [65, p. 307]. The measure of commonality determines the character, the orientation, and the mechanisms of all of the operations that manifest generalization at the given level of its development.

Thus, Vygotskii suited the entire course of his investigations to the need to *distinguish* between rational-empirical concepts ("general conceptions") and theoretical, properly scientific ones. The solution to this question, in our opinion, presupposed a special and careful consideration of its logical and epistemological aspects from the standpoint of dialectics. In particular, it was important to compare the traditional, formal-logical interpretation of the "general" with its dialectical interpretation. But Vygotskii believed it is the "logical aspect of this question that has been developed and studied with sufficient completeness" and that one must pass directly to solving "genetic and psychological problems related to this question" [65, p. 296]. But in the early 1930s such a conclusion was premature – at the time our dialectical logic had not yet grasped or assimilated the rich classical philosophical legacy in solving this question so as to be able to speak confidently of "sufficient completeness" in developing its "logical aspect."

This circumstance was detected in the works of Vygotskii himself, in his distinction between spontaneous (everyday) concepts and scientific ones. Unfortunately, Vygotskii has no well-developed basis for such a distinction. But in a work by Zh. I. Shif, the preface to which was written by himself, the following grounds for distinguishing between these types of concepts are cited:

> In speaking of spontaneous concepts, we adduce contact with a broad social milieu and the absence of a system in the knowledge thus acquired as the basic index of the conditions for forming these concepts and as their source.
>
> It is a determinant for scientific concepts ... that they are acquired and developed under the teacher's guidance and with his help and that the knowledge is given to the children in a certain system here [342, p. 32].

And then:

> The child incorporates a number of concepts in the conditions of his personal experience, in the conditions of a broad, extra-systemic contact with a broad social milieu. These are the ordinary concepts that are close to him, which we have agreed to call "everyday" concepts. Some concepts arise only in school, in the process of instruction. Their source is not the child's personal experience – they start their life with a word or with a definition [342, p. 75].

Thus, the determining difference between everyday concepts and scientific ones was found, not in their objective content, but in the method and ways of mastery ("personal experience ... the process of instruction"). Some are without a system, others are given in a system. "Scientific concepts" are concepts *specified* in school.[8]

But, as is known, *empirical* concepts also possess a certain system (for example, in the realm of genus-type relationships). In school, particularly in the primary grades, it is exactly such concepts that are taught, on the whole. Of course, scientific concepts are given in a system – but in a *particular* system (see Chapter 7). It is this point, decisive on a logical level, that Vygotskii and his associates have overlooked. Therefore the genuine criterion for "scientific concepts" was not given in their works.

As a result considerations to the effect that thought moves in a "pyramid of concepts" both from general to particular and from particular to general lose definiteness and unambiguousness. The point is that, in principle, this is allowable in a more or less systematized "pyramid" of empirical concepts. Mastery that starts from the "general," from a verbal definition in itself, in no way characterizes the scientific nature of a concept – any everyday, empirical general conceptions can be specified in a similar way in instruction.[9]

A number of Vygotskii's theses, related to the problem of generalization and concept formation, retain their scholarly significance for modern psychology. We shall point out the basic ones: 1) there is, above all, the idea of "causal-genetic analysis" as a method of investigating a problem, 2) an understanding of the need to distinguish between the "generalization of things" and the "generalization of ideas," since they are related to a different type of connection between the general and the particular, and 3) inclusion in the psychological mechanisms of a theoretical concept of the feature of awareness of the act of thought, reflection, investigation of the origin and nature of the concept itself.

The Theory of Generalization and of the Concept in the Works of S. L. Rubinshtein

In recent decades the most detailed theory of thought in our psychology is contained in the works of S. L. Rubinshtein (1889-1960), which have done much to extend the solution of a number of fundamental problems related to the study of this complex form of mental activity. We shall present the basic theses in this theory.

Thought is a *process* of specific *interaction* between the knowing subject and the object that is coming to be known.

> Thought is the most complete and multifaceted mental restoration of an object, of reality, proceeding from sensory data that arise as a result of the influence of the object [278, p. 12].

Mental *activity* solves this general problem by means of such components as *analyzing, synthesizing, abstracting,* and *generalizing,* which transform the raw sensory data.[10]

This description of thought as such, in essence, coincides with the features of its most highly developed level, the level that is specific for modern man – the features of *theoretical* thought. And this is not by chance. S. L. Rubinshtein's works give a detailed treatment – from dialectical materialist position – of precisely this sort of thought, which is designated as "scientific," "theoretical," "abstract thought." Its general goal consists in: 1) determining the nature of the phenomena being studied in the concepts, while processing from sensory data and abstracting oneself from properties that obscure the essential properties of things, 2) proceeding from the essential properties of things that are fixed in these concepts, explaining how they are manifested in the sense-observed world [277, p. 117].[11] The first step is basically analytical, the second – synthetic. Analysis consists in dismembering the relationships that overlap one another, in disclosing the "internal," essential properties of things in their regulated interconnection. This is the route from sense-perceptible concreteness to abstractions that are fixed in concepts. Through *synthesis* the reverse transition from abstract theses to the mental restoration and explanation of observed phenomena – to the concrete – is implemented. This analysis and synthesis are two basic operations in scientific-theoretical thought, whose method consists in an ascent from the abstract to the concrete [277, pp. 117-121]. "The abstract is that through which cognition most pass; the concrete is that toward which cognition is ultimately going" [277, p. 110].

Thus, Rubinshtein approaches thought primarily as *a perceiving men*tal activity. Such an interpretation of thought is inherent in the modern theory of cognition and dialectical logic. It is important to emphasize that it is in this interpretation of the general nature of thought that Rubinshtein saw the basis for his subsequent *psychological* investigation.

Thus, he wrote:

> The psychological aspect of analysis (as of any cognitive process) is inseparably connected with the epistemological – with the reflection of objective reality... The process with which logic deals is the process of development of scientific knowledge in the course of historical development. ... But psychology studies the individual's mental activity, the thought process in the regular features of its occurrence. Thus, in the theory of cognition it is a matter of the extent of the analysis, generalization, etc., of the products of scientific thought as it develops in the course of the historical development of scientific knowledge; in psychology it is a question of analyzing, synthesizing, etc., as an activity of the thinking individual [279, p. 57].

Consequently, psychology should study the *individual's* mental activity in the forms of scientific thought whose historical development process is studied by the theory of cognition or logic. In this Rubinshtein has seen what is basic for overcoming the subjectivist approach to the mental itself.[12]

At different stages in cognition the unity of analysis and synthesis takes on qualitatively different forms [277, p. 136], which, in turn, is related to different routes to generalization. Rubinshtein has singled out three of these routes.

> The first route is an elementary empirical generalization, which is accomplished as a result of comparison by singling out the general (similar) properties in

> which the phenomena being compared coincide. This is Lockean generalization.... This way can be used in a practical way, and actually is used, at the initial stages of cognition, until it is raised to the level of theoretical knowledge.... This sort of generalization is merely a selection from a number of properties that are given empirically, directly, and sincerely; it is thus not capable of leading to the discovery of anything above what is given directly, by the senses... . The general, at which one thus arrives, remains within the confines of empirical statements [277, p. 150].

Comparison, as a specific form of interrelationship between analysis and synthesis, effects an empirical generalization and classification of phenomena. It can single out the general as the similar, the formally identical, but it does not guarantee the delineation of the essential (the similar is merely an external, probable indicator of what is essential).

This route from the particular to the general forms the framework for that induction that has been elevated by the proponents of sensationalist empiricism to the rank of a supposedly fundamental and unique method of generalization. In fact, it is only an elementary method of generalization, which yields an empirical generalization of the lowest order [277, p. 150].[13]

“The second route is generalization through analysis and abstraction ...” [277, p. 150]. This is “generalization to which theoretical thought is elevated as a result of a revelation of the regular, necessary connections among phenomena” [277, p. 141].[14] Analysis, by breaking down the essential properties from the nonessential ones, the general from the particular, turns into abstraction. But synthesis appears in the transition from an abstraction to the mentally concrete. “Abstraction in scientific thought is directed at disclosing the internal, essential properties of phenomena in regulated relationships according to which abstraction is accomplished” [277, p. 140].[15]

A scientifically warranted generalization “is not the delineation of *any* general properties whatsoever. Generalization as an act of coming to know what is practically and scientifically significant is a delineation, not of any general properties of phenomena, but of ones that are *essential* for them. The essential properties are singled out by analysis and abstraction.... A scientific generalization is a derivative effect of analysis, which is related to abstraction. Here the abstracting that leads to a generalization involves a scientific concept and does not divorce the general from the particular. In a scientific concept, in a law, the particular does not disappear but is retained in the form of variables that can acquire different particular significances” [277, pp. 142-143]. A scientific generalization “is always not merely a *selection* but a *transformation* as well.... The transformation of what is immediately given, which leads to an abstract concept of a phenomenon, consists in breaking the contact ... of the attendant circumstances, which complicate or mask the essence of phenomena. A concept does not coincide with a phenomenon directly or immediately ... because what is immediately given in a concept is transformed through abstraction” [277, pp. 143-144].

Thus, a scientific concept reflects what is *essentially general*, which itself functions as a product of specific analysis and abstraction (of the objectively conditioned transformation of a thing). S. L. Rubinshtein gives the following description of an essence: “The essence of a thing is none other than the basis (included in itself) for all of the changes that occur with it in interaction with other things” [277, p. 112]. In other words, it is something *internal*, *proper* to a thing, something that functions as the *basis* for all of the changes, as their law. On this level the definition of a phenomenon in the form of an appropriate concept *coincides* with the formulation of the basic relationship to which this phenomenon is subordinated: “... The law *which a given phenomenon obeys is included in its definition”* [277, p. 111].

“The third method of generalization involves the very process of derivation or deduction,” Rubinshtein writes [277. p. 151]. This generalization, which is accomplished by *proof* is erroneously called induction (complete or full), since there is a transition from the particular to the general. Indeed, it is deduction, if we take deduction to “mean a conclusive derivation of one thesis on the basis of others, from which it follows of necessity...” [277, p. 151]. Such a theoretical derivation is accomplished by a *two-way movement* from the general to the particular and from the particular to the general – generalization and theoretical cognition are interrelated. Here one must make a clear-cut distinction between the process of empirically “suggesting” the externally general and the process of theoretically deriving certain theses on the basis of the essentially general; there a special generalization of many particular cases again occurs [277, pp. 152-153].

As was noted in the previous section, Vygotskii and a number of other psychologists have stressed that in real mental activity the person makes simultaneous counter-passages from the particular to the general and from the general to the particular. But, in ascertaining this fact, they have defined the *particular* level of thought at which this becomes possible. Moreover, they have attempted, in one way or another, to correlate this fact with thought that operates with empirical concepts on the basis of a formal, external, general property. But at this level the counter movement is *impossible.* Rubinshtein has clearly delineated this feature, revealing the internal connection between counter transitions and the process of *theoretically deriving* the concrete, the process of proof, the distinctive deduction which in itself does not rule out movement from the particular to the general (while simultaneously moving from the general to the particular).

For Rubinshtein thought is internally connected with generalizations – it is accomplished in them and leads to generalizations of a higher order [278, p. 113]. Therefore the conclusion to the effect that different levels of generalization are determined by the types of *generalization* of cognitive material is legitimate.[16] Rubinshtein has distinguished between *empirical* and *theoretical* generalization as the basis for different levels of thought (visual, and abstract or theoretical). The former is the result of *comparing* and delineating what is similar or externally identical in things (in his opinion, it does not even yield an abstraction in the proper sense of the word).[2] The latter is the product of special *analysis* and *abstraction,* which are related to the *transformation* of raw sensory data for the purpose of detecting and delineating their essence.

Such a transformation can be effected either on the level of objects or on an internal level. In other words, singling out the essence as the substance of a theoretical generalization and a concept is possible only through particular object-related and intellectual *operations.* Rubinshtein writes:

> In the study of cognition or thought, a properly oriented psychological investigation cannot fail to consider the role played, in the process of any cognition, by the person's operation with the object to be known, starting with practical operations – in life, in labor, in experimentation, and ending with such operations as the drawing of lines, the construction of new figures in the solution of geometric problems... Thought unfolds as a process that is accomplished in forms of interaction that are specific to it between the operations done by the subject and the object – a process that, when transformed by these operations, in turn affects the further movement of thought [278, p. 57].

Reasoned, object-related action is the genetically original *intellectual* operation, which is the basis of all thought. "Action therefore seems to carry thought on its own point, which penetrates objective reality" [276, p. 367]. These fundamentally important theses of Rubinshtein's create the essential preconditions for overcoming a narrowly sensationalist and conceptualist interpretation of generalization of the sort that is peculiar to traditional psychology. A decisive and complete victory over conceptualism presupposes, in our opinion, acknowledgment of the real existence of the abstract and universal (see more detail on this in Chapter 7).

In Rubinshtein's work, unfortunately, there are no sufficiently detailed special formulations to characterize this feature. But many of his views, expressed in different contexts, permit the supposition that he solved this key question in the theory of generalization in precisely this way. For example, in discussing scientific abstraction, Rubinshtein writes as follows:

> Since scientific abstraction has ... its own basis in the nature of things and the phenomena of reality themselves, then the articulation of what is abstracted from phenomena and established in concepts about them, and of that from which the abstracting is done – that is, the internal and the external, expresses the structure of objective reality itself and therefore has an "ontological" basis [277, p. 149].

A judgment about the "ontological" basis of scientific abstraction is, in our view, a basic step towards acknowledging its real existence in contrast to formal abstraction. Then, in discussing essence, Rubinshtein emphasized that it is an internal, proper basis for all changes in a thing. Consequently, an essence that is established in an abstraction is the genetically original basis for the development of a thing.

In his works Rubinshtein has indicated the *distinctive nature of the content* of abstract thought: “Thought in the real sense of the word is the penetration of new layers of the real, the unearthing and bringing into the light of day of something hitherto hidden in mysterious depths...” [278, p. 110]. He singles out the question of correlating the particular and the general as the *essential* question in the theory of generalization and the theory of cognition as a whole, in which the particular should be regarded as inseparably connected with the general [277, p. 146]. With respect to the concept, this means the following:

> ... For the generality of a real concept it is necessary that it take the general in combination with the particular and the isolated and reveal the essential in it... A general conception that is formed by singling out general features is merely an external collection of attributes, but the real concept takes this in interconnections and transitions [276, p. 358].

These extracts from Rubinshtein’s works indicate that it was *connections, transitions* between the general and the particular, the *derivation* of one from the other, that he believed to be the substance of genuine, theoretical concepts. But in some instances one finds him making formulations that seem to “erode” these theses on the substance of concepts as products of abstract thought. Thus, in one place Rubinshtein perceives the specific nature of this thought in its interaction not only with directly apprehended reality, but also with “a system of knowledge, objectified in words, which develops in the process of historical development” [278, p. 13]. Of course, a theoretical concept is objectified in such a verbal system, but this does not determine the specific nature of either its form or its content, since an empirical general notion is also related to an “objectified system of knowledge.”

It should be noted that Rubinshtein generally attaches a particular significance to *verbal* formulations in the emergence of theoretical activity. Thus, he writes:

> Only with the appearance of a word that allows a certain property to be abstracted from a thing and a notion or concept of it to be objectified in words, with the product of analysis thus established, do “ideal” objects of thought which are abstracted from things first appear as “theoretical” activity, and hence – this activity itself as well [279, p. 105].

As will be shown in Chapter 7, the “ideal” objects that arise through words are related to various types of human *intellectual* activity, but in themselves do not yet form theoretical thought as such. The latter arises on the basis of object-transforming activity having the type of a sensory *experiment* which reveals the essence of things, and this essence is then put into verbal form as well. Apart from this specific object-related reality and its mental representations, a word can be a means of establishing only an “ideal” object of the empirical type, an entity in the *practical intellectual* mastery of reality. Apparently, therefore, in describing this sort of activity as “theoretical,” Rubinshtein himself was putting the word in quotation marks, implying *any* intellectual, ideal production, in contrast to an immediately practical, material one (in one of his works it is in this broad sense that he characterizes “theoretical” activity as, in general, creating “ideal” products in science and art [278, pp. 57-58]).

The role of the word is *different* in intellectual activity in general (including, for example, operation with general conceptions) and in specifically theoretical thought, which deals with concepts, in particular. The form of existence of the latter consists, above all, not in words (they function in the role of an important and necessary but external bearer of some meaning as an *abbreviation* when a group of homogeneous objects are “encompassed”), but in *methods of movement* for thought when deriving the particular from the general (in a means of *comprehension*). Rubinshtein has not properly delineated and accentuated this feature, in our opinion – he has often appealed to *verbal* formulations as the basic means of expressing a theoretical concept.[18]

Related to this circumstance, in essence, was the fact that Rubinshtein sometimes did not quite precisely indicate the specific nature of theoretical thought and its various forms. If the sum total of his ideas, as developed in recent works [277], [278], [279], is taken into account, two types of thought – empirical and theoretical – can be singled out. Theoretical thought is an altogether “sovereign” type of thought, which transforms raw sensory data through the specific operations of analysis and abstraction (in contrast to the comparison operation that is intrinsic to empirical thought). Thought, as such, for modern man is thought that is accomplished by analysis and abstraction.

Empirical thought can occur in three forms – object-effectual, visual-pictorial, and verbal-symbolic. But *theoretical* thought also has these three genetically and functionally related forms (see Chapter 7). Therefore a distinction should be made in the types of thought – in our view – not according to the external features of these forms, but according to the nature of the problems solved by them, according to the internal content of the activity appropriate to them, according to its method (in all forms empirical thought is accomplished by comparing similar properties of things and establishing them in a general conception; in all forms of theoretical thought analysis singles out the essence of things and fixes it in a concept).

In *Fundamentals of General Psychology* [*Osnovy obshchei psikhologii*] [276] Rubinshtein did not confine himself to this basis for distinguishing the types of thought (although it was to be found there in an indirect way, it was set forth in more detail in later works [277], [278]); however, here, too, a deviation from this basis is observed in a number of instances).[19] He delineated *visual* thought and *abstract, theoretical* thought (visual thought resembled empirical thought in many of its features). The first of them is related to image-conceptions, the second – with abstract concepts that are established in *words.* Here Rubinshtein, on the one hand, noted the essential nature of the distinction between these types (levels) of thought, and, on the other hand, the relativity of such a distinction, since "visual thought and abstract-theoretical thought turn into each other in a variety of ways." These are "two aspects of one thought; both concept and image function at any level of thought, even the highest." In this unified thought concept and image-conception are given an inseperable unity – "this unity functions as a unity of the general (a concept) and the individual (a conception)" [276, p. 363].[20]

These theses introduce confusion into the interpretation of the essence of the difference between the correlation of the various types of thought. If one speaks of a *unified* thought on the part of modern man, it will be the thought that has the features of *theoretical* thought properly speaking (this is the way Rubinshtein thought later, too; see above).[21] But in this instance "visual" thought cannot be a particular type that exists along with such a different type as theoretical thought. Indeed, it functions as a special form for accomplishing the latter (in addition there are still the "object-effectual" and the "symbolic" forms). In theoretical thought that occurs, for example, in the verbal-symbolic form, there can be participation of "images" as well. But this does not detract from the *abstractness,* since abstraction consists in a method of activity, in the delineation of the essence of a thing, and this occurs in object-sensory experimentation.

The unity of the universal and the individual functions in thought, not as the unity of a concept and an image-conception, but as a *transition in the form of a concept* (only a concept permits reflection of this unity, connection, transition). Concepts rather than images-conceptions allow a mental reproduction of the *concreteness* of reality. A "visual image" and a "concept" as features of a mental unity that reflect the connection between the general and the individual can be represented only if they are deliberately interpreted in a traditional, sensationalist-empirical sense. In the dialectical materialist theory of cognition a concept is characterized, not on the basis of "abstractness" (consequently, not according to a departure from "figurativeness" and "visuality"), but according to the person's having command of a *universal* method of reproducing and constructing the respective object (therefore a concept can be "effective" and "sensory").[22] On this level theoretical thought cannot be reduced to "abstract," verbal thought and opposed to "visual" thought or "visual-effective" thought.

Thus, in psychology, as in modern cognitive theory, thought must be subdivided into *empirical* and *theoretical,* without connecting each of this internally with any particular form of implementation (only then can there be a proper understanding of the interconnection, distinctiveness, and specific potential of these forms in a certain type of thought).

We have dwelt on this question because a confusion of the basis for articulating types of thought has been observed in psychology up to now. To many it seems altogether natural to contrast and then to seek a unity of the "visual image" and the "abstract concept," of "visuality" and "abstractness," of "visual-effective" and "theoretical" thought. Rubinshtein did not avoid this opposition in his day, although it is an *imaginary* opposition. The real basis for breaking down the different types and forms of thought lies elsewhere.

Let us turn to an exposition of the materials obtained by Rubinshtein and his associates in their study of problem solving (research by I. M. Zhukova, K. A. Slavskaya, A. V. Brushlinskii, A. M. Matyushkin, N. G. Frolova *et al*. [26], [278]). Thus, in the tests by K. A. Slavskaya the conditions for the *transfer* of the solution of one geometric problem (an auxiliary one) to the solution of another (the basic one) that was homogeneous with the first in a certain respect have been traced. An auxiliary problem was given to one group of subjects at the *early* stages in analyzing the basic one, and to a second group it was given at the *later* stages. It turned out that the first group solved the auxiliary problem at first as a completely independent problem, unrelated to the basic one, and only afterwards did they return to the basic one. Generalization of the solution occurred *gradually* here, *in the course of a detailed comparison* of the features of both problems. The second group of subjects solved the auxiliary problem at once, singling out in it the essential link that connected it with the basic problem, "on the spot" – here there was no need for a special, detailed comparison of the features of the two problems.

In treating and interpreting these facts, Rubinshtein notes that the external act of transfer conceals a generalization of the solution, which is accomplished by including both problems in a single analytic-synthetic activity, where the analysis of the conditions of one problem occurs through a correlation with the requirements of the other. During such an analysis there is an abstraction from the nonessential features of the first problem and a concretization of the solution with respect to the second. The level and peculiarities of the generalization depend chiefly on the extent and the depth of *analysis* of the basic problem, on the "purity" with which its essential relationships are delineated. "*When and how a generalization is accomplished depends on the analysis of the basic problem....* The course of the analysis of the basic problem determines how the generalization of problems is done" [278, p. 74].

If the essential conditions of a solution are not dismembered "purely" enough from the attendant circumstances in which the problem is initially presented, then the generalization of the solution is either missing altogether or is quite slight. In this situation generalization is ultimately achieved "in the form of a detailed, protracted process" [278, p. 115], through a correlation and *comparison* of the different instances of solution in which the "process of singling out the general in the sense of the similar" is accomplished [278, p. 113]. But if the analysis and abstraction were done profoundly enough and allowed the dismemberment of the connections essential for solving the problem in "pure form," the problem turns out to be solved not merely in a practical sense for the particular case, but also *theoretically* for *all* fundamentally similar cases. "The solution obtained for a solitary case gets a generalized significance.... Generalized thought at a sufficiently high level is theoretical thought" [278, p. 115].

Thus, generalization of the solutions to problems can occur in two ways: empirically and theoretically. The former is realized by a detailed *comparison* of the solution of two (or more) problems. The latter – through an *analysis* of just one problem. Rubinshtein points out:

> First-order generalization is achieved by a correlation and comparison of two cases, two problems; generalization of a higher order – by analysis, delineation of the essential connections within a single whole, analysis of the essential relationships within one problem [278, p. 43].

It is advisable to compare the features of the two types of generalization of problem-solving in compressed form:

> 1) generalization of the first type is done by a detailed *comparison* of the types of solution for a *series* of problems – here every subsequent problem is solved as a relatively *independent* and particular one through trial and error; only gradually are similar features found in these solutions, and this leads to generalization;
>
> 2) generalization of the second type occurs on the basis of an *analysis* of the conditions and requirements of *one* problem, which permits its *essential* relationships to be abstracted; by virtue of this the problem's solution *immediately* acquires a generalized significance and is transferred "on the spot" to a whole class of problems, providing it with a theoretical approach from the standpoint of a single type of solution.

The consideration of Rubinshtein's work shows that from his point of view the second type of generalization is a distinctive continuation of the first as a function of the extent to which a problem has been analyzed: the initial stages of analysis provide an elementary generalization, and the latter stages lead to a theoretical generalization. “Here there is movement from a disclosure of the general as the similar to a delineation of the general that is essential for the basic problem,” Rubinshtein notes [278, p. 114]. In other words, empirical generalization as a result of the initial stage of analysis functions as a precondition for theoretical generalization.

In our view, such an interpretation of the correlation among the different types of generalization does not correspond to the actual data in psychology, and moreover, substantially distorts the real state of affairs. Actually, one can conceive of the following: All of the subjects received the auxiliary problem at the very last stage in solving the basic one. According to the end product of their *independent* mental activity (generalization “on the spot”), one can state that they have shown theoretical thinking. This end product is obtained on the basis of singling out essential connections between the condition and the requirements in the problem. But comparatively later “intervention” in the analysis process deprives the subject of the necessary conditions for realizing and obtaining an adequate result. The subjects are *compelled* to reach the goal by empirical generalization. Consequently, such a generalization functions, not as a “natural” product of the initial stages of analysis, but as a regular end result of mental activity in conditions where, for *external* reasons, the possibility of unfolding a theoretical approach to the problem is lacking (we have in mind, of course, subjects taking part in the tests discussed by Rubinshtein, and the appropriate problems). But if this approach is developed without interference, then no preliminary or intermediate elementary generalization arises – it is not required, since the possible similar features of the solution are also established when the essential connections are singled out in passing, as it were, but in their own way.

Rubinshtein’s position in the matter of correlating types of generalization contains a certain contradiction. On the one hand, he connects analysis primarily with abstraction of the essential (see above) and emphasizes that something is essential, not because it behaves like something general, but it is general because it is essential [278, p. 40]. Consequently, the essential is singled out in the analysis process, and therefore so is the general, the similar, singled out. On the other hand, in analysis itself he perceives a particular initial stage that leads to the revelation of the general as a stepping-stone to the essential. These two positions contradict each other, in our view. To be sure, Rubinshtein believes that the general or the similar is a probable indicator of the essential (therefore his hypothesis to the effect that the general is established “in the beginning,” and “then” the essential, becomes clear). But then it would also be suitable to describe the function of analysis as determining the general *and* the essential – which Rubinshtein does not do in speaking of analysis only as a means of detecting the essential and *therefore* the general.[23]

The problem of delineating the general merely as the similar is solved by comparison and special analysis and does not require genuine abstraction. This is a relatively independent level of mental activity – the *empirical* level. For most children this level of generalization is not compulsory (as it was in the tests described by Rubinshtein) but is the only one accessible to this. Krutetskii’s studies (see Chapter 4) found that most students generalize the solutions to mathematical problems only through gradual and protracted comparison. Only some children found a generalized solution when breaking down one problem and then applied it to all problems in a class at once, “on the spot.”

The features of the two types of generalization delineated by Rubinshtein coincide with the description of the two types of generalization in the work by Krutetskii and other psychologists. One can therefore conclude that in these works, as in the studies by Rubinshtein’s associates, *the difference between empirical and theoretical generalization has been ascertained experimentally in students’ mental activity* – the difference between ways and means of realizing them, as well as their cognitive effectiveness. The features of each type of generalization find their proper explanation in the revelation of their function within two different types of thought – empirical and theoretical.

This circumstance is particularly important since in another case the sources and possibilities of those types of generalization receive an interpretation that is remote from their real nature. Thus, Krutetskii does not qualify the types of generalization he has described as “empirical” and “theoretical” – in particular, he does not treat the typical features of the second type of generalization as a particular manifestation of theoretical thought, having its own logic and its own guiding principles. Therefore he could not – in our view – indicate the real sources of this type of generalization. From his point of view, they are rooted in an orientation in mathematical relationships, on certain persons' part, that has an *innate character*, depending on the innate uniqueness of the neurophysiological processes of these persons' brains [174, p. 398]. Ignored here is the historically developing nature of theoretical thought, the *mastery* of the means and norms of which by particular individuals also determines their skill in making theoretical generalizations.

Let us consider another point in Rubinshtein's theory which concerns the role of the *concept* in the process of problem solving. This process itself, in general form, is conceived as follows. Confronting a problem situation, a person first breaks down its conditions and requirements, the known data, and something unknown or desired. By virtue of this the situation acquires the formulation of a problem properly speaking, in which the unknown is present through its connection with the known. The mental activity "consists in proceeding from what is explicitly given, known, to determine what is implicitly given – that is, assigned, unknown, which functions as what is being sought during this process" [278, p. 15].

The chief link in mental activity is the particular form of analysis through synthesis. Rubinshtein writes:

> ... This basic *form* of analysis, the basic nerve in the thought process, involves the following: *the object in the thought process is included in ever newer connections and therefore functions in ever newer capacities, which are established in new concepts; all of the new content is taken out, as it were, from the object in this way; it is seemingly turned over on another side every time, and new properties are always being revealed in it* [278, pp. 98-99].

This "turning" occurs in the process of analyzing a problem's condition when it is being correlated with the requirements and, as a rule, functions in its results as a re-formulation of the problem's initial elements, which, when included in new connections, function in a new capacity and therefore in a new conceptual characterization.

> Re-formulation ... means a change in the object's conceptual characterization as a result of the subject's mental activity and at the same time the dependence of the subsequent course of the subject's mental activity on the conceptual characteristics in which the object is functioning [278, pp. 136-137].

During the re-formulations some theses are replaced by others that open up greater opportunities for further analysis aimed at articulating the problem's condition in the *proper* sense – that is, those theses that determine the reasoning process leading to the solution. Analysis also includes the delineation of the *essential* condition that leads to a *generalized* solution.

Before ascertaining the role of "conceptual characteristics" in the problem-solving process, there must be a brief description of the interpretation of its general features in traditional psychological teachings about thought. As is known, in most of these teachings it has been presumed that thought arises in a problem situation, whose resolution requires a certain modification of the conditions openly given in it (what is known – that is, the original subject of thought). During this modification ("analysis," etc.) of the conditions there is a delineation ("judgment") of the previously concealed relationships, reliance on which also leads to a solution of the problem. Here the interpretation itself of the peculiarities of the raw data and of the structure of the "analysis" is quite different and even opposing (classical associationist, behaviorist, Gestalt, and other theories).

But in one aspect all of these theories, as a rule, are similar: it concerns the interpretation of *what* determines whether relationships are specified as "open" or "closed." It is assumed that, for all of the difference in content in these relationships, whether they are specified directly or indirectly depends on the presence or absence of certain intermediate content characteristics of the object that permit passage from the known to the unknown. In principle it is admitted to be allowable for certain new relationships that are detected by thought to be specified openly at once in another situation and *established in the same form of conception or concept in which the "old," open properties were established.* The possibility of some relationships being specified in an open or closed way is not linked *with* a *certain form of reflection* and operation with the object of thought in these theories.

Therefore the matter of *what form of specification* makes certain relationships concealed or open for the subject and the *form in which to translate* the raw data in order for them to "manifest" the qualities necessary for solving the problem is not delineated or especially investigated within the confines of the theories under consideration. Naturally, with such an approach the subject's activity in *translating* the raw data into the form of reflection (conceptual form, say) at whose level the possibility of treating new relationships and qualities in an object is disclosed is not given special treatment. The mechanisms of the thought processes amount to a *modification in the content of the objects of thought themselves* by "taking away" or "adding" to them certain "parts" and "relationships" – that is, the subject's activity in changing the forms for specifying certain known relationships is ruled out of them.

It is known that, for example, in Gestalt psychology problem solving is characterized as a series of "conversions" and "transformations" of the initial problem situation [385]. But, as Rubinshtein has shown, in these instances "new aspects" that are detected during the transformations of situations are treated by Gestalt psychologists, not "as the subject's discovery of new sides to an object, but as a modification – a re-centering ... of the situation, whose dynamics is supposedly made up of the thought process" [278, p. 18]. The *actions* of the subject himself with the *object* are ruled out of this process. If a problem's solution presupposes a correlation between its conditions and its requirements, then it is treated by Gestalt psychologists as a correlation into which "the problem's conditions and requirements enter with one another, by virtue of the dynamics of the situations, apart from the thinking subject's activity of correlating them" [278, p. 18]. The solution is opened up here "in the dynamic instruction of phenomenal situations;" thought is transferred to the "phenomenal object" [278, pp. 18-19]. Thus, in this essential question Gestalt psychology is akin to associationism.

In our opinion, this is one of the consequences of absolutizing the empirico-sensationalist approach to thought, in which it is impossible to indicate the specific nature of the objective content that is *discovered* by the person only in concept form. With such an approach the transition from perception and conception to a concept was regarded merely as a change in the subjective form of the *same* content, which is independent of it – therefore the possibility of detecting new content was regarded apart from the connection with the change in its form.

In this question Rubinshtein's position does not overcome the fundamental aims of traditional psychological theories. According to his theses, an object is included in new, real connections and *therefore* discloses its new qualities. A concept is a means of *establishing* new qualities, which are consequently detected by the subject even *before imparting conceptual form to them*.[24] The conceptual characteristics function here as a means of *retaining* new qualities of an object that have already been found, but not as an active form of accomplishing the *discovery* of new qualifies or new relations in an object.

Here the central problem, which concerns the function of a concept in a mental act, is set aside: *by what means can the subject* set an object into new relationships, thereby also discovering its new qualities? *With* what "subjective levers" does a person *turn* an object in order to have an opportunity to "exhaust" its new qualities?

These questions do not get an answer within the confines of theories that do not connect the process of discovering a new quality, the process of "turning" an object, with the *particular* forms of reflection as modes of the subject's activity.

If concepts are taken *only* from the standpoint of their substance, their establishing function, then the detection process for implicitly specified properties remains unexplainable, since in this instance it is impossible to indicate the subjective means of goal-oriented movement in an object's content, the means of "turning" it. But this process becomes explainable, in principle, if a concept is considered, not just from the standpoint of content that has already been found and established, but also as a specific *means* for the subject to *act* in detecting still hidden qualities of an object (not just any qualities but *completely definite ones*). Such a function belongs to a concept because the concept is a special type of model created in the process of human cognitive activity. Translating an object into the form of a *model* permits detection of properties in it that are undiscloseable when operating with it directly (for more detail on this, see Chapter 7, as well as [422]).

We have, of course, by no means exhausted the whole range of ideas in the theory of thought created by Rubinshtein. In the context of our own problem it was important to show that the following theses are clearly drawn in this theory: 1) a characteristic feature of the "mind" of modern man involves determining the essence of things when there is a subsequent explanation of different phenomena on the basis of a concept of this essence (ascending from the abstract to the concrete as a method of theoretical thought), 2) the difference between ... empirical and theoretical thought is determined by the difference between ways and means of accomplishing generalization, 3) the uniqueness of a theoretical generalization is that it is accomplished by analysis and abstraction of the essential properties of things (this serves as a basis for a generalized solution which is developed for an isolated problem and then is transferred "on the spot" to all problems in a class), 4) mental operations (analysis, generalization, etc.) should be revealed as forms and methods of the subject's activity with an object.

These theses create the preconditions for overcoming the consequences of the empirical theory of thought which, in our opinion, are the greatest obstacles to developing the psychological foundations for students' instructional activity. Rubinshtein has connected sensationalist empiricism and the absolutization of empirical thought with the traditions in the psychology that has relied on traditional formal logic. It was a thorough reliance on the principles of dialectical logic during the design of a psychological theory of thought that he saw the only way to liberate psychology from sensationalist empiricism, in general, and from the empirical theory of generalization, in particular.[25]

Jean Piaget on the Role of Operations in Thought

The comprehensively developed theory of the development of the intellect, which relies on numerous experimental studies, belongs to the contemporary child psychology of Jean Piaget. One of the central features of this theory is the profound discovery of the role of a subject's operations in his thinking, which, naturally, distinguishes Piaget's position in an essential way from the aims of associationism and Gestalt psychology and largely promotes his proper understanding of the basic principles governing the formation of children's intellect.[26]

Cognition, according to Piaget, relies on a real, practical interaction between subject and object. The subject affects the object and thereby transforms it. In these transformations the subject grasps the mechanism by which the object is produced, reveals its properties and methods of reconstruction. "... Knowing means reproducing an object dynamically, but to reproduce one must know how to produce...," Piaget writes [244, p. 43]. Within this interaction "the subject, revealing and coming to know the object, organized his actions into a structured system, which constitutes the operation of his intelligence or thought" [244, p. 43].[27]

The development of a person's thought is – in the most general form – an organization and coordination of actions into a system that constitutes his operations (operator structures). The formation of this system provides the subject with a necessary equilibrium with objects by self-regulation (equilibrium on the basis of intellect is a particular case of biological equilibrium in general).

Operations (operator structures), which function as psychological mechanisms of thought, are "internalized actions in their general form, reversible and coordinated into structures of a coherent whole" [244, p. 34]. The formation of the intellect thus consists in the internalization of object-related actions, in their acquisition of reversibility, coordination, and coherence.

Along with internalization, the chief constituent property of operator structures is their reversibility – that is the mind's capacity for moving in one direction or its opposite. This is the fundamental law of composition, which is intrinsic to thought.[28] Reversibility takes place when (Piaget writes) "operations and actions can unfold in two directions and an understanding of one of these directions elicits ipso facto an understanding of the other" [243, p. 15].

Reversibility has two forms, which supplement each other but are not reducible to each other: conversion (inversion or negation) and reciprocity (compensation). Conversion is observed, for example, where the spatial shift of an object from A to B can be canceled out by transferring the object back from B to A, which in the result is equivalent to the null transformation. Reciprocity presupposes the case where, for example, an object is shifted from A to B and remains at B but the person himself is shifted from A to B, and the initial situation is thereby reproduced – the object is opposite his body once more. The object's movement is not canceled out here, but it has been compensated by the corresponding shift in one's own body [243, p. 16].

In Piaget's works it is shown that these forms of reversibility arise originally in the form of sensory-motor schemes (age 10-12 months). A gradual coordination of these schemes, symbolic and linguistic representations, lead reversibility to become a property of intellectual operations in a series of stages.

As is known, modern mathematics (the works of N. Bourbaki [50]) delineates three basic productive structures – the *algebraic structure*, the *structure of order*, and the *topological structure*. Piaget believes that his studies of the development of operations in the child allow the operator structures of thought to be correlated precisely with these mathematical structures [243, p. 13]. Thus, to the algebraic structure (the group) there correspond operator structures that are subordinate to one of the forms of reversibility – inversion (negation). A group has four elementary properties: 1) the product of two elements in a group also yields an element in a group, 2) to a direct operation there corresponds one and only one reverse operation, 3) there exists an identity operation, 4) consecutive compositions are associative. In the language of actions this means: 1) the coordination of two systems of actions constitutes a new scheme, which can be annexed to the preceding one, 2) an operation can be done in two directions, 3) when we return to a starting point we find it unchanged, 4) we can arrive at one and the same point in different ways. Piaget writes: "In a general sense a 'group' is a symbolic translation of certain definite fundamental properties of the action of thought; the possibility of coordinating actions, the possibility of return and of deviations" [243, p. 16].[29]

A form of reversibility such as reciprocity corresponds to an order structure. In the periods from 7 to 11 and from 11 to 15 years of age, the system of actions that is based on the reciprocity principle leads to the formation of an order structure in the child's thought [243, p. 20].[30] Studies of the formation of geometry concepts in the child have shown that first he develops topological intuition, then an orientation towards projective and metric structures. Therefore, as Piaget notes, in the first attempts at drawing the child does not distinguish along squares, circles, triangles and other metric figures but is good at distinguishing between open and closed figures, "outside" or "inside" situations with respect to a boundary, division and proximity (without, for the time being, differentiating distances), and so on [243, p. 23].[31]

Since operator structures of thought pass through a series of periods in their development, it is important to represent the scheme for them as outlined by Piaget.

The first period in this process is related to *sensory-motor intelligence* (it develops in the second half of the first year of life and continues until two years). In its schemes inversion and reciprocity are already occurring, but as the child's purely external, motor behavior (for example, moving an object and bringing it back toward oneself). But here the schemes for the various motions are *coordinated* by *combining* (joining two movements into a single whole), *ordering* (using means to achieve a goal; for example, the child begins pulling on a blanket in order to reach an object lying on it), *establishing a correspondence* (imitation), and so on. These coordinations, which develop even before speech appears, serve – in Piaget's words – "as a logic of action of their own kind" and as a foundation for further development of operations.

Coordination of actions ends (for example, coordination of shifts in one's own body or in objects – by 12-18 months) by forming the structure of a "group" (it acquires reversibility and associativity). "Reversible mobility" of sensori-motor structures is the prototype of reversibility of future operator structures [244, pp. 38-39].

The period of preparing for and organizing concrete operations contains two sub-periods; the pre-operational *thought sub-period* (2-7 years) and the period of organizing *concrete operations themselves* (7-11 years). In the first one the child develops a symbolic function, which allows a distinction to be made between a *designation* and the thing *designated* and thus the use of designation for mentally reproducing what is designated or for indicating it (the action of substitution). In this way *conceptions* appear, symbolizing objects not directly perceived. The schemes for external actions are transferred to the level of conceptions; they acquire the form of "mental experimentation." The child passes through the real sequence of events in his mind, as it were, seemingly reproducing the sequence on the outside (for example, he does the transferences mentally whereas before he did so by using objects). Here there is still no essential schematization, reconstruction, and transformation of the sequence itself, no chain of real actions. Therefore their mental repetition does not yet *possess* reversibility [244, pp. 45-46].

Piaget calls these mental formations which are riveted to real actions "preconcepts," whose connection in judgments is accomplished by the transduction principle (from the particular to the particular) [393, pp. 221-230].

The period of organizing (forming) *concrete operations* comes at the age that is for us primary-grade age. A general feature of this sub-period, in contrast to pre-operational thought, is that here the child's mental activity gradually takes on the property of reversibility and a definite structure – that is, it rises to the level of operations. But this is found, for the time being, only in object situations rather than at the level of purely verbal statements and judgments (these are *concrete* operations). At this age the child shows himself to be a reasoning being, who is able to make a systematic correlation between certain ordered concepts and the real objects in his surroundings.

It is typical of this sub-period that the child can perform operations of the type of *groupings*, arithmetical *groups,* and can perform *measurement.* One of the types of grouping is the primary composition of classes. To verify whether it has been formed, the child is offered the following assignment on inclusion of classes, for example. The child is given 20 wooden beads (B), 17 of which are brown (A), but the other 3 are white (A'). The child is to answer the question: "Which necklace will be longer – the one made of *brown* beads or the one made of *wooden* ones?" [394][32] Another assignment on the same grouping might be as follows: the child is given several pictures of flowers (for example, 7 primroses, 2 roses, and 1 carnation), and the question is raised: "Are there more primroses or flowers in the bouquet?" [244].

Children of 5 or 6, who are at the level of pre-operational thought, as a rule, respond in this way: "The necklace of brown beads will be longer because there are only three white ones" or "There will be more primroses because here there are three flowers." According to Piaget, such responses occur naturally because these children still have no *reversible* system of operations with classes by which they could retain both the whole and its parts in their thinking at once. When the children start thinking about a part (A) they destroy the whole (B), and only the other part (A) remains. Therefore they respond that A > A', although they are being asked about the relationship between A and B (A < B). After the aggregate B has been divided it no longer exists for these children – which is an index of the pre-operational character of their thought. Piaget writes: "To understand the inclusion A ⊂ B, one must mentally preserve the whole and be able to reason backwards: A + A' = B, and therefore A = B – A' – that is, A < B" [244, p. 46].

By the age of 7 or 8 children solve these assignments correctly, since they regard A, A', and B in a state of reversible equilibrium – A and A' function both as independent classes and simultaneously as sub-classes of B. The ability to think about parts and the whole *at once* is an index of reversibility as a property of an operation (then for B = A + A' the children conclude that A= B – A' and A' = B – A) .

Another classic test of Piaget's describes a grouping related to the multiplication of relations [244]. If a child of 5 or 6 years pours water from glass A into a narrower glass B, he usually states that there is more water in B since it rises higher. The child's failure to understand the conservation of matter here again – in Piaget's opinion – is explained by the absence of reversibility at the pre-operational level. The child does not consider that the contents of B can be poured back into A, and, what is most important, he does not grasp that although the column of liquid in B is taller, it is thinner. Children who are at the level of concrete operations solve this problem correctly, since they consider not only the observed state but also the nature of the transformation that led to it. These children consider the compensation feature since they can already multiply the "higher than ..." relation by the "narrower than ..." relation. As a result they discover the fact that although the column is higher it is also thinner, and consequently the amount of water is identical.

At the level of concrete operations the children begin to treat particular cases of transformation as a special manifestation of some *integral* system of potentially possible operations. If a child can combine any two classes according to the relationship A + A' = B, then he can continue such a combination further: B + B'= C, C + C' = D, and so on. An integral classification therefore emerges.

In the period of formal *operations* (11-15 years) adolescent children form the level of equilibrium toward which all of the previous development of the intelligence has been moving and which is intrinsic to adults. The basic feature of operator structures in this period involves a characteristic correlation between the immediately actual state of things as observed by adolescents and their potentially possible, conceivable connections. At the level of concrete operations the children discovered the sphere of the potentially possible as a direct *continuation* of directly established relationships. But at the level of formal operations the solution to a problem begins immediately with the establishment of all possible relationships, with a rough draft of the possibilities themselves, and only then is there an experimental check of which of them actually occur. In other words, a series of hypotheses is advanced initially here, and then a systematic verification of them follows – and accordingly thought has a *hypothetical and deductive* character.

Construction of arguments of the following type is typical at this level: “According to the available data, A alone or B alone or both of them together can be a necessary and sufficient condition for the event N; check these possibilities in turn and establish which one of them is observed in fact.” In this instance a series of combinations – hypotheses – are advanced in the beginning during the analysis of the causes of the event. For example, the following combinations can be constructed for variable factors A and B as possible causes of N: 1) A leads to N but B does not, 2) B leads to N but A does not, 3) A together with B yields N, but neither of these variables taken separately leads to N, and so on. Then one must verify experimentally, and according to a certain plan, which of these combinations is true and which are false (appropriate tests with adolescents are described in detail in the works of Piaget and his associates; see, for example, [380, pp. 105-120], etc.).

At the level of formal operations thought is accomplished on the plane of *sentence statements* which record the results of previous object actions in verbal form. This sort of thought establishes *logical* connections between statements – that is, it constructs arguments. It is hypothetical and deductive, and combinatory. When encountering certain problems, adolescents and adults solve them by an appropriate combination of factors, by delineating and monitoring variable factors, and by formulating and checking out hypotheses (for instance, causal connections can be discovered by keeping some one factor unchanged for the purpose of detecting the consequences of varying the others). These features of formal intelligence allow the person to be an excellent instrument for *scientific* investigation of the cause-and-effect relationships of things.

Piaget describes such thinking as follows:

> Formal thought is reflection about ideas.... At the same time formal thought is a change to reverse relationships between the real and the possible; empirical data are included as a separate part in the sum total of possible combinations....
>
> The structure of theories in the adolescent always shows that he has mastered the capacity for rational thought and at the same time that his thinking permits him to break away from the realm of the real and to encroach upon the domain of the abstract and the possible [380. p. 341].

We shall return to a consideration of the essence of Piaget’s notions on thought below. But here we shall be treating the way in which he describes the role of the *concept* in thought and its correlation with perception and conception. According to the general aims of his theory, physical, mathematical, and other aspects of reality have the form of *states* and transformations. In cognitive functions the so-called figurative aspects (perceptions, images of a conception) correspond to states, and the operator aspects which reproduce these transformations, by virtue of which an understanding of them occurs, correspond to transformations. Piaget writes: “... Without affecting the object or transforming it, the subject cannot understand its nature and will remain at the level of simple descriptions” [244. p. 34].

The problem of correlating these aspects is made concrete in the form of three questions; 1) Does a concept follow exclusively from the figurative aspects, or are operator mechanisms necessary for its formation? 2) Do these mechanisms arise autonomously, or do they result from figurative structures? 3) Are figurative aspects developed autonomously or under the influence of operations? The analysis of many experimental materials which Piaget has made shows that *concepts* have much more content than perceptions. Thus, the concept of projection includes two kinds of properties, which go beyond the limits of immediate perception: coordination of different points of view, permitting revelation of the *reason* for a change in the apparent form of an object that is displaced, by the possibility of *foreseeing* that form for an object, which it will only have upon a subsequent displacement. These features result, not from perception, but from the subject's *actions* in the process of their internalization and acquisition of reversibility. This operator aspect of a concept cannot be expressed in perceptual structures. Piaget writes; "The possibility of deriving operator structures or structures of concepts from perceptual structures is thus ruled out" [244, p. 37].

Attempting to extract a concept from just one perception ignores the fact that, in addition to these two terms, there is a third fundamental one – their *common source* as a system of sensori-motor structures; as for the images of conceptions ("mental images"), they are necessary to operations as symbols of states, but are likewise altogether inadequate for an understanding of transformations. Summarizing the appropriate data, Piaget answers the three aforementioned questions as follows: 1) images of perception and conception are insufficient for forming concepts – an operator activity that is not reducible to figurative data corresponds to them, 2) figurativeness lacks the revelation of transformations as changes in states, 3) perceptions are not developed autonomously – their evolution occurs under the determining influence of operations.

Consequently, according to Piaget, actions – the transformation of an object and the reproduction of the transformation (these processes are *understanding* of the object) – underlie a concept. The internalization of object actions, their acquisition of a systemic quality and of reversibility, provide the concept with its logical content and its form at the level of formal (rational) thought.

Piaget clearly and directly *opposes* this approach to the concept to the positivist position which comes to logic from Aristotle (in essence it is the position of *traditional* formal logic and of its corresponding empirical associationist psychology). Thus, he notes that for the positivists the elements of a concept follow exclusively from the figurative aspects:

> ... Positivists ... see in concepts the product of perception – abstract, generalized, and formulated with the aid of language [244,p. 34].

Indeed,

> even though a concept extracts the necessary information naturally from perception, still this concept does not result from perception by simple abstraction and generalizations, as Aristotle believed and as modern positivists think. The operator aspect of a concept ... is formed by sensori-motor structures or else by structures of action in general [244, p. 37].

The description of concept formation by "simple abstraction and generalizations" of the data of perception, the interpretation of a concept as a product of perception that is "abstract, generalized, and formulated with the aid of language" – all of this, as has been shown above, is typical of the empirical theory of the concept which is peculiar to traditional formal logic and associationist psychology and then adopted by modern positivism. Piaget shows the *actual unsoundness* of this treatment of the concept, which ignores the object action that transforms the object, as a genuine basis for a concept, for understanding. The experimental data obtained by Piaget and his associates have considerable significance for criticizing and surmounting the empirical theory of generalization and concept formation.

Piaget's criticism of the positivist approach to the concept is merely a particular feature of his general critical attitude toward the ideas of *traditional* formal logic (or the "logic of textbooks," to use his own terminology). Thus, he writes: "Classical logic (that is, the logic of textbooks) and the naive realism of common sense are the two mortal foes of a healthy psychology of cognition..." [242, p. 64]. Piaget believes that classical (traditional) formal logic and 19th-century associationist psychology were unanimous in their interpretation of the data of perception and the images of conception as the exclusive sources of thought.[33] At the same time the fear of "logicism" in psychology has meant that psychologists have begun turning less and less to modern logic as a basis for their general approaches to thought. As a result, as Piaget notes, "most modern psychologists try to explain intelligence without any treatment of logical theory" [246, p. 574].

But, in opposing the traditional "logic of textbooks," Piaget at the same time clearly understands that the psychology of thought loses the *objective* criteria of its structure if one does not proceed from a certain *logical* conception. He stresses the need for a *unity* in the psychological and logical approaches to thought.

In many of his works (see, for example, [243]. [246]. etc.) Piaget consistently develops the idea that real cognitive structures can be investigated most adequately through the resources of *mathematical* logic, which describes various logical structures. Thus, logical groupings of classes and relations correspond to the level of concrete operations. But the structure of formal thought can be described correctly by prepositional logic and the logico-mathematical concept of a group.

According to Piaget's views, *modern* formal logic (mathematical logic) describes its own structures in axiomatic form. But psychology, in studying the stages in the formation of intelligence, finds real operator structures that are appropriate to them, which are different levels of equilibrium for operations. Psychology investigates the principles governing the formation of these levels of equilibrium in the individual, and in definitive, formulated form they correspond on the whole, to the structures described in mathematical logic.

To understand the internal basis for this position of Piaget's, an essential distinction that he draws between the sources of physical and logico-mathematical experience must be taken into account. Above all, he emphasizes that the subject's actions with objects are at the foundation of both of these. But if physical experience is formed by transforming objects and abstracting their *own* properties, which belong to them even before the actions with them, then what is intrinsic to mathematical-logic experience – as Piaget writes – is an abstraction "from the object of characteristics pertaining to the actions themselves, which change that object, rather than from the object of the characteristics revealed through these actions but independent of them" [244, p. 50].

Thus, the uniqueness of logico-mathematical experience is that it involves "abstractions from the actions themselves and coordination of them." These abstractions are the basis for logico-mathematical operations. The point is not merely that these operations are derivatives of actions, but that all of these actions, included in the person's real, physical experience, are "inseparable from the general coordinations, whose nature is a logico-mathematical (combining, ordering, setting up a correspondence, etc.)" [244, p. 51].

According to Piaget, intelligence, thought, mind is ultimately a *coordination of actions* into a system, and since this coordination by its nature has a logico-mathematical character, thought, too, as such, has the logico-mathematical structures described by the appropriate logic at its basis from *the very beginning.*[34]

A certain physical characteristic of an object is reproduced by man through a specific action. But in order to become an object of thought (a concept), it should be drawn into a system of internalized and coordinated actions – into operations that are subordinate to the laws of mathematical structures. Only in this system does any real property, while remaining the object of physical experience, at the same time function as a mental object in general, as an object of formal thought. Therefore, as Piaget notes, the objects of logic and mathematics in themselves remain "uncertain, since the matter concerns general coordinations rather than concrete and differentiated actions, as happens in physical experience" [244, p. 51].

Thus, even in sensori-motor acts certain general coordinations show up as prototypes of specifically mathematical logical structures. At the level of concrete and formal operations, an internalization and systematization of these general coordinations is accomplished. At the formal level these structures acquire the "purity" and "completeness" that permits their formal features to be established in the concepts of mathematical logic. The operator structures of thought that have developed serve as a psychological basis for mathematics itself. Piaget writes directly that "Bourbaki's three fundamental structures correspond to the elementary structures of thought, of which they are a formal extension" [243, p. 16].

Here we have approached the innermost point in Piaget's entire theory. The materials cited above provide grounds for concluding that he has *illegitimately* converted one particular aspect of combined human mental activity that is related to these structures into a description of all of thought as a form of activity. The property of reversibility is specific to orientation toward the mathematical aspect of reality; Piaget has made an index of thought as such.

Piaget's notion about the role of invariants in cognition is the source for a similar reifying of one aspect of thought. The formation of reversibility is the basis of decentering the relation between subject and object. This is equivalent to deepening the objectivity of knowledge, since the development of the reversibility (systematic quality) of operations permits the subject to single out and establish the *invariant* features of an object that are persistently retained when the particular conditions for its observation are constantly changing or when it is undergoing various transformations. The delineation of such invariants liberates the person from possible illusory notions about the object and functions as a basis for forming a concept of it.

Most of the experimental studies by Piaget and his associates were aimed at clarifying the stages in the formation of children's "understanding" of the principle of *conservation* of quantity, substance, weight, and volume in objects when they undergo various external changes and transformations. An "understanding" of conservation presupposes delineation, *from the whole variety of relationships of an object,* of a certain invariant of this (for example, the volume of a fluid is conserved throughout all the changes in the height and diameter of a column of fluid when it is poured from one vessel into another). Formal thought is characterized by its possession of the "idea of conservation" and is guided by it in appropriate situations. Since mathematics has the most powerful formal apparatus for describing invariants, Piaget takes the mathematical theory of invariants – in particular, group theory – as a means of describing and analyzing mental activity in general.

Considerable attention has recently been paid in works on logical methods to the problem of invariants as the particular content of thought (see, for example, [186], [230], [277]. etc.). Thus, Rubinshtein made the observation that invariants are *indicators* of objectivity and the degree of the independence of knowledge from a person's point of view from his cognitive perspective [277, pp. 125-126]. Theses are often promulgated to the effect that invariants serve as particular objects of specifically scientific thought in contrast to everyday, commonplace thought.[35] Is this actually so? And is it legitimate, in delineating invariants, to perceive – as Piaget does – a higher level of mental activity?

In the analysis of the nature of invariants one should turn to the category of essence that is used in dialectical logic. The point of view of essence is the surmounting of the immediacy of things, the demonstration that they are substantiated by something else.[36] Essence is the *basis* that lies under transitions from quantity into quality and vice versa. This is *identity* with itself.

In considering this identity, one can abstract oneself from the differences, which here are either simply omitted or "merge" into a single certainty. Then we single out the essence in the form of a *formal* or *rational* identity. The reflection that leads to such an essence is also formal – it only externally divorces the direct and the mediated, merely translates an external content into internal form (such reflection is typical of daily life and of the descriptive disciplines, since here, as Hegel believed, it is merely a matter of satisfying the "domestic requirements of cognition" [79, p. 209]).

The real problem of thought is to preserve an identity which includes differences and occurs in combination with them – that is, to preserve a *concrete* identity. In such an essence each serves as the "other" to the other, by virtue of which the essence can also be a basis of something that is, a unity of identity and difference. This sort of concrete identity serves as a basis for a genuine concept reflecting the process of development of a whole, where the identity of what has been differentiated within the whole is made immediate and external.

For instance, a plant develops from its own embryo – *develops*, since although parts of the plant do exist in embryo, they do not exist as real parts (not in a reduced real form), but as a potential for them.

Consequently, cognition does not dwell on discovering essence – it passes to a concept as a method of representing a thing's *development* from some genetic base, as the derivation of the different within the whole, as a realization of the unity of identity and differences. Only on this path of ascent from an abstractly expressed essence to the concrete does thought display its real theoretical force and depth of reflection (we shall describe this process of ascent in detail in Chapter 7).

If the typical features of invariance are compared with this picture, it can be found that invariance does not exceed the limits of essence as a certain "abiding" foundation for the transitions made between quality and quantity – that is, formal identity. Actually, in transformations of things that sharply alter their external certainty, one detects in them the persistence, or invariance, that functions as a common basis for all possible and particular states (the conservation of a total volume or weight when a thing is divided into parts, and so on). The domain of invariants is the domain of essence, to which the entire diversity of its manifestations is *reduced.* But this is not yet the domain of the real concept as a form of theoretical thought, as a method of deriving this diversity from essence, although, to be sure, establishing invariance creates the *preconditions* for such thought.

According to Piaget, formal thought, in the first place, is reflexive (it is "reasoning thought"); second, it encroaches upon the area of the abstract and the possible (see above). It would seem that these are the characteristics of conceptual thought. But this is far from being so. Reflection in itself can remain within the confines of essence. Moreover, reflection can remain purely formal, merely opposing the immediate and the mediated, without connecting this through a consideration of a thing's process of development.

The reflection described by Piaget has just such a character – it permits man to dismember the stable, the invariant, the essential from assorted particular features that seem to be "merged" into one certainty of purely *quantitative variation* in this invariant. Thus, the same volume can be represented by *different variants* of the relationships of the solid's length, width, and height. The search for, the establishing of, and then the actual checking of the *possible* sets of these relationships or combinations are by no means equivalent to theoretically *deriving* the different from the general as a reflection of the development process. Finding possible combinations *does not reveal the origin* of the particular phenomena or their universal form, which exists as a real, genetically originating relationship.

The interpretation of the mentally general as a reflection of a real relationship that is given by the senses and that engenders the entire diversity of the concrete is alien to Piaget's position. The invariant as the general is an abstract-formal formation, which is delineated in things by means of specific *transformations* of them.[37]

The level of thought described by Piaget as "formal" cannot be defined as the highest level of "thought in general." "Formal thought" as described in his works is thought that stays at the "intellect" level and does not yet reach conceptual form. The "intellect" feature is necessary, of course, in the integral process of theoretical thought.[38] But if this feature begins to prevail and to become the "predominant force" in real mental activity, thought takes on primarily a classifying and combining character. Ultimately it can be converted into activity that is directed at making up different formal combinations by applying a certain strict set of rules.[39] The feature of comprehension here is kept to a minimum or even disappears altogether (the latter is observed, for example, in so-called "machine thinking").[40] When thought is concentrated on searching for variants of the existence of some "invariant," there is an autonomization of its intellectual combinatory aspects, a conversion of them into a relatively independent type of activity.

Something analogous is also observed in the theory of the logic of psychology. Primary study of the conditions for the delineation of invariants as a basis of judgments can lead to making this form of thought absolute if the doctrine of ascent as the method of constructing the theory of the subject is not accepted. In our opinion, this is just what has happened in Piaget's studies. Ascertaining the formation of reversibility, he identified with thought in general only that type (stage) of it that provides for the construction of judgments and conclusions on the basis of combinatory schemes.

The adoption of mathematical logic as the only possible type of modern logic leads Piaget to a one-sided study of thought, since this logic "grasps" only those aspects of a concept and of judgment that are important for constructing a *formal* conclusion (see Chapter 2). These aspects are adequately described by mathematical *structures*.[41] Thus, in one of his own works he notes that the scope of a concept is determined by systems of classes in which there is a conversion leading to an algebraic structure. But the concept's content is determined by a system of relationships in which there is a reciprocity leading to an order structure. There is a close connection between these structures, which is affected by the connection between the scope and the content of the concepts [243, p. 22]. But the study of such structures as these by no means covers all of the properties of mental activity in general and its theoretical level in particular.[42]

Let us consider another question, which Piaget connects with the sources of coincidence between operator structures and mathematical structures. As has been noted, he stresses that in the experience of mathematical logic, it is not the "absolute" properties of things that are abstracted but the characteristics that are related to the performance of the action itself and that are not present in the object prior to it. Thus, a stick was flexible even before the child bent it – it did not become flexible because it was bent. At the same time neither a linear nor a cyclic order of stones existed in *these* stones before they were arranged by an appropriate action which imparted *new* characteristics to them. This feature of the experience of mathematical logic serves as a foundation for the deductive character of all mathematics – instead of being done with stones, this same action can be done on any other objects – in particular, on those that are designated by symbols 1, 2, 3 or X, Y, Z. The properties of these objects still depend on the actions rather than on the objects themselves.

In our opinion, the general nature of the objects of the type of thought that is investigated by Piaget shows through distinctly in these examples. If an action introduces some new characteristic into an object (for example, conferring ordering on a pile of stones), this means that the object is appearing to the person only from an aspect in which any changes do not deprive the object of its objectivity and which, consequently, is *indifferent* to all qualitative peculiarities. But this is the quantitative aspect of the object *itself*, its maximally general space-time characteristics. And no matter how distinctively they have been delineated, regardless of the actions with which they are connected – they are still characteristics of the things themselves, forms in which they move.

The child encounters space-time properties very early. At the age of 2 or 3 he gains a practical mastery of many of the relationships of things related to these properties – that is, specifically with the quantitative aspect of reality. This familiarity is accomplished by means of manipulations of objects. Those "operator structures" ("reversibility" in particular) constantly being discussed by Piaget can develop on the basis of these. But *from the outset*, they function as mechanisms in the child's *mathematical* thought as he deals with the general space-time characteristics of things. Going deeper into the quantitative determinacy of object relationships leads, in particular, to children's development of classification and seriation, which are clearly transformations of a specifically mathematical character rather than general "logical" structures, as Piaget supposes. The correspondence between operator structures and mathematical structures becomes clear on this plane – the former are formed, from the start, as mental mechanisms for the child's orientation in general mathematical relations. It should again be noted that the presence of a specific "abstraction from action" as described by Piaget does not, in itself, rule out an *objective* basis for operator structures. The internalized "mathematical-logic actions" that compose them initially arise themselves when the person is oriented toward those *real* characteristics whose uniqueness consists in their indifference to the concrete qualities of things. In other words, these actions reveal and establish quantitative *determinacy* as such.[43]

Piaget directly raises a central problem in epistemology with respect to mathematics:

> ... Are mathematical relationships engendered by activity of the mind, or does this activity merely disclose them as a certain external reality, one that really exists? [243, p. 10].

He does not formulate his own position unambiguously in solving it, although he does emphasize the empirical sources of mathematical knowledge. The point of view actually taken by him towards the sequence of appearance of operator structures and mathematical structures, as described above, allows us to think that he is inclined to conceive of the latter as engendered by "activity of the mind." But an unambiguous materialist solution to this problem requires, in particular, an understanding of operator structures (in the properties attached to them by Piaget) as those that from the very start of their formation are oriented toward mathematical relationships as "an external reality that really exists."

In the general view of the theory of thought that Piaget has created, it is important to stress that, above all, it substantiates the decisive role of object activity as a basis of intelligence. By virtue of material action a person goes beyond the limits of immediate objective reality in things and singles out their invariant (essential) relations. To be sure, for Piaget the characteristics of these relations remain on the plane of rational aspects of thought. At the same time it is his studies that have shown that their operator structures develop by much more complicated ways than was assumed previously. Thanks to these studies, modern psychology has made a major step toward definitively surmounting the still-prevalent principles of the empirical (positivist) theory of thought.

Ascertaining the role of action in thought as the object-sensory, "experimental" base for it leads Piaget close to revealing the features of specifically theoretical thought. As noted above, some of his theses are close to those formulated in dialectic logic. But merely "close," since here Piaget comes to a paradoxical situation. He does not actually recognize this logic as most adequate to the study of the development of thought (although he is familiar with the basic theses of dialectics). He combines an aspiration to investigate the development of thought with a creed that professes a type of logic that is abstracted from the content-based processes of development and concentrates its attention on the intellectual aspects of thought.

Piaget is interested in the mathematical-logic structures that are common, for example, to neuron networks and formal intelligence. Here the stages of internalization of these original structures, which are presupposed *in advance* of the data (for example, even on a physico-chemical level) are chiefly studied. During internalization only a distinctive "purification" of them within the subject's activity occurs. In other words, here the development of the *content of* thought itself is not considered and neither – as a consequence of this – are the appropriate logical categories – the investigative task is confined to describing the sequential changes in the subjective form of the same operator content (structures).

According to this direction in Piaget's theory, mastery of an increasingly complex concrete mathematical or other content does not lead to the formation of logical structures, but, on the contrary, the immanent development of the latter serves as a basis for subsequent mastery of the mathematical discipline and other disciplines. P. Ya. Gal'perin and D. B. El'konin have formulated this as follows in general form:

> ... Piaget's typical position is that the development of thought is the development of operator structures, that cognition of things does not lead to the development of logic, but, on the contrary, the development of logic leads to the development of the cognition of things... [75, p. 619].

Piaget's preferential use of the apparatus of mathematical logic leads him to a highly one-sided treatment of the peculiarities of thought. J. Flavell, for example, takes direct note of this circumstance:

> In Piaget's use of various algebraic-logic models there is something from an interpretation resembling a Procrustean bed [316, p. 561].

Gal'perin and El'konin express a similar point of view when they write that they do not concur with his position, as if "the level of formal-logic operations constitutes a higher level in the development of thought" [75, p. 600].

And in fact, Piaget does not even touch upon theoretical scientific thought proper, since it is formed, on the whole, at a later age than that to which investigation is limited at the level of formal intelligence. This feature is stressed by J. Bruner, for example, who points out that adults' thinking differs from the thinking of adolescents studied by Piaget [369]. Gal'perin and El'konin note that from the thought of the adolescent and young person there opens up only a remote prospect for development into the thought of the "mature man" or the "highly experienced person," into the "wisdom of an elder," but it is the latter, "rather than formal operations, that constitutes the ideal for the development of thought" [75, p. 601].[44]

In concluding our consideration of Piaget's theory, let us dwell on one more important question. Although Piaget takes the subject's object activity as a basis for the intellect, the real basis for the transitions from actions to operations are still revealed altogether insufficiently in his theory.[45] In particular, no matter how strange this may seem at first glance, for him the subject's own activity, by which these transitions should have been made, falls out of this internalization process altogether.[46] Piaget describes them as progressive coordinations and integrations of actions, as the formation of their general schemes, but all of this, in essence, remains on the phenomenological level of a shift in "stages" without revealing the real reasons for such a shift, without clarifying why and how the child *himself* replaces some types of "coordination" with others.[47] Without an answer to these questions, "development" proves to be merely an external modification in the character of actions and their forms – the internal moving forces of this process remain beyond the limits of psychological investigation, which, nevertheless, is what happened in Piaget's works.

7
Basic Propositions in the Dialectical Materialist Theory of Thought

In this chapter we shall first present the basic theses of the dialectical theory of cognition, and then, in this context, we shall characterize theoretical generalizations and concepts in contrast to their empirical analogues.

In presenting the basic ideas of dialectical logic we shall use primarily the works of K. Marx, F. Engels, and V. I. Lenin, as well as the results of the development of their original ideas in modern Marxist-Leninist cognitive theory. There is a considerable special literature on the problems of dialectical logic. We shall use the theses of many works whose authors, in our opinion, reveal most clearly the features of the dialectical approach to thought.

To substantiate and illustrate a number of the theses in dialectical logic it is advisable to enlist some material from *Capital* and other works by Marx that are closely related to it, since, as is well known, in this work the principles of *materialist dialectics as the logic and theory of cognition* are applied and developed, in a systematic development of the foundations of a single discipline (political economy). Lenin has written:

> If Marx did not leave us a Logic (with a capital letter), he did leave us the logic of *Capital* ... In *Capital* there is an application to a single discipline of the logic, the dialectics, and the theory of cognition of materialism [three words are unnecessary – they are one and the same], which borrowed everything of value from Hegel and pushed this valuable material further to a single discipline [17, p. 301].

Above all it is necessary to elucidate the formation of different forms of thought, which is regarded in the dialectical materialist theory of cognition as an "objective process in the endeavors of humanity, a functioning of human civilization, of society as the real subject of thought" [170, p. 153]. An individual person's thought is the functioning of historically developed forms of society's activity which have been *conferred on* him. One of the basic weaknesses in traditional child and educational psychology has been that it has not treated the individual's thought as a historically developed function of its "real subject," a function that is learned by him.[1] At the same time, as M. G. Yaroshevskii rightly notes, the "psychologist is helpless in understanding the ontogenesis of scientific thought without knowing the basic landmarks in its phylogenesis, an understanding of whose principles requires a departure to the realm of object-historical logic" [361, p. 129]. Such a "departure" is, in our opinion, necessary for the proper orientation of psychological investigations into the formation of children's thought.

Practical Activity as the Basis for Human Thought

Productive activity that concerns practical objects – labor – is the basis of all human cognition. Only within historically developing modes of this activity, which transforms nature, are all forms of thought formed, and only within this do these forms function. F. Engels has written: "... The most highly essential and immediate basis for human thought is precisely man's *modification of nature*, rather than nature alone as such, and man's reason has developed according to how man has learned to modify nature" [6, p. 545]. An analysis of the origin and development of thought must begin with a clarification of the features of human labor activity.

For human beings the entities in nature function as objects and means of taking tools and using them. Marx wrote: "Thus something given by nature itself becomes an agent of his [man's – V. D.] activity, an agent which he connects to the organs of his body, thus lengthening the natural dimensions of the latter, the Bible notwithstanding" [7, p. 190].

The process of using the tools of labor presupposes the establishment of a goal and guidance by the goal as an *ideal* image of the needed product. Marx has described this basic feature of labor as follows:

> At the end of the labor process a result is obtained which existed in the person's conception even at the start of the process – that is, ideally. The person does not only change the form of what is given by nature; in what is given by nature, he at the same time accomplishes his own conscious purpose, which, like a law, determines the method and character of his actions and to which he is to subordinate his will" [7, p. 189].

Modification of what is given by nature is an act of overcoming its immediacy. Natural objects in themselves would not have acquired the form that is attached to them in conformity with the requirements of man in *the community*. Here people are to take into account, in advance, those properties of objects that permit metamorphoses that are appropriate both to the set purpose and to the nature of the objects themselves.[2] Without this the object might not change in the direction required by the purpose. Consequently, in the labor process man should take into account not only the external properties of objects but also a measure of their "shakability" – their internal connections of which an assessment permits their properties and form to be changed and translated from one state to another.[3] This measure cannot be revealed *before* a practical transformation of the objects or *without* it, since it is only in this process that it reveals itself.

In "forcible" modification the person introduces the object into a system of other objects, in interaction with which it acquires a certain form of motion. Engels has noted:

> The circumstance that these bodies occur in a reciprocal connection includes the fact that they influence one another, and this reciprocal influence of theirs on one another is motion [6, p. 392].

In this way the object's immediacy is removed – it acquires a mediated being and discloses internal, essential connections in its movement.[4] L. K. Naumenko writes: "The internal or essential, in contrast to the external, has existence only in a relationship, has a *reflected* rather than an immediate being, a being mediated in itself" [221, p. 250]. The object obtains this mediated quality with respect to itself, but only through certain modes of activity by a person – and the form of the object's movement is *reproduced* in this activity.[5] Two circumstances are important here. First, this reproduction is done *repeatedly* and in more or less changing external conditions and situations. Second, people convey the modes of this activity to one another from generation to generation, and "models" and "standards" of these modes must be used for this transmission. Both require that people single out and establish only the decisive, genuinely necessary conditions for reproducing a certain form of motion of objects. Incidental conditions are "filtered out." There remain those conditions that really and necessarily determine the modes of activity represented of their societal patterns.

Thus, the transformation of objects in the labor process reveals their internal, essential properties – the *necessary* forms of their motion. Lenin has written:

> Man's activity, which has composed an objective picture of the world, *changes* external reality, destroys its certitude (= changes certain aspects or qualities of it) and thus removes its features of appearance, externality, and insignificance, asking it real itself-in-itself and itself-for-itself (= objectively true) [17, p. 199].

Engels analyzed this feature of labor by using the example of the category of *causality*. It is known that observing a simple sequence of one event after another still does not prove their causal connection – that is, the conclusion of "*post hoc, ergo propter hoc*" is illegitimate. In what, then does the proof of a causal connection consist? Engels answered the question as follows; this "proof of necessity is included in human activity, in experimentation, in labor: if I can do something *post hoc*, then it becomes identical with *propter hoc"* [6, p. 544]. In labor and in experimentation as a form of sensory-object activity, in acts of reproducing a sequence of events, their incidental sequence one after the other can be differentiated from a necessary connection: "... Man's activity *makes a check* so far as causality is concerned" [6, p. 545]. Here, in a single act of doing, one event loses its immediacy and appearance, becoming identical to another event; it passes into the other, finding in it the form for its own manifestation. This is also an actualization of the internal, essential, universal, and necessary connection between given events.

In the presence of appropriate requirements people can disclose an altogether definite motion (interaction) of objects if they recreate in their labor the necessary conditions in which it occurs in nature. Moreover, as Engels noted, people “are able to evoke movements that are not encountered at all in nature (industry) – at least, not encountered in that form – and we can attach to these movements certain directions and dimensions that are predetermined” [6, pp. 544-545]. Thus, one can use a curved glass to concentrate the sun’s rays in focus and to elicit the same effect that concentration of rays in an ordinary fire yields – this *practical* action (actually a special experiment) proves that heat comes from the sun.

Engels cites another example: if a person loads a gun and fires, he is expecting a certain effect, since he can trace the entire process of converting a hard substance into a gas and the latter’s pressure on the bullet. Knowing the conditions for such a conversion permits the assertion that it will, of necessity, be repeated the next time – that is, the causality of phenomena is proved here. After this example Engels formulates the following thesis: “Both natural science and philosophy up to now have completely neglected the investigation of the influence of a person’s activity on his thought” [6, p. 545].

Labor activity, experimental in its essence, permits people to reveal necessary, universal connections in objects. Engels writes: “... The form of universality is the form of internal completeness.... The form of generality or universality in nature is a law ...” [6, pp. 548-549]. If a person knows that chlorine and hydrogen combine into a gas and make an explosion when acted upon by light and at a certain temperature and pressure, he thus knows that this will occur *always and everywhere* such conditions develop. This knowledge does not depend on whether “it occurs once or is repeated millions of times or on how many heavenly bodies” [6, p. 549].

Here Engels is discussing “knowing” and the “mental raising of the isolated into the particular and then into the general,” but it is clear that these conditions, which “complete” the process “internally,” are sought only in practical experimentation as a particular form of production activity. If people are capable, in their practical experience, of finding and taking account of the conditions for reproducing a certain event, then these conditions are sufficient and necessary, and the event itself is effected in this activity entirely naturally, in a universal form, in its internal completeness.[6]

With the development of practical activity, which is social in origin and in modes of performance, people begin to reproduce in that activity, in principle, *any* objects of nature, as well as to create objects that are included only potentially.[7] This becomes possible because people treat nature from the standpoint of all of their own kind, all of humanity. A certain object is involved in their practical experience only on the basis of *social* needs. Only through them does nature become reality for social *production* as well, which transforms the objects in nature according to their *objective* laws, reveals their own possibilities and internal completeness.[8] Marx and Engels have written the following in connection with this:

> The practical creation of a *world of objects*, the reworking of inorganic nature, is man’s assertion of himself as a conscious kindred being.... To be sure, an animal also produces.... But the animal produces only that for which he himself or his young have an immediate need; he produces one-sidedly, whereas man produces universally.... Man reproduces all of nature... . The animal shapes matter only in conformity to a measure and a requirement of the sort to which he belongs, whereas man is able to produce according to measures of any kind, and wherever he is able to apply an appropriate measure to an object ... [1. p. 566].

The problem of man as a measure of things arose even in antiquity (Protagoras and others) and often led to subjectivism, where man himself was regarded merely as a purely natural being. Its solution became possible when man came to be regarded as social man. Humanity that has formed a society, in proportion to the degree of its universality, is *capable* of reproducing and assimilating objects in conformity to their *own* measure and essence. G. A. Davydova writes:

> Man proves to be the measure of all things because he reproduces, in the modes of his activity with things, the universal forms of existence and evolution of the things themselves. It is only in man, in his activity, that these universal forms function in pure form, as such ... [103, p. 303].[9]

The universality of practice, as well as its direct capacity for embodiment in “humanized nature,” which finds its own measure (generality) here, make it the basis for all forms of cognition, including theoretical cognition. It is this circumstance that was formulated by V. I. Lenin:

"Practice is higher than (theoretical) cognition, for it has both the merit of generality and of immediate reality" [17, p. 195].

The Ideal as the Image of an Object and the Uniqueness of Human Sensation

Intellectual activity is intertwined with the practical life of a society, appearing as an ideal reflection of it.[10] The need for such a reflection is involved in the production and consumption of the society. Marx has written: "And if it is clear that production gives consumption an object in its external form, then it is equally clear that consumption *understands* the object of production *in an ideal way*, as an internal image, as a need, as an incentive, and as a goal" [2, pp. 717-718]. The ideal is a reflection of object reality in the forms of the subjective activity of man in society (in his internal images, incentives, and goals), who is reproducing this world of objects. It reveals itself in the goal-oriented *formation* of a necessary object that is carried out in an activity. As E. V Il'enkov notes,

> the form of an external thing that is enlisted in the labor process is "removed" into the subjective form of object activity ..., and then ... the verbally expressed conception is converted into a deed, and, through the deed – into the form of an external thing that can be contemplated by the senses.... It is only in this constantly recommencing cyclic movement that the ideal, an ideal image of a thing, exists [136, p. 222].

It is this cyclic movement of "thing—deed—word—deed—thing," which is realized in social production and consumption, that materialist philosophers treat as consecutive transformations, starting with a *thing.* Man detects its forms as a material object in practical action, and only then do they pass to the level of an *ideal conception.*[11]

How does a sensory conception arise – in what form is the ideal proposition of an object expressed – that is, in Il'enkov's words, is it the "form of a thing but outside of this thing" [136, p. 221]? The problem of the origin of the ideal is very difficult – there is very little precise psychological data, but the existing information allows an outline to be made of the general path toward "idealizing" practical object activity. Along this route the fundamental change in the character of a person's *sensation* itself, in comparison with animals' sensation, has decisive significance. It is this change that has provided human sensation with the function of a connecting link between specifically material actions and conceptions – the function of the initial form of an ideal proposition for objects which has led to the development of all types of human intellectual activity, including thought. In what does the uniqueness of human sensation lie?

Planning of only the most immediate behavioral acts on the basis of direct images of perception of the environment is intrinsic to animals even the highest ones. This environment is independent of the animals and exists in all of its immediacy. But within object-transforming activity on the part of human beings, natural objects function as something that a person *needs* and that, in converted form, satisfies his social requirements. Rubinshtein has written: "Objects of needs and actions, rather than objects of contemplation, are given initially" (cited in [210, p, 348]). Knowledge about the surroundings is established now in the forms of object-sensory activity. Its chief agent has been, of course, the hand, with its capacity for touch and for many movements. The eyes and other analyzers have acquired a corresponding orientation in the world of objects in interaction with the hand. Forms of activity that have provided for the planning and regulation of complex techniques and for man's manipulations of objects and of the means of his labor have developed in the sense organs. This, in turn, has led to the sense organs having begun to observe and single out in objects properties and relationships that were important for precisely this kind of regulation. Thus, the eye began to single out in objects the properties that were important for treating objects in a mechanical respect, when changing their spatial form, and so on. Labor made similar demands on the other analyzers.

This is why man's senses have not merely become more highly perfected than animals, but have essentially changed their character. Engels has written:

> An eagle sees considerably farther than does man, but the human eye notices significantly more in things than does the eagle's eye. A dog has a considerably more subtle sense of smell than does man, but it does not discern even a hundredth of the odors that are, for man, definite attributes of different things [6, p. 490].

Of course, these attributes have become significant for man only by virtue of his expanded actual contact with things and orientation to them. Here the operation of the sense organs has seemingly "added to itself" – in a unique cognitive form – the purpose and methods of human beings' actual activity with objects and the properties of things that correspond to it.[12]

The world of objects that are created by mankind, and the orientation to them, have gradually become a basis for the operation of the analyzers themselves. This circumstance has been clearly expressed in the following thesis by the classic proponents of Marxism:

> It is only through a wealth of human existence that is developed in detail by objects that the wealth of subjective human sensation develops, and is, in part, first engendered.... The formation of the five external senses is the of work of all world history that has occurred up to this time [1, pp. 593-594].

The activity of labor – which is social by nature – is related to the delineation of *rules* of action and of appropriate facts about objects by human beings and to the transmission of theme to one another. All of this is formulated in language, by which it becomes the property of the group.

Initially people orient toward certain similar and repetitive, sensorially given objects which meet their needs or are capable of serving as a basis for labor operations and for product distribution. Engels has noted: "At a certain very early stage in the development of society there arises a need to encompass in a general rule the acts of production, distribution, and exchange of products that are repeated from day to day..." [4, p. 272]. The objects that are enlisted in the activity of labor and their relationships are singled out from the totality of the others at first in a practical way, then "theoretically" also, in the form of naming words. Marx has written:

> ... After people's needs and the types of activity by which they are met have multiplied, developing further all the while, people give particular names to whole classes of these objects, which they differentiate from the rest of the external world by experience .... This verbal name merely expresses, in the form of a conception, the fact that a repetitive activity has been converted into experience... People merely give these objects a particular (generic) name, for they know the capacity of these objects for meeting their needs ... [5, p. 377].

Thus, the different *types of activity* for meeting certain social needs are the basis and criterion for singling out *classes* of objects – and a sensory image of objects of these needs serves as a sort of "visual standard" for attributing particular objects to appropriate classes, to which a generic name is given. If it is taken into account that when production and distribution becomes more complex, the range of needs expands and becomes more complex, then it becomes clear how new names are constantly being attributed to the objects and means of labor, to its particular components, to the different aspects of human production and community life. And in all of these instances the criterion for singling out the objects included in a common genus has been either a certain recurring labor operation that is done on similar objects or with similar means or images of objects that satisfy certain general rules – for example, for the preservation and use of products, means of labor, and the like.

These criteria could not have been the "whim" of particular individuals; they must have been accessible and clear to the whole group that uses the names and that orients itself on the basis of the conceptions related to them.[13] In other words, these criteria and the content of the conceptions and words should be generally significant. But this general significance in itself, it would seem, still does not signify *objectivity* for the conceptions, since the criteria and standards are based on subjective human needs.[14] But this is only at first glance, since it is a matter of *every kind* of need related to the needs of *universal* production, which itself requires people's orientation toward the properties of objects that provide for their objectively natural changes in accord with set goals.[15] Marx has expressed this fact as follows: "He [man – V. D.] uses the mechanical, physical, and chemical properties of things to apply them as tools to affect other things according to his own purpose" [7, p. 190].

Thus, primitive people were able to make stone tools of the required form and quality only because they knew how to single out a specific and totally objective order of hardness in the objects that entered into mechanical interaction. This order cannot be established by a simple visual observation or by touch. For this, what was required was a *confrontation* of the different objects with one another, then an establishment of the results of this interaction on some scale of hardness, objectified, for example, in a series of material samples which the entire group might use.

Thus, perceptual activity, as a component of man's practical operations with objects, can *reproduce* in the forms intrinsic to it the methods of singling out and evaluating objects, their properties and relationships, which are the objects of these operations. Therefore it can perform a planning and regulatory role in the overall labor process. Both the classes of objects singled out by the sense organs and the methods of perceptual activity themselves receive stable verbal names, which become an important means of organizing the activity of the sense organs itself. All of this attaches a number of specific features to man's sensation. *First*, the very range of perceived objects and the methods of delineating them are determined, not by the person's individual features, but by the potential and interests of social production and by the methods of actuating it (the individual only appropriates and assimilates these interests and methods). *Second*, the organization of perceptual activity occurs with the aid of language and material standards. Third, the use of language and standards permits a reliance on conceptions of objects, not only in the labor process itself, but also in communication situations, and therefore the processing of the conceptions might become a relatively *independent type* of man's activity (it might even become a particular occupation of particular persons, who would no longer take part in material production). Engels has pointed out: "... The mind's planning work, even at a very early stage in the development of society (for example, even in the simple family), has had an opportunity to compel other hands than its own to do the work contemplated by it" [6, p. 493].

These features of the work of the sense organs show that, with respect to immediate activity of actual production, it has acquired a distinctive *theoretical* character. As Marx and Engels wrote: "The eye has become the *human* eye in precisely the same way as its *objective* has become a social, *human* objective, created by man for man. Therefore the *senses* have become *theoreticians* directly in their practice" [1, p. 592].

The distinctiveness of *man's* sensations has been revealed in a number of Marx's theses concerning the philosophy of L. Feuerbach [15]. As is well known, in the first half of the 19th century, in Germany, as well as in all of Europe, the Hegelian idealistic dialectics, which made an absolute of abstract-theoretical thought, had considerable influence. Feuerbach opposed the dominance of this philosophy, its theses that perceive the true meaning of human activity in theoretical thought, in operation with mental objects. According to Feuerbach, real, sensory vital activity is the genuine basis for human existence, and material, sense-perceptible reality is the object. This was, of course, an important step in the war against idealism. But this campaign was conducted from the standpoint of metaphysical, contemplative materialism, which proceeded from the notion that society consists of particular individuals who are connected by purely *natural* bonds ("civil society"). For these individuals the reality of objects functions only in the form of objects that are independent of them or in the form of passive sensory *contemplation.*

But it was noticed long ago in philosophy that man in his cognition functions as an active being. This active aspect of cognition, in opposition to materialism, was developed by idealism (particularly German classical idealism), but developed abstractly, one-sidedly, and wrongly. Idealism was unable to find the real source of the active aspect of cognition – it perceived it in certain internal, immanent properties of the spirit itself. It should be noted that, for example, Hegel singled out the active aspect not only in mental activity proper (this was noted by all rationalist philosophers), but also in human sensation (for him sensation was merely an "underdeveloped" concept).

Feuerbach, who sharply broke with idealism and who tried, in Marx's words, "to deal with sensory entities that are really distinct from mental entities" [15, p. 102], found this distinction only in the feeling that is a passive contemplation of an isolated individual. But this was a renunciation of the materialist explanation of the *active* aspect of both sensory and rational cognition by man.

For such an explanation a "new materialism" was needed, which, when furnished with the positive attainments obtained within idealistic dialectics, could approach human activity and the life of society differently than did the old, metaphysical materialism. Instead of the notion of "civil society" it was to take the point of view by which society "is human society or social humanity" [15, p. 104], which arose on the basis of labor, material production, which is a *genuinely human* activity and the source of all forms of both the practical-intellectual and theoretical-intellectual assimilation of reality.

Dialectical materialism became such a philosophy, according to which nature functions as an object of human cognition only because it is enlisted in object-transforming, productive activity, in practice; it becomes *humanized* nature.[16] Objects and reality are given to social man, not through passive contemplation, but only in the forms of his practical, *sensory-object* activity. This is the source of the active aspect of the work both of the "senses as theoreticians" and of the higher forms of theoretical scientific cognition.

The conceptions that arose in the sensory activity of human beings and in their relations with one another began increasingly to serve as a means of *planning* future actions, and this presupposes a comparison of their different variants and a choice of the "best" one. Because of this the conceptions themselves became an *object* of man's activity without a direct recourse to things themselves. There arose a reflecting activity, which permits a *change* in the ideal images, the "designs" of things, without a change in the things themselves, for the time being.

Such a change in a thing's "design," which relies on experience in making actual transformations of it engenders the type of subjective activity by a person which in philosophy is commonly called *thought*.

> To think means to invent or construct "in the mind" an idealized (corresponding to the purpose of an activity, to its idea) design of the real object that is to be the result of the presumed labor process. ... To think means to convert or transform the original image of an object of labor into a certain idealized object, in conformity with an ideal design or idealized scheme of action [25, p. 29].

This "transformation" of images can be made on the level either of sensory conceptions or of the verbal-discursive activity that is related to it. But in both instances the means of expressing ideal images in symbols and signs – verbal and material standards describing and representing objects and methods of producing them – have an essential significance.

Thus, a thing that is involved in the labor process is transformed not only in its "flesh and blood," but also in the *reflective* aspect of labor – on the ideal, mental level.[17] When the design of a thing is constructed and changed, a *rational understanding* of the object of activity itself also arises. This feature is clearly expressed in the following statement by V S. Bibler:

> To say that an object becomes an object of activity means to note that it becomes an object of understanding, that it is reflected in an ideal object, that it (in its given reflections) has become an object (feature) of logical movement, has acquired – entirely objectively – the stature of an "hypothesis" in labor [34, p. 193].

The process of "understanding" itself is highly complex and contradictory. Here, depending on the goals and means of the combined cognitive activity, it can be attributed to two different, although closely related, interconnecting features of object reality and its reproduction. Thus, in rational form the immediate, external aspect of reality, its *authentic* being, can be expressed. But, moreover, the mediated, internal being of objects, their essence, can be reproduced in a concept. This determines the difference in *content* of "understanding," which leads to different forms of its expression – to a difference between *empirical* and *theoretical thought* as two levels of cognition.

The Characteristics of Empirical Thought

In historically early times (and at a certain level, even up to now) the work of the "senses as theoreticians" and the transformation of conceptions as a particular type of intellectual production were indissolubly related to human beings' practical material and sociopolitical activity. Marx and Engels have written:

> The production of ideas, conceptions, consciousness, was originally directly intertwined with material activity and the material contacts of human beings, with the language of real life. The formation of conceptions, thought, and intellectual communication of human beings here is still a direct result of their material actions [15, p. 29].

In this initial period of cognition the *conceptions themselves* arise and are given shape in different symbol and sign systems (verbal and material); a primary "idealization" of certain aspects of material life – and, above all, of those that can be observed and ascertained directly in perception – occurs. All of this allows new classes of objects to be singled out and designated verbally. On the basis of the verbal designations of general conceptions and direct observations, man can construct a judgment-statement ("This is a stone," "This is a house ... ... "This little gray animal is a rabbit – it is used for food," and so on). A number of these particular judgments about certain objects can be replaced by a new word-name, whose content will be an abbreviated conception of the objects in the judgments. Consequently, words, in *abbreviated* form, can encompass a group of sensorially perceived objects (Engels, for instance, has noted the presence of this function in abbreviation-words [6, p. 550]). With the aid of general conceptions and the judgments made on their basis, a person can make rather complicated conclusions. For example, by relying on his own past experience, a hunter can use the tracks left by animals to draw conclusions both about the very fact of their being present and about their number, the time of an event, and so on.

Thus, the formation of general sensory conceptions that are directly intertwined with practical activity created the conditions for highly complex intellectual activity that is commonly called thought. The formation and use of generic name-words permitting the form of *abstract universal generality* to be attributed to sensory experience, is typical of it. By virtue of this form experience can be *generalized* in judgments, used in deductions. Such generality, based only on the principle of an abstract, formal identity, is, as was shown in the previous chapters, a feature of *empirical* thought. It develops in persons as a transformed and verbally expressed form of activity of the "senses as theoreticians" that are intertwined with real life. This is a direct derivative of human object-sensory activity.

Since it has been agreed in traditional formal logic to call any abstract universal generality expressed in words a "concept" (in fact, this is merely a general conception), then empirical thought occurs in such "concepts." Thus, as G. A. Kursanov indicates, "The first forms of conceptual thought still have a directly empirical character, have a figurative sensory expression, although they receive their own necessary verbal expression" [179, p. 30].

Here the *immediate* character of empirical knowledge is stressed. As L. K. Naumenko rightly notes, "the empirical is not only immediate knowledge of reality – what is more important, it is also knowledge of *the immediate* in reality, and of precisely that aspect of reality that is expressed by the category of being, number, quality, property, measure" [221, p. 244]. The existence of an object in time and space, in all of its givenness, in the unity of present being, demonstrates its immediacy or externality primarily with respect to *itself*. This *content*, which appears to a particular person as immediate existence, determines the form of its *expression – sensation*. "*Empirical* cognition is movement in the sphere of this externality, assimilation of the aspect of reality that is outlined by the category of being" [221, p. 245].

One of Lenin's theses, which he formulated when giving a materialist interpretation of a text of Hegel's concerning the characteristics of the general route to cognition, is of considerable interest:

> At first impressions flash, then *something* is singled out – then the concepts of quality (the definition of a thing or of a phenomenon) and *quantity* develop. Then study and reflection guide thought to the knowing of identity – difference – basis – essence versus phenomenon – causality, etc. [17, p. 301].

The conversion of "flashing impressions" into "something" gives man the knowledge of the qualitative-quantitative definiteness of a sensorially perceived object. "First and foremost is sensation, and *in it* inevitably is quality as well. .." [17, p. 301]. Identity and difference are also accessible to man in a visual-figurative sense. Finally, even such complex phenomena as are characterized by the categories of oppositeness and contradiction can be grasped by the resources of empirical thought, in the form of ordinary conceptions. Lenin has written: "An ordinary conception grasps difference and contradiction..." [17, p. 128].

Although empirical thought moves in the categories of present being, its cognitive potential is very *broad*. It provides human beings with considerable scope in singling out and designating objects and their relationships, including those that are not observable at the present moment but that are found indirectly on the basis of deductions.

We have designated the method of obtaining and using sensory data by persons who have language as empirical *thought.* But thought is *rational* cognition. Consequently, with respect to the activity of social man in general it is impossible to apply the category of "sensory cognition" as a particular and special level that precedes "rational cognition." Cognition on the part of socialized humanity acquired a rational form *from the very beginning.* Many Soviet philosophers are coming to this point of view at present. Here it is important to emphasize that *only* sensations and perceptions, sensory data, serve as the foundation and the source of all of man's knowledge about reality. But, as has been shown above, the results of the activity of the "senses as theoreticians" are expressed in verbal form, which carries the experience of other people.[18] P. V. Kopnin writes:

> The sensory and the rational are not two levels in cognition, but two features that permeate it in all forms and at all stages of development... The unity of the sensory and the rational in the cognition process means, not that one follows the other, but that both participate necessarily in our cognition.... There can be no discussion of sensory cognition as such in man [170, pp. 177-178].

The "rationality" of sensory data appears not only in the fact that a generally significant verbal form (or the form of a judgment) is attached to them, but also in the fact that an individual person, guided by social needs, singles out the objective properties of objects, in addition to reckoning with other people's opinions and judgments, relatively unselfishly, from the standpoint of the entire species. But the ability to single oneself out from nature and from among other people is social man's *consciousness* proper. Here, as Lenin has pointed out, the categories of cognition, particularly those that are intrinsic to empirical thought, are the levels for such a delineation [17, p. 85].

The Characteristics of Theoretical Thought

Mediated, reflected, essential being is the substance of theoretical thought. This thought is an idealization of the basic aspect of practical activity involving objects, and of the reproduction in that activity of the universal forms of things, their measures, and their laws. This reproduction occurs in labor activity as a unique sensory-object experiment. Then this sort of experimentation increasingly acquires a cognitive character, allowing people, with time, to pass to *mental* experimentation, to mentally ascribing a certain interaction, a definite form of movement, to objects.[19]

V. S. Bibler singles out the following basic features of mental experimentation: 1) the object of cognition is mentally transferred to conditions in which its essence can be discovered with a particular certitude, 2) this object becomes the object of subsequent mental transformations, 3) the *environment,* the system of connections in which this object is located, is mentally formed in this experiment; if the construction of a mental object can still be conceived as a simple "abstraction" of a real object's properties, then this third feature is, in essence, a productive addition to the mental object – only in this *particular* milieu does its content finds its discovery [25, p. 30], [34, p. 200].

These features of mental experimentation form the basis of theoretical thought, which operates by *scientific* concepts. A *concept* functions here as a form of mental activity by means of which an idealized object and the system of its connections, which reflect in their unity the *generality* or *essence* of movement of the material object, are reproduced. A concept simultaneously also functions as a form for reflecting the material object and as a means of mentally reproducing, constructing it – that is, as a particular *mental action.* The first feature permits man to be aware, in the thought process, of an object's existence independent of him – an object that is given as a prerequisite for activity. This prerequisite attaches a feature of *passivity,* a contemplative quality, a dependence on objective content, to a concept. And, at the same time, to have a concept of an object means to reproduce or construct it mentally.[20] This *action* of constructing and transforming a mental object is an act of understanding and explaining it, of discovering its essence.[21]

Kant, for example, has astutely noted that "thinking" means "acting;"

> We cannot think of a line without *drawing* it mentally, cannot think of a circle without *describing* it, cannot conceive of three dimensions in space without drawing three mutually perpendicular lines from a single point... [151, p. 206].

But mentally "drawing," "describing," etc., is none other than reproducing or constructing an object on an ideal level.

The internal connection between a concept's real content and the method of constructing it or idealizing it is noted, for example, by the eminent Finnish mathematician R. Nevanlinna, who writes as follows:

> ... The constructive and idealizing tendency is developed particularly clearly in the theoretical sciences, primarily in mathematics, where it has deliberately been raised to the rank of a guiding principle [222, p. 21].

This tendency is found, for instance, in the transition from visible space to space that is imagined, which occurs "only partially by the process of abstraction – that is, exclusion (from the standpoint of geometry) – of details and qualities not having significance. In what is essential this transition is also affected by a constructive – one might say 'productive' – feature. Not enough attention is paid to the latter circumstance in the general case in describing the origin of concepts" [222, p. 21]. As we can see, R. Nevanlinna especially singles out the feature of constructiveness, the "supplementary tendency," in concept formation.

H. A. Rozov's special analysis of the methods of constructing scientific abstractions has shown that the abstraction process itself consists in portraying the *independence* of a state or position of some object under consideration from certain factors. As a result this initial object is mentally replaced by another – its *model*, during subsequent work with which these factors are no longer taken into account [274]. In other words, as a result of abstraction a new idealized object is obtained, which is mentally correlated with conditions with which the original object has not interacted. The construction of this new object functions as a certain mode of activity – as abstraction, which has as its object the interrelationship between dependence and independence of factors that characterize the existence of the real object.

Both intellectual and material production have their own means of reproducing an object. Here man uses "cunning" – he reveals the properties of objects and recreates relationships and connections with one another through them. One thing becomes a means of embodying the properties of other things, functioning as their standard and measure. The result of this sort of embodiment can be represented, for example, as a scale of hardness or in a depiction of forms of space. Here the properties of the measure and the standard represent, not their own nature but the nature of *other* things – the measure and the standard turn out to be symbols of them. Different symbol systems (material ones, graphic ones) are means of "standardizing," and thus idealizing material objects, means of translating them to a mental level. E. V Il'enkov writes: "The functional existence of a symbol involves its ... being a means, a tool for portraying the essence of other sensorially perceived things – that is, of their universal..." [136, p. 224]. Disclosure and expression in symbols of the mediated being of things, of their universality, is a transition to the *theoretical* reproduction of reality.

It must be kept in mind that symbols expressing the universal in objects are themselves forms of human activity. Therefore, if a particular person (rather than society as a whole) uses symbols and standards in practical action for the purpose of obtaining some particular thing that belongs to a given universality, then its idealized form (concept) on the temporal sequence plane, will be *more primary* than the real, sensory, particular thing.

This highly important thesis is usually illustrated with the remarkable definition of the essence of a circle given by Spinoza. Let us use this example, too. Spinoza perceived the essence of a circle in the act of its emergence or construction ("creation"). Its definition should express the reason why the given thing *arose*, the method of *constructing* it. Spinoza writes: "... According to this rule, a circle must be defined as follows: It is a figure described by a line, one end of which is fastened and the other end of which is movable" [298a, p. 352]. Here a method of obtaining any and infinitely varied circles is given. Incidentally, as Yu. M. Borodai has rightly noted, here "Spinoza is giving none other than *a description of the construction and method of operation of an elementary work tool – the compass*" [45, p. 97]. In other words, in the form of the concept of a circle a literal idealization of a scheme for activity with an elementary tool is given – the activity of constructing an object in its essential, universal characteristics.[22]

As Borodai has shown in detail [45], Kant introduced the concept of a "schema" for designating a universal conception (sensory concept) about the *method of constructing* any empirical image, in his doctrine of the productive imagination.[23] This schema, once created, becomes the *prototype*, the scale for evaluating sensory things. For example, such schemata as a "kilogram," a "circle," or a "table" function as means of delineating and comparing real things. According to Kant, the original formation of a schema is an act of the *productive imagination,* as an essential ability of the human mind. Its development, according to Kant, permits man to create schemata, not only of the things "created" by him (such as "circles" or "houses"), but also of natural things, since the imagination begins to act as a universal principle for connecting *any* sensory data.[24]

Of course, the imagination has an essential significance for the formation of "universal conceptions," prototype-schemata. But Kant converted this ability into the immanent "power" of the mind. Indeed, as has been shown above, a practical, object-related action with a real tool of labor is a genuine act of singling out and reproducing a universal. In a conception the universal functions as reflected, idealized from the object-related method of activity. But the construction of the image is itself done only because of the well-developed capacity of the imagination. Kant was right in indicating its role in constructing a concept.

Concepts that have developed historically in society exist *objectively* in the forms of man's activity and in its results – in propitiously created objects [103, p. 310]. *Particular* persons (and children, above all) receive and assimilate them *before* they learn to act with particular empirical manifestations of them. The individual must act and produce things according to the concepts which exist as norms in the society *beforehand* – and he does not create them, but accepts or assimilates them. Only then will he be conducting himself with things *in a human way*. The "general" as a form and norm of activity for individuals functions in instruction as *primary* with respect to the particular phenomena that are suited to it. This "general" is a prototype, measure, or scale for evaluating empirically encountered things. In other words, the individual *does not have* before him any "unassimilated nature," a nature by operating with which he is to form concepts – they are already assigned to him as crystallized and idealized, historically developed human experience. But this "general," naturally, functions as a *secondary* formation with respect to the total productive activity of all of socialized humanity.

On the Specific Content of Theoretical Thought

For a clearer understanding of the relationship between empirical and theoretical thought, it must be borne in mind that the most general universal problem in cognition is, as Lenin has written, to *encompass* "the universal principle governing a nature that is perpetually moving and evolving" [17, p. 164]. Within the evolving natural whole, all things are constantly changing, passing into other things, vanishing. But each thing, according to dialectics, does not merely change or disappear – it passes into its *own* other, which, within some broader interaction of things, proceeds as a necessary consequence of the being of the thing that has vanished, retaining everything positive from it (within the limits of all nature this is also a *universal* connection).

Cognition initially singles out and establishes a thing in its external changes, in its particular connections and relationships. G. A. Davydova notes:

> If this connection is established as independent, as existing in and of itself, as not derived from another and not engendering another, we have some notion of change, we have an empirical ascertainment of a particular fact ... [103, p. 316].

This sort of ascertainment in itself does not yield knowledge about what its *own* other is and why the given thing passes into it, in particular.

But the particular changes and connections of a thing can be treated as features in a broader interaction, within which it is naturally replaced by its own other, and this transition retains everything positive in it that is necessary for this integral system of interaction. This will be a theoretical treatment of the very formation of things, of their mediation of one another. Such thought “always pertains to a *system of interaction,* the realm of successively connected phenomena that, in their totality, make up an organized whole” [103, p. 316].

Consequently, theoretical thought has its own particular *content,* which is distinct from. the content of empirical thought – this is the realm of objectively interconnected phenomena, which make up an integral system. Without it and apart from it, *these phenomena* can only be the objects of empirical observation, however.

Marx used the example of social production to show the essential significance of the *whole* for the particular components that make it up:

> Every form of society has a certain industry which determines the place and the influence of all other industries, and whose relations therefore also determine the place and the influence of all other industries. This is a general illumination, in which all other colors disappear and which modifies them in their features. This is a special ether that determines the specific weight of everything real that is detected in it [2, p. 733].

In empirical relationships a particular thing functions as an independent reality. In relationships revealed by theory, one thing functions as a method of manifesting another within a certain whole. This transition of thing to thing, the removal of the specificity of one thing when it is converted into its own other – that is, their internal connection – functions as an object of theoretical, scientific thought. This thought is always dealing with real, sensorially given things, but perceives the process of their passage into one another, their connection within a certain whole and in relation to it. Marx has written: “... The problem of science is for apparent motion that only functions in a phenomenon to be reduced to real internal movement ...” [9, p. 343].

The difference in content between the two rational levels of cognition has engendered a difference in their forms, in the methods of retaining that content. As has been noted above, empirical relationships can be expressed verbally as the results of sensory observations. Since they are repeated, some classes of relationships must be differentiated from others. Differentiation and classification appear precisely as functions of general conceptions, or empirical concepts. Marx gives the following description of this method of interpreting things, which is peculiar to an “observer who is alien to science” and who, instead of penetrating the inner connection, “merely describes, catalogues, relates, and subsumes under schematizing definitions of concepts what is externally manifested in a life process, in the form in which it is manifested and comes to light ...” [11, p. 177]. External repetition, resemblance, dissociation of parts – these are the general properties of reality, which are grasped and subsumed “under schematizing definitions” by empirical concepts.

In contrast to this, internal, essential relationships *cannot* be observed directly by the senses, since they are *not given* in available, established, resultative, and dissociated being. The internal is detected in mediations, *in a system,* within a whole, in its emergence. In other words, here the “present,” what is observed, must be mentally correlated with the “past” and with the potential of the “future” – in these *transitions* there are mediations, formations of a system, of a whole, from. *different* interacting things. A theoretical idea or concept should bring *together* things that are *dissimilar, different, multifaceted,* and *not coincident,* and should indicate their proportion in this whole. Consequently, the objective *connection* between the *universal* and the *isolated* (the integral and the distinct) emerges as the specific content of a theoretical concept. Such a concept, in contrast to an empirical one, does not find something identical in every particular object in a class, but traces the interconnection of particular objects within the whole, within the system in its formation.[25]

In dialectical materialism it has been agreed to call *concrete* this objective *integrity* that exists in the connection of individual things. The concrete, according to Marx, is “unity of the varied” [2, p. 727]. In its externality, as having become, it is available to both contemplation and conception, which capture the feature of the mutual interconnectedness of its manifestations with one another. But the problem is in representing this concreteness as *becoming,* in the process of its origin and mediation, for only this process leads to the entire diversity of manifestations of the whole. This is a problem of considering the concrete in development, in motion, in which the internal connections in a system, and thereby the connections between the individual and the general, can only be revealed.

It is important to stress that the chief difference between theoretical concepts and general conceptions is that these concepts reproduce the *development or formation,* of a system, an integral quality, something concrete, and only with this process are the features and interconnections among individual objects discovered. Lenin has emphasized: " ... Nature is reflected in a *unique way* (N.B. *in* a *unique* way and dialectically!) in man's concepts" [17, p. 257]. Thus the objective nature of the whole and the individual is disclosed. In describing the difference between a concept and a conception, Lenin has indicated the highly important circumstance that a concept "by its very nature = transition" [17, pp. 206-207]. They express cohesion, law, the necessity of individual things.

Lenin wrote: "An ordinary conception captures difference and contradiction, but not the *transition* from one to the other, and *this is highly important*" [17, p. 128].

What is the correlation between the empirical and the theoretical levels of cognition? Historically, the former preceded the latter, and now it is still the prevailing form of everyday experience for human beings. Empirical thought is retained in certain branches of knowledge that have lingered at the stage of pure description of objects. In particular, educational psychology and didactics have been guided by a model of this sort of thought up to now, in directing the mass practice of school instruction. Empirical thought has its own objective and its own guiding principles, which have found partial expression in some of the theses of *traditional* formal logic (see above).

Theoretical thought also has an ancient origin. Its potential is included in the process of productive labor itself. It is a derivative of this object-oriented, practical activity and is always internally related to sensorially given reality. Moreover, it is theoretical thought, and never empirical, that realizes to a complete extent the cognitive potential that is opened up for man by object-related, sensory practice, which recreates in its experimental essence the universal connections of reality. Theoretical thought "snatches up" and idealizes the *experimental* aspect of production, first attaching to it the form of an object-sensory cognitive experiment, and then that of a mental experiment done in concept form and through a concept.[26] To be sure, considerable time was required for theoretical thought to acquire sovereignty and contemporary form in the process of the historical development of industry and science.

Sometimes the opinion is encountered to the effect that even *at present* theoretical thought is supposedly relying on empirical thought and is built as a superstructure over it, as it were, retaining it as a foundation. This, in our opinion, is a mistreatment of their relationship. Modern theoretical thought, in the process of its formation, has assimilated the positive features and means of empirical thought – has "borrowed" them into itself.[27] Within its *own* movement, it now solves as its *own* particular problems what previously was (and in special conditions still remains) the prerogative of empirical thought, but it is doing so in its own way, more completely and effectively.[28] The description of present being as prerequisites and consequences of mediated being is one of the problems of *theoretical* thought, but a problem that is resolved in the light of the main purpose – to clarify the essence of an object as a universal law of its development. On this route theoretical thought finds experimental facts and facts of observation, and *creates* within its own system the sensory means of determining and recording these facts (the mental specifically and the sensory occur in unity here). But all of this is accomplished in the single process of studying the formation of some integral system.

The term "empirical stage" is sometimes applied to this important *but not independent* aspect of scientific-theoretical cognition "in the old way." If this designates the period of collecting, comparing, and elucidating the factual data that describe the features of the present being of a system that is being studied *theoretically,* then this term in itself is permissible. But if it is used in the sense of a delineation of a particular stage of cognition, standing *outside* and *before* the integral and unitary scientific-theoretical reproduction of reality and subordinated to the principles inherent in specifically empirical thought, then this, in our opinion, although highly prevalent, is still an incorrect and erroneous interpretation of it.

Methods of collecting and processing factual data in a system of scientific-theoretical thought are different from those at the empirical level of cognition, which emerges as an historically independent form. It is sufficient to point out that modern science basically depends, not merely on observations, but also on *experimentation,* and this, as was stated above, is a method of activity that is internally related to productive labor.[29] Here experimentation itself has meaning only within a certain theoretical idea that anticipates it (for example, in the presence of an hypothesis, etc.). N. N. Semenov writes: “Experimentation is always done with a purpose, in order to extract from nature the answer to a question that has been formulated in a rigorously theoretical way” [287, p. 52].

Modeling as a Means of Scientific Cognition

All types of human intellectual activity, including scientific activity, are not accomplished by isolated individuals but are social processes. They have socio-historically developed methods and means of constructing and operating with objects, of idealizing, recording, and transforming them. Theoretical scientific thought also has certain means, which we have mentioned above – symbolic and sign systems. Because of them, as M. K. Mamardashvili notes, there occurs a “separating out by man of a certain form of subjective activity and its transportation outside as a material object and the material conditions for intellectual labor...” [202, p. 17]. In this way idealized objects are constructed, reproducing aspects of reality that are essential for practical activity. Theoretical thought “means above all the creation of specific objects (of specific “objectness”) and thought about reality by means of them, through them” [202, pp. 18-19].

In principle this sort of thought *does not have* as its objective the empirical diversity of things that are given directly – it approaches it *through* this specific, idealized objectness, and only then does it bring into play its own scientific view proper. On this objectness “there seems to be strung the whole mass of empirically observed properties and connections of reality, which in this case are taken scientifically rather than by some different image that is possible for consciousness. Man is in the position of an *investigator* with respect to them” [202, p. 18]. This interpretation of a “scientific objectness” enables the still-current (particularly in pedagogical disciplines) *naturalistic* treatment of it to be overcome – the treatment related to the empirical theory of cognition in general and to the empirical theory of a concept in particular.

Symbols and *signs*, as well as mixed forms of them, serve as the material means of idealizing and constructing scientific objectness. Symbols are, in the words of Hegel, the sensory representatives of a certain genus or type (they can be combined with signs – with a word-sign designation, for example). The sensory form of a symbol is *similar* to the entities which it represents. For example, a materially represented scale of hardness is the symbol of a certain quality of ordering with respect to the property of “hardness.” The sensory form of a sign itself has no physical similarity to the entity it designates (sign systems include natural language and artificial scientific signs, such as mathematical ones).[30]

Modeling is a particular type of symbol-sign idealization in science. This term is used very extensively and frequently now with different meanings. In our opinion, the following definition – by V. A. Shtoff – is the most acceptable: “A *model means a mentally conceived or materially realized system that, by representing or reproducing an object of investigation,* is capable of replacing it so that the study of it will yield new information about this object for us” [345, p. 19]. Let us cite a description of modeling, given by this author, that expresses the essence of this method of cognition most adequately.

V A. Shtoff singles out types of models – material and mental (ideal). The former he attributes to the sphere of practical activity – the latter to theoretical. Of course, a general subdivision of models into material and mental ones is legitimate, but at the same time, in the first place, all of them belong to the sphere of theoretical cognition, and, second, material models also serve as a means of constructing an idealized object (on these two points Shtoff gives an imprecise description of the character of models, in our opinion). Material models tolerate object transformation, but mental ones, naturally, tolerate only mental transformation. The former type is subdivided into three subtypes: 1) models representing the spatial features of objects (mock-ups for example), 2) models having a physical similarity with an original (the model of a darn, for example), 3) mathematical and cybernetic models representing the structural properties of entities. Mental models are divided into: 1) pictorial-iconic (drawings, illustrations, spheres and pivots, etc.), 2) symbolic models (for example, the formula for an algebra equation, etc.). Symbolic models require special interpretation, without which-in themselves-they lose the function of models.

Any model, in Shtoff 's opinion, should be visual, but it is a distinctive visuality. Thus, the distinctiveness of the visuality in a material model is that its perception is inseparably related to the theoretical interpretation of its structure.

> Visuality in the perception of a visual model presupposes, at the same time, significant participation by thought, the application of accumulated theoretical knowledge, accumulated experience. In perceiving a model, the experimenter ... understands what is occurring in it [345, pp. 283-284].

The matter of the visuality of symbolic models is difficult, since particular elements of them have no similarity to the original. At the same time, as Shtoff rightly notes, scientific symbol systems, whether in mathematics, chemistry, etc., reproduce or copy the object's structure in the structure of their own constructs. For example, a chemical formula is a symbolic model, whose connection and sequence of elements transmit the character of a real chemical connection, the structure of a substance. Of course, as in any other form of models, this reproduction is approximate, simplifying and schematizing the real object.

Shtoff cites the words of the well-known American scholar R. Feynman, who said: "A chemical formula is simply a picture ... of a molecule. When the chemist writes a formula on the blackboard, he – to put it crudely – is attempting to draw a molecule in two dimensions" (cited in [345, p. 163]). The prominent Russian mathematician P. B. Chebyshev expressed an analogous view in his day, about mathematical formulas: "Any relationship between mathematical symbols represents corresponding correlations between real things" (cited in [33, p. 37]). In other words, symbolic models reflect the connections and relationships of real objects, and in this sense the connections and relationships between particular symbols (mathematical, chemical, etc.) can be considered a visual expression of an original.

Models, as is well known, are widely used in experiments. Instead of studying some real object according to certain causes, it is advisable to study its representative, which reproduces the object in a certain relationship. The investigation of such a representative allows new information to be obtained about the object itself – this is the principal function of the representative as a model.

But models are not simple representatives of objects. The conditions for the creation of a material model, for instance, are such that "essential and necessary connections that form a completely definite structure are singled out in it and reinforced in its elements and in the relationships between them" [345, p. 281]. Models are a form of scientific abstraction of a particular kind, in which the essential relationships of an object which are delineated are reinforced in visually perceptible and represented connections and relationships of material or symbolic elements. This is a distinctive unity of the individual and the general, in which the features of a general, essential nature come into the foreground.

It should be emphasized that the visual-pictorial, concrete-object expression of the essential relationships of reality is not an act of elementary and primary "sensory judgment..." of them. Models and the model conceptions that are related to them are the products of complex cognitive activity, which includes above all the mental processing of raw sensory material, purification of incidental features from it, and so on. Models function as products and as a means of accomplishing this activity.

In our treatment of modeling we have disclosed a distinctive form of connection between the sensory and the rational in cognition. The question of the correlation of these features needs a more detailed analysis.

The Sensory and The Rational in Cognition

The preceding exposition has repeatedly pointed out that practical experience with sensory objects and sensory-object experimentation are the source and the basis for all human knowledge. Apart from sensations and perceptions, man can get no information about external reality – but this sensation is active; it functions only as a feature in activity with objects (it is "vital contemplation"). The results of receptive activity are given rational form – in empirical conceptions and in theoretical concepts (these conceptions and concepts themselves actively organize the work of the sense organs).

But it should be kept in mind that, along with the rational, mental methods of assimilating reality, there are also the artistic, the religious, and the practically *intellectual* (morality, law) methods [2, p. 728]. They are of course related to sensation in a different way from thought, and yet interact in one way or another both with one another and with thought – but this is a special problem.

Man's sensation as practical-object activity is contradictory in its content. Sensation and perception, in themselves, reflect present being. But a different content – the mediated quality and the coherence of being, its inner content – "penetrates" sensation through practical action, which brings things together in an expedient way (the object and the means of labor). Practical action, which is oriented toward sensory *objects*, combines an opposing content within itself – the external and the internal, the present and the mediated, the individual and the general. These features occur here in an immediate unity.

The growing complexity and evolution of practical experience and human contact, on the one hand, have developed means of idealization (the plane of conceptions), and on the other hand have led to a split in human integral work endeavors, to a dissociation of the work of the "planning head" from the "doing hands." The reinforcement of this dismemberment has had its own historical socioeconomic causes, whose real content presumes special research.

The immediate unity of opposite features of the content of practical actions collapsed for particular reasons. On the one hand, conceptions establishing the immediate properties of being, translated into the language of abstract generality, began to develop separately. Because of this, people's elementary rational orientation toward the objects and the means of labor, toward the phenomena of the life of the society and the coordination of the corresponding conceptions was cultivated. This was an orientation toward the settled and canonized methods of production with relatively stable tools requiring "training," the acquisition of "skills." This type of orientation toward present, external being became the basis for the empirical thinking of the mass of the toiling performers of social and labor operations.

On the other hand, human beings developed an ability to plan production and their life as a society, to create designs for new tools and the techniques of making and using them. Another feature of practical action was particularized in their activity – that which was connected with the delineation of the universal, mediated properties of things. This particularization apparently occurred through a different route from the former instance. It can be presumed that the sensory-practical action retained its external, object-related form, but changed its purpose – it came to be used, not for directly obtaining a product, but for cognitive purposes in the role of "fitting," "testing," or "trying out." This engendered specific sensory-object actions of a comprehending nature which reproduced a certain form of the movement of things. For example, operations such as those noted by A. N. Leont'ev can solve problems in evaluating

> the suitability of raw material or of a by product by a preliminary testing, a practical "trying out" of it. Operations of this kind, which are subordinate to the cognitive purpose, whose result is the knowledge obtained through them, are genuine thought in its external, practical form [191, p. 90].

The reproducing character of methods of labor activity was idealized in this kind of thought – thought in its *external form.* Here sensory-object experimentation developed, in essence. Mental activity was gradually converted into "internal activity," into work done by man "for himself."

Here it is important to stress the following. In the form of an *object operation* that is cognitive in character, human sensation *goes beyond* the limits of the appearance and immediacy of being. This operation can reproduce features of mediation, the connections of things, their universal nature. This possibility is reinforced and expanded through the use of material symbols, then of verbal signs as well (the use of the latter serves as a means of passage from external and object-related forms of cognitive operations to their verbal-discursive analogues – that is, to mental actions properly speaking [191, p. 91]).

The organization of sensory-object experimentation and the use of material symbols presuppose complex types of activity based on vital contemplation and conceptions. In it a considerable role apparently belongs to *imagination.* At the historically early stages of development this sort of cognitive sensory activity was clearly somehow related to other methods of assimilating the world – in particular with the artistic one, in which the reflection of general forms of things is also inherent in a unique form (see, for example, [139], etc.).

Comprehension through the contemplation and conception of the universal connections of being lies within the reach of this combined sensory-object activity, which relies on the productive imagination – but it is accessible only as a fact, as an undissociated manifestation of a whole, as a general impression. Engels detected this capacity in the ancient Greeks, for example:

> For the Greeks – precisely because they had not yet reached the point of dissociation, of analysis of nature – nature is still regarded in general, as a single whole. The universal connection among the phenomena in nature is not proved in its details; it *is*, for the Greeks, a result of direct contemplation [6, p. 369].

Here Engels used the words "direct contemplation," and synonyms for these words that have been learned from empirical psychology might come to the surface in the minds of some readers: "sensations, perceptions, observations of nature" (and *then,* on "their basis," abstract thought arises, and so on). Indeed, in our opinion, these words have a different meaning that is altogether out of the ordinary for traditional psychology textbooks: The Greeks' "direct contemplation" is their *philosophy,* in which "dialectical thought functions in primordial simplicity" [6, p. 369]. "Contemplation" is equal to "thought," but it is still genuinely human, reflective, and reasoning thought – that is, *dialectical* thought. Traditional psychology and traditional formal logic cannot concur, of course, with this sort of identification of the terms designating *different* forms of cognition. For them it is *nonsense,* and only that!

For the dialectical theory of cognition this matching of the terms is entirely allowable. As was noted above, the emergence of sensory-object experimentation was, in essence, also the emergence of theoretical thought in its external, practical form. Particular types of sensory activity ("vital contemplation") are capable of reflecting a general connection – that is, they can perform the *role* of theoretical thought, but of reflecting in a still undissociated form, since this thought still appears "in primordial simplicity;" it is still undeveloped-has not achieved complete sovereignty.[31] To be sure, as will be noted in the next section, even when there are well-developed means of contemporary theoretical thought, contemplation and the conception of the general connections in a system that is being analyzed are an important condition for reproducing it correctly and successfully in concept form.

Thus, one cannot speak of sensation "in general" when determining its relationships to the different types of thought. Having said, for example: "This is an object perceived by the senses," we are not predetermining the character of its rational expression. If the object is considered by itself, apart from any system or connection with other objects, it will become the content of empirical thought. But if the same object is analyzed within certain concreteness and only here reveals its real features, it will become an element in the content of theoretical thought. The latter depends entirely on actual data, on sensory information; it is a particular method of *combining* and *explaining* it.[32]

But if general connections are still accessible to a particular kind of sensory activity – and this is the principal goal of theoretical thought – can it not be presumed that its content, in principle, is reducible to its "own" sensation in the same way as the content of empirical thought is to its "own"? This question is legitimate and raises a complex theoretico-cognitive and psychological problem. Let us attempt to find one of the possible answers to it. In our opinion, when treating this problem one must determine with all clarity the peculiarities of the problems to be solved by theoretical concepts. *First,* a certain integrity, a unity of the diverse, a system is always their object, one must understand this wholeness – that is, reproduce or construct it in special intellectual form, ascertaining the reasons and bases of this connection-rather than another-among its unitary components within the whole and by means of it. *Second,* this concreteness must be reproduced in its own necessary forms, free from interactions that are accidental and insignificant for it, inevitable ones in the objective existence of the system – that is, the concreteness must be taken in "pure form." *Third,* the first two problems can be solved only by considering the object in its *development,* in the process of forming the whole itself The point is that only in these conditions can the really necessary and the merely incidental forms of motion of the given concreteness be mentally broken down, since in the process of development the system reproduces as its own consequences that which is its *necessary* preconditions. As Marx wrote: "If everything that is posited is at the same time a precondition .. . in the completed bourgeois system, then it occurs in any organic system" [14, p. 229].

Precisely for this reason it is only in the analysis of development that cause cannot be confused with consequence, or form with content. Consideration of development constantly requires an expression of a certain result through the process that leads to it (a process that is already *accomplished!*), but expression of the process through the expected result (which is *not yet accomplished!*). Only in this way can individual objects within a concreteness be understood and analyzed in their real interconnections. These are the conditions for the activity of theoretical thought. Can even an increasingly highly developed and sharpened sensory activity satisfy them?

This sort of sensation can *ascertain* the presence of a universal connection, the wholeness of an object, the dependence of everything on everything else. This is a very important feature in theoretical activity. Moreover, the image of this wholeness is a necessary precondition of it. Such sensation can yield detailed information about the actual relationships of the system's components. But it cannot provide information about their mediation of one another, for these mediations are none other than *transitions* from process to result and vice versa (from that which existed to that which exists and from that which exists to that which is capable of existing). Reproduction, or the playing out in subjective activity of these transitions on the scale of the *entire system, is beyond the potential of sensation.* But these mediations or transitions are an *internal* movement, whose form is necessity, generality – that is, internal completeness and "purity." This sort of reproduction, on the strength of theoretical thought alone ("transitions, mediations" are its elements!), and its content (the specific type of connections of the individual within the unified) *cannot* be reduced to any kind of sensation.[33]

The assumption that theoretical thought "goes beyond the limits" of sensory perceptions and conceptions often relies on the idea of the limited "solving capacity" of the analyzers (for example, they have relatively high sensitivity thresholds, and so on). From this point of view, a lowering of the thresholds or an expansion in the "channels" of communication of the sensory formations supposedly allows the analyzers to grasp what cannot be perceived by them now (of course, again within certain limits). In other words, the "defect" in sensation is not in its qualitative nature, but in the quantitative scope of reality. In principle, the view that thought is needed where our "eye" cannot glance, either because of external space-time obstacles (for example, the opposite side of the moon was such for a certain time), or because of the exceptionally small or large dimensions of the objects being studied (the atom or the galaxy), also amounts down to this point of view. Because of difficulties of a similar kind, there also arises the problem of how to represent visually what is not immediately observable (temporarily or in principle). The previous treatment of the nature of thought allows us to conclude that these problems, as well as the very tendency toward "visual" conception of "nonvisual" objects, arises along the route of an expansion in empirical thought, an expansion that is a consequence of making empirical thought absolute. Such thought, which deals only with sensory data, supposes that any content should amount to this, but if it does not "amount to it," then it is for *external reasons (far, small, large)* or because of quantitative boundaries ("It is impossible to bound the unbounded"). In the latter instance an image of the "nonvisual" must be constructed, even if it is by analogy with the "visual."[34]

This viewpoint passes over the question of the *qualitative boundary* of sensory activity, but the whole problem of correlating it with thought consists in this. As was shown above, there is such a boundary, objectively speaking, and it is set, not by the specific nature of our cognizing means, but by the very nature of *objective* reality, which is reflected in the forms of human cognition and which has determined their relative boundaries. Any merely mediated whole that is coming into being is *not yet defined in itself.* It has not "melted down" into its own forms the collection of individual, incidental interactions, and thereby has not yet *acquired* necessity, universal generality ("internal completeness"), or a rule-conforming nature ("stability" – it is not "settled" or "serene"). In other words, it is still *not* real-it is *not* yet, and there is only its *possibility*. Therefore here there is not yet anything for sensation to "grasp," since a new integrity has not been formed from the old preconditions – it is *in the process of coming into being*. To reproduce precisely this process in thought, a demonstration of how it *is possible is* important. Lenin, in studying Hegel, constantly singled out the circumstance that for dialectics reality functions as a unity of being and nonbeing. He made this observation: "'Disappearing features'= being and nonbeing. This is an excellent definition of dialectics!!" [17, p. 245]. And again: "How does dialectical transition differ from nondialectical? ... In the unity (identity) of being and nonbeing" [17, p. 256]. It is interesting to compare these statements with Lenin's extracts from Hegel: "Coming into being is a given element in being as well as nonbeing," "Transition is the same as coming into being" [17, p. 95].

Coming into being, or motion, is often represented only as a simple sum, a sequence of externally defined, set states, acts of rest. But this describes only the results of coming into being (at times highly "fractional" ones, but still results) *rather than coming into being itself.* Its reproduction contains – as Lenin emphasized – a demonstration of its potential. Only by virtue of this are the contradictions between continuity (process) and discreteness (result) as disappearing features in real coming into being resolved dialectically (see Lenin's analysis of these questions [17, pp. 230- 233]).

It is the coming into being or development of an object and its forms that should *reproduce* theoretical thought. As a concept it should express a possibility that *passes* into necessity through the interconnection of isolated things, through their interaction. It should express the interconnections between the individual and the general, whose genuine reality and vitality exists only in development, in the conversion of a possibility into a necessity. This also means that a concept embraces the *transition, the* identification of the different within the unified which occurs in reality itself. In describing the logic of Hegel, who divined the dialectics of thins in the dialectics of concepts, Lenin wrote: "Relationships (= transition = contradictions) of concepts = principal content of logic, with these concepts (and their relationships, transitions, and contradictions) *being shown* as reflections of the objective world" [17, p. 178].

Thought accomplishes its activity often after the real development of an object has occurred. Thought reconstructs it. Reality itself has become concrete, necessary, and general, and thought shows "how it happened." But in proportion to its development it can run ahead of "nature" and, in industry, can accomplish what is only on the order of a possibility in "nature." The conditions for converting it into reality are found by thought, but only together with experimentation as a form of practical experience that is implemented for cognitive purposes.

Thus, in a certain sense sensory activity reflects what has *already* been accomplished, and theoretical thought – what is being accomplished as possible and by virtue of which that possible becomes a reality. This distinction between being and coming into being exists in reality itself, and it determines the qualitative boundary between the content of sensory activity and theoretical thought. And this boundary is not to be sought in the macro- or micro-cosmos. It is in very simple and nearby things as objects of cognition, for in them there is always an external and an internal. If we are finding an abstract identity, forming classes, cataloging and giving hierarchical order to name-words according to their "genus-type" significance, then we are moving in the sphere of external, rationalized sensory content that is obtained through observation and merely conceptualized. But if we are trying to find out *how* a given thing – that is, a certain concreteness occurred or was formed, we shall be obliged, not merely to observe its changes, but also to "search" for the conditions that really determine its coming into being – that is, we begin *experimenting,* reproducing the thing and mentally tracing all of the circumstances of this process (it is another matter if we "find out" some of these circumstances from other sources of theoretical science).

Consequently, the boundary between sensory experience proper and theoretical thought passes along the line between *taking* an object as it is in itself, or in an observed connection with others, and *not taking* it as such but ascertaining its origin (for what purpose and why, on what basis, by what possibility it became this way rather than another). The first test relies on observations and conceptions. The second activity, which includes (but in a distinctive way, differently) observation, relies on cognitive *action* that reveals the unobserved, internal connections as a source of observed phenomena. The actions connecting the external and the internal (the isolated and the general) are comprehension. Tracing the concrete by means of such actions is thought in concept form – theoretical thought.

In discussing action, we have in mind primarily *sensory-object,* cognitive action. Therefore it is still "sensory" – and does it reveal *internal* connections? Yes, it is *sensory,* but with an important addition-an *object-related action, really changing the object of study, experimenting on* *it*. It has its own prototype in practical-object action, but, remaining cognitive, has been converted into a phase and basis of theoretical thought. Sensory-object cognitive action receives its real revelation and meaning only within global problems in this kind of thought, which reproduces the general in concept form. This action is an aspect of the motion of concepts that are expressed in symbolic-sign form. In turn, concepts always rely on such actions and realize all of their potential, disclose the features of the general content of objects-features *revealed* by them, bring them into a system, form a *theory* of the concrete, and reproduce it in idealized form. This "form" is *not reduced* to the sensory sources; it corresponds to the internal content of reality itself.[35] It is in these two-sided connections between object-cognitive actions and the motion of "pure" concepts as actions with sign-symbols that the unity of the sensory and the rational in theoretical cognition of reality consists. To divorce the one from the other means depriving work with concepts on the level of mental experimentation of both the elements of general content and of the object source of new forms of mental actions. But an object-related, cognitive action itself loses meaning, purpose, and aim when there is such a divorce. Of course, in modern science the unity here is not direct but mediated by many intermediate "points" right up to the division of labor in general, science itself and its individual branches in particular.

Thus, assertion of the specific nature of the objective content of theoretical thought is not an "infringement" on the role and significance of the sensory sources of cognition. Here the place and the form of their inclusion in thought are merely determined, and the necessity of thought as a special method of reflecting reality whose purpose is to "encompass" it more profoundly, more certainly, as a whole, is discovered.

The specific nature both of the content and the form of theoretical thought has been delineated and stressed by Lenin. We have cited some of his theses above, but it is advisable to provide another, directly concerning the relationship between sensory conception and theoretical thought. Lenin wrote:

> ... in a *certain* sense, conception, of course, is lower [than thought – V. D]. The point is that thought should *encompass* all of "conception" in its movement, and *for this purpose thought* must be dialectical. Is conception *closer* to reality than thought? Yes and no. Conception cannot grasp movement *as a whole* – for example, it does not grasp movement at a speed of 300,000 km in 1 second, but *thought* does and should grasp it [17, p. 209].[36]

This statement expresses, in a concentrated way, the essence of the dialectical approach to the correlation between conception and thought. The task of thought is to encompass all of conception in its movement – that is, to express the entire collection of sensory data *in development*, and for this, *dialectical* thought is necessary. Such thought must grasp movement *as a whole* – and it solves this problem, reflects this objective content that is inaccessible to conception. So as not merely to write down the numerals for the speed of light but to *understand* it as the maximum speed for any movement ("to grasp it as a whole'), *theoretical* thought is required.

It would be helpful to provide some brief historical information on the problem that we are analyzing. The struggle between empiricist-sensationalists and rationalists has a long history. The turning point in it was Kant's approach to the problem. Kant, in trying to overcome the "dualism" between the sensory and the rational, introduced the category of a "sensory concept," which is capable of expressing the general in sensory form by virtue of the activity of the productive imagination, which creates "schemata" (see above). At the same time Kant precisely pointed out the content of reality that is not given to sensation – the "connection of the diversified," the joining of the different in the one (in the *concrete,* to speak in Hegelian terms) [151, p. 190].

In evaluating the cognitive potential of sensation, it is also important to take account of Hegel's position (see, for example, [80, pp. 207-245]). He singled out three levels of consciousness – sensory, perceiving, and rational consciousness (the next and highest form of the spirit is self-consciousness). *Sensory* consciousness, whose content is given by sensations, reveals an object to man in its immediacy and solitariness – as a real unity of the diversified and particularized content of sensations, as something *given,* about which man does not know where it comes from and why it has precisely this definite nature. It is noteworthy that Hegel, who was constantly singling out and emphasizing the specific nature of thought, at the same time had an excellent understanding of the role of sensations as the real source of all types of cognition. Thus, he wrote:

> *Sensation* contains *all of reason – the entire totality of the spirit's material. All* of our conceptions, thoughts, and concepts of external nature, about right, about morality, and about the content of religion evolve in our feeling intelligence [80, p. 245].

In the *perceiving* consciousness the unitary stands in relation to the general – but without revealing their real unity. Perception can set sensory material in relation to a general that is not immediately observed, by understanding the connectedness of separate, individual things. But since individualities thus remain independent and fundamentally different from the general, their connectedness is a *blending* of the two. Hegel perceived the goal of perception in "making clear that if given circumstances are available, then this is what follows ..." [80, p. 211]. At this level, according to Hegel, is *experience*, on which cognition depends.

The blending of the individual and the general in perception leads to contradictions, which are resolved in the *rational* consciousness. It understands the unity of the individual and the general, but only as their abstract identity, undifferentiated within itself (the differentiation typical of a concrete identity comes at the self-consciousness level).

Thus, in addition to sensation-observation, Hegel singled out another form of sensory activity – perception, which is capable of correlating the individual and the general, which establishes the general conditions for the accomplishment of some event (envisaging consequences according to the conditions at hand). In our opinion, here Hegel has come very close to describing the role of sensory-object *activity* in disclosing the necessary connections among phenomena. This significance of activity was clearly delineated by Engels, using the example of man's establishment of necessary causal connections.

Above we have repeatedly spoken of the distinctive nature of vital contemplation as a form of reflection. Certain of Hegel's ideas are of considerable interest in this matter. He notes especially that in a very broad sense the name "contemplation" can be given to sensory consciousness (properly speaking, this often is done). But in its real significance contemplation differs essentially from the immediacy of sensory consciousness. An object of contemplation has the designation of being "*not individual,* not disintegrating into a diversity of aspects, but a unified whole, a firmly *retained connection of the completeness* of definition .... Intellectualized, true contemplation, on the other hand, grasps the *substance* of an object *in all of its completeness*" [80, p. 251]. Therefore in all sciences it is right to *proceed* from contemplation of an object – only then can one move forward in considering its particular features, which are rooted in substance, without getting lost in particulars, in a variety of uncoordinated parts. But for all of the exceptional importance of contemplation, which establishes the substance of an object, genuine cognition cannot stop at it. Hegel writes:

> In direct contemplation, to be sure, I have before me the entire object as a whole, but only in comprehensively developed cognition which returns to the form of simple contemplation does the object stand before my mind as a *systematic* unified whole that is articulated within itself [80, p. 252].

Thus, contemplation, which reflects an object's concreteness, cannot be identified with any sensational quality. As was shown above, it was this form of direct contemplation of a "unified whole," of the universal in nature that Engels found among the ancient Greeks, believing it to be the beginning of dialectical thought in its "primordial simplicity."

The Method of Ascent from the Abstract to the Concrete

The theoretical reproduction of the real concrete as a unity of the diversified is done by the only possible and scientifically correct *method of ascent from the abstract to the concrete.* In the words of Marx, this

> ... method, with the aid of which thought assimilates the concrete to itself, reproduces it as the intellectually concrete.

If the intellectually concrete, the mental whole, is the product of a thinking mind that is acting by this method, if, in thought, concreteness "functions as a process of synthesis, as a result, and not as a starting point," then in reality it is genuinely the starting point and, "as a consequence of this, also a starting point for contemplation and conception" [2, p. 727]. The real concrete at first appears to man to be given sensorially. Sensory activity in its particular forms of contemplation and conception is capable of perceiving the wholeness of an object, the existence of connections that lead to generality in it. But sensation cannot establish the nature of these connections. M. M. Rozental', noting the distinctive nature of the expression of the concrete in contemplation, writes: "It can be said of this concrete that it is as it is visible as invisible" [271, p. 436].

The task of theoretical thought is for the data from contemplations and conception to be reworked in concept form, thus reproducing in a comprehensive way the system of internal connections that engender the given concreteness and reveal its essence. This general task of theoretical thought, as is well known, was especially noted by Lenin when considering the example of revealing the essence of motion: "... The question is not whether there is motion but how to express it in the logic of concepts" [17, p. 230].

With what must such reproduction begin? The very name of its method indicates that one must go from the *abstract,* and, actually, "abstract definitions lead to reproduction of the concrete by means of thought" [2, p. 727]. In the description of the abstract, dialectical logic branches off from the narrow interpretation of it that has been intrinsic to traditional formal logic and that we have set forth in detail in preceding chapters. We recall that in it the "concrete" implies a particular, sensorially perceived object or its visual image, and the "abstract" implies repetitive, similar, particular properties of some collection of objects that are mentally detached from these objects and considered independently. To form an abstraction means to find such general properties and to detach them from others mentally. Then it is possible to deal only with these abstracted properties without conceiving of the entire object with its properties intact. Clearly, the content of such an abstraction does not really exist. A property cannot be detached from the object itself as a carrier in reality (this is possible "only in the abstract").

These abstractions, which permit classes of objects to be delineated and a classification of them to be made, are altogether necessary in the empirical description of any more or less complex concrete reality (a real whole). Thus, any economic system has many aspects and components. To orient oneself in it, and, all the more so, to describe it in one way or another (even for purely practical purposes), it must somehow be broken down, particular simple components delineated, then correlated with one another – coordinated. Observations, comparisons, and analysis allow this problem to be solved. They show that the population of a country has needs that are met by the products obtained in the labor process, that these product-commodities can be exchanged – they have an exchange value, and so forth. All of these elementary definitions (aspects) of the system are an abstraction of its real, complex whole. Because there are no needs *in general,* the abstractions are particular and very different individual needs, such as the particular concrete types of labor (industrial, agricultural, etc.). Marx noted: "*Production in general* is an abstraction, but a reasonable abstraction, since it actually delineates the general, establishes it, and thereby saves us from repetitions" [2, p. 711]. In the description of reality these abstractions seem to "compress" a multitude of similar phenomena into "one" and, by speaking only of it, to imply all of the rest *without* repetition.

By virtue of these abstractions, many properties and relationships among things become *known* to people. But, as Hegel wittily observed, just because something is known does not mean that it is comprehended. Such facts, no matter how extensive they are, in themselves provide no knowledge about the real connections and transitions in the entities observed, about the causes and tendencies in their changes. All of this lays the groundwork for a rather false interpretation of the real state of affairs. Thus, Marx has shown how unnaturally the participants in capitalist production interpret their interrelationships by perceiving its mechanism in the relationships of the things themselves rather than in property relationships (commodity fetishism). And no small number of examples might be cited of fetishism of a different kind, one emerging in the empirical relationship toward reality.

In the descriptive disciplines attempts have always been and are being made to order the abstractions that have been created, to connect them, to construct a *system* that provides the whole picture of the object from which they were originally "torn away." But how can this be done? This kind of synthesis cannot consist in simply drawing the resulting abstractions closer together mentally – then it is not a system that is obtained, but a collection of ordered definitions. The real concreteness included many connections, and not all of them have a significance in the theoretical reproduction of it. Consequently, the central or the essential must be detached from the structure of random abstractions, and, furthermore, in thought one must keep to the essence of the matter rather than to accessory mediating qualities that exist everywhere in a complex whole. But where can we obtain a criterion for "essentialness" – and then how can one be guided by it in choosing initial abstractions, for example? In themselves they do not have this criterion. Among them it is impossible to delineate the initial and the subsequent, the central and the non-central, in an unambiguous way. Traditional formal logic does not formulate any rules on this score.

There are two more difficulties on the way toward using the resulting abstractions. First, the theoretician who uses them cannot be confident that the collection at hand is sufficient to build the edifice of a system – could some particularly important abstractions suddenly be lacking? Second, in the creation of a system in the proper sense of the word, it is necessary that some theses be derived from previous ones, but *within that content* which is obtained by *that derivation,* and not within previously given content. But the very notion of designing a system from abstractions that are already formed contradicts this requirement.

These facts (in principle, they might be extended) show that formal abstractions obtained at the descriptive-analytic stage in the study of an object do not contain in their collection the conditions needed to reproduce concreteness. These conditions lie *beyond* such abstractions, which, incidentally, were by no means aimed at later use in an ascent to the concrete in their formation anyway. They emerged for other purposes – to single out classes of objects according to a general property and to systematize these classes.

As was noted above, theoretical thought can reproduce its object only through consideration of its *development.* The point is that only then can there be a grasp and a rational expression, not only of the existence of certain things and their properties, but also of their *possibility,* as such, with a subsequent determination of the conditions of their manifestation in a certain form, though necessarily a *general* form. If *something* arises, it arises in a simple, undifferentiated, undeveloped form. Both time and the particular conditions requiring differentiation or development of this *something* are needed for the variety of its manifestations. But if the something in its development takes on particular forms and aspects, they will be particular with respect to its simple, undifferentiated existence – that is, to their general basis, as such. Theoretical analysis is always striving to discover the rise of these general forms for a certain object that is being studied and to represent them as theoretical abstractions.

Thus, Marx was interested in why and how money emerged in cost relationships – money *as such,* in its general form, independently of the particular aspects it then assumed (this is a question for special study, but this kind of particular can be understood only on the basis of disclosure of the content of the general form). Moreover, he was interested in how profit as *such is* possible and how it is obtained when the exchange of costs on the marketplace occurs equivalently (Marx found the source of profit as such and then, consequently, of all of its particular types, right down to ground rent by revealing a commodity of a particular kind-the work force, the use of which allows part of the working time to go unpaid, under conditions of capitalism).

A thing's general form seems to "die" in its particular manifestations, but it is retained as a basis of their reproduction and unity (for example, for all of the various particular types of money, all of them together realize the function of money as such). It is this unified internal basis for the various phenomena of one kind that empirical abstractions-in contrast to theoretical ones – do not express – they establish the features of their external similarity, often omitting from the kind delineated those instances that do not have such features (in Chapter 3 we cited an example of the difficulties in forming a formal abstraction of "man," since it does not grasp the internal unity of the human race).

In the methodology for familiarizing students with the concept of *number* there is a "dualism" between the natural and the real numbers, for which fundamentally different sources are perceived (counting and measurement). Here consideration of the form of a number as a distinctive method of expressing quantitative relationships in human activity is ignored. An analysis of the origin of this concept is needed, so that its general form can be discovered, the types of numbers themselves. Disclosure of their general base is hindered by the traditionally formed empirical characteristics of number as described in the *methodologies* for mathematics teaching [424], [428].

In empirical abstractions that establish formally general properties for set things, the content of their general form is not grasped, and therefore they – as ready-made abstractions – cannot be applied in considering the conditions for the emergence of the general form, which is necessary in the ascent to the concrete.

Thus, the presence of ready-made empirical abstractions obtained during a preliminary analysis of some integral entity does not, in itself, assure an ascent. Moreover, these abstractions are now suitable *in their content* for a mental ascent to the concrete. Abstractions of a different kind are needed for this purpose.

At first glance, this contradicts the real correlation between the descriptive and the theoretical periods in the development of the sciences. In particular, Marx, noting that bourgeois economists reduced sensorially rich conceptions to gaunt abstractions, mentioned that they then attempted to restore the concrete [2, p. 727]. Indeed there is no contradiction here. In the real history of the sciences there are no "pure" periods of empirical description and construction of theories. Within the descriptive period theoretical abstractions are created from the outset of necessity (therefore we are referring to a *science*), which then permit the assimilation of factual material that is expressed by empirical abstractions. In the history of the sciences there are stages in "liberation" from the dominance of empirical abstractions and the crystallization of the requirements for the construction of theories when previously created abstractions are verified by facts, critically analyzed in their form, etc. The path from the sensorially concrete to the abstract is seemingly traveled all over again here (but much more rapidly), but now it meets the requirements of the subsequent ascent to the mental concrete. Marx himself carried on a vast effort, in the struggle with empiricist-economists, to create genuinely theoretical abstractions in political economy, where the method of abstraction created by Locke had previously dominated in a number of cases, (see the analysis of this question in the books by E. V. Il'enkov [134], [270], and elsewhere).

Moreover, the construction of theoretical abstractions by no means ignores the factual material gathered at the descriptive stage. On the contrary – it is used thoroughly, though critically, to be sure, since the form of movement that is specific to ascent is attached to it. Here, of course, formal abstraction itself is necessary as a means of abbreviated operation with similar phenomena and things that permit the avoidance of repetitions when surveying them.

Theoretical thought, which has need of abstractions, also provides itself with them. E. V Il'enkov has clearly delineated this feature:

> The "reduction" of the concrete fullness of reality to its abbreviated (abstract) expression in the consciousness is not only a "precondition," not only a prehistoric condition of the theoretical assimilation of the world, but also an organic feature in the very process of constructing a system of scientific definitions – that is, of the mind's synthesizing activity... . Particular abstract definitions, whose synthesis yields the "concrete in thought," are formed in the process of the ascent itself from the abstract to the concrete. Thus, the theoretical process, which leads to the attainment of concrete knowledge, is always, in each of its individual links, as in the whole as well, at the same time a process of reducing the concrete to the abstract [134, pp. 114-115].

Although both processes ("reduction" and "ascent") occur in unison, the leading one is *ascent*, which expresses the nature of theoretical thought. Movement toward the concrete, as a principal goal, determines the methods of mental activity, within which "reduction" functions only as a subordinate feature, as a means of reaching this goal. Therefore, in an epoch when the theoretical form of thinking was developing and was consciously realized, it would be irrational to require that every new science first pass through a particular and independent stage of empirical description of an object (contraction of the sensory to the abstract). On the contrary – from the very start one must establish the goal of reproducing the concrete and within this process developing abstractions that meet this goal [134, pp. 118-119].[37]

The characteristics of theoretical abstraction are determined by the goals of ascent to the concrete. These goals permit the formulation of requirements for the *initial* abstract definition.

First, this abstraction should indicate the "direction" of the system's formation. This means that its content should correspond in reality to the *beginning of the emergence* of the concrete itself, to the beginning of the simple and general. This content, at the same time, should contain those contradictions whose resolution would have occurred by its division into different features that yield the result of a broken down integral system. *Second*, the content of this abstraction, qualitatively, should correspond to the nature of the entire system, should be a very simple, undetailed form of *relationships* within the whole and a distinctive feature of it; this simple form does not depend on other, more developed relationships in the whole. *Third*, as a general, genetic base for the whole this abstraction expresses its essential foundation or essence, which provides for the unity of all of the breakdowns into different, relatively independent components. These properties of the initial abstraction can be expressed briefly as follows – it is the historically initial, contradictory, simple, and essential relationship of the concrete that is being reproduced. Marx has written: "The course of abstract thought, which ascends from the elementary to the complex, corresponds to a real historical process" [2, pp. 728-729]. Engels has noted: "... In history, as in its literary expression as well, development in general and *on the whole* occurs from elementary relationships to more complex ones as well..." [3, p. 497].

The aforementioned requirements can be met only by an entirely *real* relationship that is given in a form *that can be contemplated by the senses.* As an aspect of something concrete – that is, having its *particular* form – it at the same time functions as a genetic basis for another whole (and in this sense it functions as a universal). Here the real, objective unity of the individual (particular) and the universal, their *connection*, which mediates the process of development of the whole, is observed.

The uniqueness of this sort of initial abstraction appears in the names for it: "concrete abstraction" [134], [271], "the concrete-universal relationship is the objective cell of the whole that is under investigation" [103], "content-oriented abstraction" [134], [159], or simply "cell" [134], [126]. These names express in different ways the essence of an initial abstraction as a simple relationship of concreteness. It incorporates the potential of the whole, and at the same time it is again reproduced by this whole as its general basis. In our opinion, while all of these names are legitimate, it is advisable to use the term *content-oriented, real abstraction*. In contrast to formal abstraction, it is historical (it is a genetic basis), and its content exists *concretely*, in the form of a relationship that can be contemplated rather than merely in the mind.

But why is this formation an "abstraction?" Perhaps because it is expressed in the form of an idea? By no means. Here it is necessary to dwell in more detail on the very concept of "the abstract," as it is used in dialectical logic. The concept of "the concrete" can be correlated with it-which, as was noted above, means some developed whole, interconnection, unity of different aspects – it is the synonym for the determining role of the whole with respect to its parts, features, and aspects. "The abstract" usually has several characteristics – it is something *simple, devoid of differences, fragmentary, and undeveloped.* All of this is merely a designation of aspects of the abstract as a certain delineated independent part of the whole which exists in relative independence of everything else. Only what is relatively simple, homogeneous, devoid of qualitative differences, and internally undeveloped can be such a part.[38]

The abstract and the concrete are features in the breakdown of an object itself, of reality itself, as reflected in the mind, and only for this reason are they derivative features of mental activity. Asserting the objectivity of both of these features is a major feature of dialectics as logic. Lenin has noted: "Nature is both concrete *and abstract* ..." [17, p. 190]. The abstract functions "only as a feature in a constantly changing material reality" [17, p. 298].

Marx established that commodities are the products of abstract labor, to which all of the things of concrete labor are gradually reduced. Marx wrote: "This reduction is represented by an abstraction, but it is an abstraction that occurs daily in the social process of production. The reduction of all commodities to working time is no more but again no less a real abstraction than the conversion of all organic bodies into air... . Labor, as it is represented in exchange values, might have been called *universal-human* labor. This abstraction of universal human labor exists in average labor..." [3, p. 17].

A real abstraction of universal-human labor exists in average labor as a social phenomenon that is typical of mature capitalism, where the real reduction of all particular types of labor to their single societal measure (working time) becomes the principle and where there is a constant transition from one type of labor to another. Marx wrote:

> Indifference to a certain type of labor corresponds to a social form in which individuals pass with ease from one type of labor to another and in which a certain type of labor is accidental for them and therefore a matter of indifference. Labor here, not only in the category but also in reality, has become a means of creating wealth in general and has lost its specific connection with a certain individual [2, p. 730].

Clearly, the real abstraction of labor must be differentiated from the formal abstraction of "labor in general" that exists only in the mind; this kind of labor is always the basis for human life. This difference, which is very important for an understanding of the dialectical approach to abstraction and to the universal, was clearly defined by Marx himself when he wrote:

> This example of labor proves convincingly that even very abstract categories, although they – precisely by virtue of their abstractness – have force for all epochs, and in the very certainty of this abstraction are to the same extent the product of historical conditions and have *full* significance only for these conditions and within them [2, p. 731].

These statements emphasize the features that real abstraction, on the one hand, exists through the reduction of certain complex formations to simple and homogeneous ones and, on the other hand, has its complete certainty and unambiguousness only under certain historical conditions and within them (in a certain "phase" of development of some concrete whole). Clearly, the disclosure of conditions that attach full certainty and reality to an abstraction presupposes a special analysis of the content of the respective whole and its development (for example, only an analysis of the capitalist formation and its development permitted Marx to reveal and describe the real abstraction of "wealth in general" and the form of "universal-human labor" or labor as such).

Returning to a description of the genetically original "cell" of a certain concreteness, we have the opportunity once again to note the legitimacy of designating it *content-oriented* abstraction (its certainty is related to the content of certain historical conditions) and as a real *abstraction* – it functions as a simple, homogeneous formation or, in the words of M. M. Rozental', it is an "undeveloped element of a developed whole" [271, p. 441].

So real, content-related abstraction has at least two forms. First, it can function as a still undeveloped, simple, and homogeneous entity that has not "been successful" in acquiring the necessary breakdowns – this would be the genetically initial abstraction of some whole. Second, it can have the form of an entity which is *already losing* its particular differences at a certain stage of development, becoming homogeneous – in this instance its differences are levelled when there is a real reduction of the particular types of entity to one another. But if real abstraction is regarded in the aspect of an ascent from the abstract to the concrete, then it – in opposition to empirical abstraction – is characterized as theoretical.

The definition of the *individual* and of the *universal* which we have discussed above, is closely related to the question of the nature of abstractions. Dialectical logic believes that, outside of the mind of the knowing person, there exist individual, particular things and phenomena that function as products and features in the development of a certain concreteness. The basis for this process is an altogether real, sensorially perceived object relationship – the "cell" of that concreteness. And although it exists itself in an entirely particular form of object relationship, at *the same time this "cell"* has the property of being a universal abstract form, determining the emergence and development of other particular, special and individual phenomena within a certain whole. For example, the general definition of cost in Marx's *Capital* coincides with the features of a simple (direct) commodity exchange, since *these features* consist in serving as a genetic base or as a "cell" for the entire system of particular types of cost.

In dialectical logic no particular is like any other particular! There is a particular that is simultaneously a general. And in this sense it is impossible to say which of them is absolutely primary [271, p. 388]. But such a general is "lifeless" in and of itself. Lenin notes: "The meaning of *general* is contradictory: it is lifeless, it is impure, incomplete, etc., etc., but it is merely a stepping-stone toward getting to know the concrete ..." [17, p. 252]. Only in the process of development, movement toward concreteness, does it really reveal its general nature by functioning as the basis for particular phenomena, through a connection with them, realizing its own function of combining them, their concreteness. Here the universal is characterized according to a specific function within the whole. It corresponds, on the one hand, to the potential of the genetic basis of this whole (that is, is related to its initial informal abstraction), and on the other hand, to a highly developed whole that subordinates itself to its own part and that constantly engenders its own base (on this level the universal is connected with the entire aggregate of abstractions that reproduces the concrete). The *realization* of a universal of this type occurs in the coincidence of these two features ("beginning – end," "possibility – reality").

A universal of another type is connected with the reduction of particular types of object to an abstract object. In addition to the aforementioned example of universal-human labor, Marx considers a number of other instances that are similar on a logical plane. Thus, he writes:

> ... Capital in general itself has a *real* existence that is *different* from particular real capitals. This is acknowledged by ordinary political economy although not *understood* by it, and forms a very important feature in its teachings about equalization low profits, etc.... The general, which is, on the one hand, only *conceivable* as a *differentia specifica*, is at the same time a certain *particular* real form, along with the form of the particular and the individual.... This is how matters stand in algebra also. For example, *a, b, c* are numbers in general, in general form; moreover, they are whole numbers, in contrast to the numbers *a/b, b/c c/b, c/a, b/a* etc., which presuppose these whole numbers as general elements, however [14, p. 437].

The reality of "capital in general," along with its particular forms, is detected – as Marx shows – in *monetary* capital.

The analysis of the logical content of the equating (identification) of figures in geometry that has been made by V. A. Lektorskii and N. V. Karabanov has shown that equality (generality) is understood here, not as an undifferentiability of the properties of figures, but as a particular *type* of connection between them. The equating itself "is done, not by comparing the properties of figures, but by *moving, changing, converting* one figure into another." The possibility for such a conversion exists within the framework of an *integral* system – a definite group of transformations [187, p. 233]). It is not difficult to observe that this transformation of figures in geometry is close in its type to the real reduction of particular types of labor in universal-human labor or to the existence of "capital in general" in the particular real form of monetary capital – that is, to the facts of the delineation of the general in political economy.

Thus, the form of the universal or the general *really* exists *along with* the forms of the particular and the individual, exists as a particular type of *connection* between them and reduction of them to one another. It is on this *dialectical* level that the meaning of Lenin's statements on the identity of the particular and the general is adequately revealed:

> Therefore, opposites (the particular as opposed to the general) are identical: the particular exists in no other connection from what leads to the general. The general exists only in the particular, through the particular. Every particular is (in one way or another) general. Every general is (whether tiny particle or aspect or essence) of the particular [17, p. 318].

It should be emphasized that the reality of the universal as a particular form, "along with the form of the particular and the individual," is found *in an interconnection* between particular and individual phenomena. This interconnection can exist both in the process of development of concreteness and in the reduction of an object's particular aspects to their universal form. In other words, like the abstract and the concrete, the individual and the universal function as definitions of a *reality* that is sensorially given to man. E. V. Il'enkov writes: "In this instance the problem of the relationship between the universal and the individual will appear not only and not so much as a problem of the relationship between mental abstraction and sensorially given, objective reality, as a problem of the relationship of sensorially given facts and sensorially given facts, as *an object's internal relationship towards itself,* the relationship of its various aspects to one another, a problem in internally differentiating object concreteness in itself. And, on this basis and as a consequence of it – a problem in the relationship among concepts that express an objective, dissociated concreteness in their connection" [134, p. 44]. Only on the basis of a clear awareness of this fact, that all of these features are aspects of *objective reality* itself, can the ways of reflecting them in thought on the basis of the operations of abstraction and generalization, the forms of their subjective expression in concepts, then be properly discovered.

In the preceding text we have repeatedly used the words "essence and phenomena." Now it is useful to give them a special description. It is well known that dialectical logic, in contrast to traditional formal logic, provides a content-related criterion for the *essential* in things. Above all, it should be borne in mind that the essence of a thing can be revealed only by considering the process of its *development*. It exists, merely *passing into* a phenomenon. On this level the essential is commonly characterized as mediated or internal, as the basis for phenomena, and the latter – as an immediate, external expression of essence. Here phenomena seem to lie on the surface of things, while essence is hidden from direct observation. As Marx has written, "The former are directly reproduced by themselves, as ambulant forms of thought; the latter can be revealed only through scientific investigation" [7, p. 552]. Empirical thought, which ascertains the external relationship of things, can be attributed to "ambulant forms of thought," of course.

Thus, essence is an internal connection, which, as a single source, as a genetic base, determines all of the other particular features of a whole. These are objective connections, which, in their articulation and manifestation, provide for unity of all aspects of the whole – that is, they lend concreteness to an object. In this sense essence is a *universal* definition of an object. Therefore a genetically original, informal abstraction expresses the essence of its concrete object. A real abstraction of the reduction of certain objects to their universal form (for example, of particular types of labor to universal-human labor) establishes their essence.

In turn, as was noted above, the universal as essence functions in the form of a law. Lenin noted as important the following thesis, which he formulated in reading Hegel: "... A generic concept is the 'essence of nature' – is a law" [17, p. 240]. A law is characterized as "the identical in phenomenon" [17, p. 136]. "Identity" here can be defined as generality.

Moreover, "law is an essential phenomenon,"[39] and Lenin concludes that "... law and the *essence* of a concept are homogeneous (of the same order) or, more correctly, of the same degree ..." [17, p. 136]. Consequently, in dialectical logic the concept of *essence* is of the same degree as the concepts of law and universality. To know essence means to find the universal as a base, as a single source for a variety of phenomena, and then to show how this universal determines the emergence and interconnection of phenomena – that is, the existence of concreteness.[40]

Having set forth the meaning of the basic categories connected with ascent, we can return to the matter of the methods of delineating an initial abstract definition. Clearly, the investigator can find it only in studying actual data and their relationships. Among the particular relationships, he should use *analysis* to single out the one that simultaneously has the characteristic of universality, functioning as a genetic base for the whole that is being studied. This is the basic task of analysis, which consists in *reducing* differences within the whole to the single base that engenders them – to their essence. Marx wrote: "... Analysis is a necessary precondition of the genetic treatment or interpretation of the real process of the development of forms in its various phases" [12, p. 526]. Noting the considerable success of classical political economy in the use of analysis, he provides the following description of it:

> Classical political economy tries, by analysis, to reduce different established forms of wealth that are alien to one another to their inner unity and remove from them the form in which they stand indifferently next to one another; it wants to interpret the inner connection of the whole in contrast to the diversity of forms of manifestation [12, p. 525].

To find the basis of "the process of the development of forms," the actual data on the development of the whole must be studied carefully and comprehensively, and, in addition, the concepts that have already developed in sciences must be critically analyzed (therefore the analytical level of ascent is at the same time a point in the analysis of concepts – that is, a point of *reflection* as a specific feature of genuinely theoretical thought in contrast to empirical). On the basis of this complex theoretical activity – analysis – it is necessary to delineate, and then to study the universal form of the whole separately, specially, without confusing it with the particular forms of it in which it is manifested. The force and the *completeness* of the abstracting ability of thought are what are needed for this purpose.

Thus, in connection with the problem of a particularized consideration of surplus value, Marx reproaches Ricardo for an insufficient force of abstraction: “Ricardo nowhere considers surplus *value* particularly and separately from its particular forms – profit (percentage) and rent” [11, p. 411]. But it is this kind of particularization that is necessary for a theoretical understanding of nature as surplus value itself and of its derivative, converted forms.

The reduction of particular phenomena to the basis of the process of the development of forms, their essence, cannot be done through simple comparison and induction that single out only external similarity and formal generality. For this purpose a special analysis is needed, permitting the delineation and consideration of the essence of a certain object during the study of itself or of an ideal image or model of it. It is known that Marx studied capitalism by using basically the data on its history in England *alone,* where it was most fully developed. But his conclusions were drawn about capitalism in general – and this was possible because Marx discovered the essence of capitalism, its general basis and the laws of its development, which are real for any “particular” capitalism.

Engels stressed the specific nature of the analysis of *one* object for the purpose of ascertaining the essence of its action. Thus, he pointed out that Sadi Carnot studied and analyzed the operation of the steam engine, eliminated the collateral circumstances that were of no consequence for its principal processes, and constructed an ideal steam engine that exhibited its processes in pure, independent form [6, pp. 543-544]. And this operation of a single imaginary engine enables an explanation of its processes to be made no less persuasively than for many thousands of real engines.

If the “cell” of some whole is delineated on the basis of analysis, then the basis is thereby created for deriving it genetically by ascent, by creating a whole system of connections that reflects the development of the essence, the general basis of the concrete. Here, one traces in which forms, and why precisely in those forms, the essence that has previously been found for an entity under study is embodied. In the investigation of these questions there must be an enlistment of information about the relationships from which it was necessary to abstract oneself when discovering the essence itself. In other words, on a general level this is primarily a *synthesis* process, although within it analysis is always being done in order to obtain the necessary abstractions.

The “mechanism” for ascent is the disclosure of contradictions between the aspects of a relationship that is established in an initial abstraction, then in a more concrete one. It is of theoretical importance to find and designate these contradictions. Since they have already had a certain resolution in reality itself, the investigator will be seeking the method and form of this resolution in it. Here the theoretical rational movement of thought constantly depends on *actual* data. Lenin demonstrated a general scheme for this theoretical movement of thought by using the example of Marx’s disclosure of the dialectics of bourgeois society (it is a particular case of dialectics in general). Lenin writes:

> In Marx’s *Capital* there is first an analysis of a very simple, ordinary, basic *relationship* of bourgeois (commodity) society – a relationship that is mass-form, very commonplace, encountered billions of times: commodity exchange. In this elementary phenomenon (in this “cell” of bourgeois society) analysis discloses *all* of the contradictions (*respective* embryos of *all* of the contradictions) of modern society. The subsequent exposition shows us the development (both the growth and the movement) of these contradictions and of this society, in the $\sum$ of its particular parts, from its beginning to its end [17, p. 318].

The universal that is obtained in analysis does not coincide immediately and directly with particular, individual phenomena. Therefore during ascent there can be no simple, formal subsuming (fitting) of particular phenomena under the general, under a law. Here it is impossible directly to subordinate a certain concrete formation to its abstract essence (for example, as Marx has shown, absolute ground-rent cannot be derived directly from the operation of the law of cost). The derivation process should be very “cautious” – many *mediating* links must be found in order to explain and understand a concrete phenomenon as appropriate to its essence – all the more so as here there can be significant distortions of the “pure” conversion of the general into the particular.

There is another difficulty in the ascent process – the investigator must consider and include in the mental concrete only those connections and relationships that can really be derived from its essence and at the same time do not burden it with attendant, collateral properties and details. To be sure, in this matter the theoretician is “assisted” by the very nature of real abstraction, which includes only what should be reproduced again and again by the well-developed concrete object (only what is *reproduced* by itself, what is genuinely *necessary* for the given concrete thing and should be retained in its mental construction). But it is important for the investigator to have a *general level* for the whole that is under consideration, in its basic, principal breakdowns, so as not to be led astray in the ascent into roundabout paths under its guidance and so as to create the needed abstractions in due time. The specific function of this sort of plan is performed by a particular *image of the whole*, which, in Marx’s words, should “constantly wander into our conception as a precondition” for theoretical operations [2, p. 728].

The possibility of contemplating general connections and the integral nature of objects has been treated above. It should again be noted that in a developed form this is, in essence, the capacity for *imagination* as an ability to “see the whole before its parts” [142, p. 265].[41] It is also quite important as a prerequisite and one of the necessary conditions for the *theoretical* reproduction of reality. It can be stated that imagination understood in this way is one of the manifestations of theoretical thought. Considering the conditions for the formation of new concepts, A. S. Arsen’ev mentions the following noteworthy fact:

> ... The new always arises as a *whole*, which then forms its own parts, turning into a system. This looks like thought’s “grasping” of the whole before its parts and constitutes a characteristic feature of meaningful creative thought in science. In dialectics it is one of the essential features of movement from the abstract to the concrete [25, p. 224].

Of course, only when there is a very well-developed imagination can a person retain in his images objects of such complexity as an economic system, an historical epoch, and the like.[42]

Thus, theoretical thought is accomplished in two basic forms: 1) on the basis of an *analysis* of the actual data and a generalization of them, a content-related, real abstraction is delineated, establishing the essence of the concrete object that is being studied, and expressed in the form of a concept of its “cell,” 2) then, through disclosure of the contradictions in this “cell” and a determination of the method of practically resolving them, there should be an *ascent* from the abstract essence and the undissociated universal relationship to a unity of assorted aspects of a developed whole, to the concrete.

From the standpoint of the description of the *general route* in cognition, these forms can be represented as two *sequential* stages in it (the analytic and the synthetic). At the same time, *within* each of them, these forms occur in unity when particular cognitive problems are being solved. For example, in ascent itself (synthesis), there is constantly an analysis that singles out the abstractions needed for further movement toward the concrete.

In theoretical thought the *concrete* itself appears twice: as the starting point in contemplation and conception as they are processed in concepts, and as the mental result of a connection of abstractions. Here it is important to stress that ultimately “concreteness” or “abstractness” in knowledge depends, not on how close it is to sensory conceptions, but on its own objective *content.* If a phenomenon or object is being treated by man irrespective of some whole, as something externally particularized and independent, it will be only *abstract* knowledge, no matter how detailed and visually adorned it is, no matter what “concrete” examples are used to illustrate it. And, on the other hand, if a phenomenon or object is taken in combination with a whole, is considered in connection with other manifestations of it and in connection with its essence, with a universal source (law), then this is *concrete* knowledge, although it is expressed with the aid of highly “abstract” and “conditional” symbols and signs.

In delineating the dialectical nature of concreteness, Engels expressed the following externally paradoxical thesis: “A general law of change in the form of movement is much more concrete than every particular, ‘concrete’ example of this” [6, p. 537]. Lenin has especially indicated that scientific abstractions “reflect nature more profoundly, more truly, *more fully*” than does sensorially given concreteness [17, p. 152]. Clearly, all of this makes sense for the categories of the *abstract* and the *concrete* as adopted in dialectical logic rather than in formal logic.

The Basic Features of Content-Related Generalization and The Theoretical Concept

Content-rich abstraction and generalization function as two single aspects of the ascent of thought to the concrete. By *abstracting,* man isolates and, in the process of ascent, mentally retains the specific nature of the real relationship of things that determines the formation and integrity of assorted phenomena. In *generalization* he establishes real connections between this isolated particular relationship and the particular, individual phenomena that arise on its basis. Only in establishing these connections does some particular relationship disclose its own general character and rise to a universality. The informal general is inseparable from the particular and the individual – they are expressed by each other. This general, as M. M. Rozental' notes, reveals itself as the *basis* of real phenomena, and only by its *connection* with the individual and the particular does it prove that it is really their basis.[43] "... Generalization is the detection of an interconnection or interrelationship between the general and the individual" [271, p. 211].

In this sense the general potentially contains the entire diversity of the individual, disclosing it in the process of its own development, its realization and concretization – in this general "the wealth of the individual will not die out ... but is retained" [271, p. 214]. This important idea of dialectical logic, which was expressed by Hegel, was given high marks by Lenin, who wrote, *apropos* of Hegel's statement: "An excellent formula: 'Not just an abstractly universal, but a universal that embodies the wealth of the particular, the individual, the separate' (the entire wealth of the particular and the separate!)!!" [17, p. 90]. It is important to emphasize that this retention of the individual in the universal occurs in the process of reproducing an object's *development* in the form of *concepts,* in the process of theoretically deriving the individual from the universal.

Content-related generalization discloses the *essence* of things as the guiding principle of their development, as that which determines their development.[44] To make such a generalization means to discover a principle, a necessary *connection* of the individual phenomena within a certain whole,[45] the law for the formation of that whole. Disclosure of the general nature of some real relationship occurs, as was noted above, in the process of *analyzing* those of its features that allow it to be the genetic base of a developed system.[46] The beginning of concretization of these features is the beginning of discovery of the generality of the relationship that has been delineated. Here, as B. M. Kedrov emphasizes, "generalization is achieved, not through simple comparison of the attributes in particular objects, as is typical of purely inductive generalization, but through analyzing the essence of the objects and phenomena being studied; their essence is determined by the presence of an internal unity in their diversity ..." [159, p. 48].

The general relationship that is found by analysis functions as a universal, not because it simply has identical external attributes with its particular manifestations, but because it is *detected* in these particular forms. The features of the particular manifestation of the universal not only do not coincide with the properties of the universal relationship, but often even contradict them. For example, the universal relationship that permits determining man's essence ("the production of the tools of his labor") is such because it underlies all of the manifestations of human activity that are at times highly remote from this original relationship and dissimilar from it.

Thus, one type of content-related generalization involves discovering through analysis of the simple, universal form of some system its genetically original, essential relationship. With another type of generalization there is the detection of a simple, universal form, into which certain complex phenomena are constantly *passing,* and to which they are reduced. Both of these universal forms which are found in the generalization process function as fully real, sensorially given relationships or states.

Typically, the search for them occurs, not through comparison of the external features of objects, but through a special analysis of *the function and role* of a certain relationship within a certain system, through tracing the *transitions* of some of the different states of an object or the different phenomena into some homogeneous state.

Content-related abstraction and generalization underlie the formation of a scientific, *theoretical* concept.[47] Such a concept functions as a completely definite and concrete *method of connecting* the universal and the individual, as a *method of deriving* particular and individual phenomena from their universal basis. By virtue of this, an object's *development* functions as the content of a theoretical concept.[48]

A concept is a means of realizing a content-related generalization, a method of passing from essence to phenomena.[49] It establishes in itself the conditions and means of such a transition, such a derivation of the particular from the universal. Tracing the formation of a concept of mechanical movement, for example, V. S. Bibler makes special note of the particular role in this process of the theoretical conception of an idealized lever, to which all possible instances of the displacement of bodies have been reduced. Then he writes:

> All of these cases amounted to the "case" of an ideal lever, but still could not be derived (and this is extremely essential) from this form – with full necessity and according to a certain functional law of the increase in the velocities and ranges of displacement. ... Only in this case ... will the general conception cease to be a conception and become one of the necessary definitions of a scientific concept [25, pp. 174-175].

The *derivation* of possible particular cases from some universal form according to a definite law (this is also a method of derivation) characterizes the functioning in thought of a specifically theoretical concept, and not merely of a certain conception.

In a certain sense it can be supposed that theoretical generalization consists primarily in reducing diversified phenomena to their single basis, and a theoretical concept consists in the appropriate *derivation.* But here the result of the reduction should be such as to provide for a derivation – that is, should be simultaneously the initial form of a concept, and the realization of the derivation should disclose the authenticity of the reduction – that is, should be simultaneously a form of generalization. In other words, these processes are interrelated and serve as forms of actualizing one another.

In particular and special phenomena theoretical thought considers only what connects them with the *specific nature* of a given universal relationship and makes it concrete. Therefore the consideration of some object on the level of a concept always functions as its *abstract* consideration, which rules out a multitude of the features and particulars that are inessential for a connection with the initial universal relationship (this is why it is legitimate to speak of the *abstractness* of a concept).

Thus, *in content* a theoretical concept functions as a reflection of the connection between the universal and the individual (essence and phenomenon), but *in form* it functions as a method of deriving the individual from the universal. This method relies on the specific nature of the interconnection of phenomena within a given system, on the homogeneous character of this kind of interconnection at all levels of the ascent to the concrete.[50]

This is why the implementation of such an ascent both in content and in form emerges as the development of a single concept, which, in its relatively finished form, is a theory for the given system.[51] A theory is a comprehensively developed and concretized concept, and a concept is an abstract principle and method of constructing a theory (as a principle it establishes the system's universal relationship; as a method – the type of disclosure of the relationship, its conversion into particular forms).

Thus, the movement of thought from the sensorily concrete to informal abstraction and to the delineation of the universal as essence and of the law of the system's development leads to the formation of a concept. It now functions as a starting point for the theoretical recreation of the concrete. Only in the process of ascent to the mental concrete and within it does the concept reveal its real theoretical significance and disclose its original content, processing in itself the data from contemplation and conception, an entire collection of factual information about an object.[52] Apart from this process it becomes simply a word that establishes some general conception as the sum of the external attributes of an object.

A concept is the form, not of any kind of knowledge, but only of a completely definite knowledge – it represents an individual and particular that is *at the same time* also universal. Since a concept reflects an object's essence, the source of its form-development, though within this dissociated object not every feature can be such a source, a specifically conceptual form of an entity's expression is by no means always required. Therefore it is impossible to call every term a "concept of this specific thing," although it does have a clear-cut significance. Everyday practical living does not require that a person use concepts; it is satisfied with general conceptions (for example, "table," "grass," and the like).

On the other hand, only a certain level of development of the object itself (or a degree of accumulation of actual data about it) allows its universal basis ("substance") to be singled out and the appropriate theoretical concept thus to be created.

The orientation of theoretical abstraction, generalization, and concept toward fully defined *content* of an object is a major feature of theoretical scientific thought, of its dialectical logic, in contrast to empirical thought and the traditional formal logic that is related to it. In analyzing Hegel's *Science of Logic*, Lenin wrote approvingly: "Hegel requires a logic in which forms would be *gehaltvolle Formen-forms of* a vital, real content that are inseparably linked to content" [17, p. 84].

As was shown in the preceding sections, a concept is a means of mentally reproducing or constructing an object's essence. Having a concept of an object means mastering a general method of constructing it, a knowledge of its *origin*.[53] This method is a person's particular mental action,[54] which is itself formed as a derivative of an action with objects that reproduces the object of his own cognition.

A theoretical concept and its underlying informal abstractions and generalization reflect a certain universal relationship in a system; therefore the *action* that is appropriate to it cannot be "any" one or "external" to such a relationship. This action that is specific to every concept allows, on the one hand, the given relationship to be delineated and generalized, and, on the other hand, its use as a method of form-development.

In other words, every concept conceals a particular action with objects (or a system of such actions), whose disclosure represents a special investigative problem.

Considerable interest attaches to Isaac Newton's views directly pertaining to the correlation between geometry and mechanics but highly important from the standpoint of general indications of the need for special disclosure of the practical-object sources of the basic concepts in these sciences. Thus, Newton has written:

> Even the very drawing of straight lines and circles, on which geometry is based, pertains to mechanics.... Geometry relies on mechanical practice and is none other than that part of universal mechanics that precisely presents and proves the art of measurement (cited in [175, pp. 1-3]).

"Drawing," "mechanical practice," "the art of measurement" – all of this describes altogether special object actions of a cognitive type.[55] Without ascertaining their structure and interconnection, it is impossible to establish the real nature of the initial concepts in mechanics and geometry.[56]

These statements enable us to draw a conclusion to the effect that the abstraction, generalization, and concept that provide for theoretical thought, are different in form and content from the way they are in empirical thought. This difference stems primarily from the different problems facing these types of thought. Empirical thought basically solves the problem of unilateral cataloging or the classification of objects and phenomena. Scientific-theoretical thought pursues the objective of reproducing the developed essence of an object. Let us provide a brief summary of the basic differences between "empirical knowledge" and "theoretical knowledge" (the term "knowledge" is an abbreviated way of designating abstraction, generalization, and concept in their combination).

> 1. Empirical knowledge is cultivated in the comparison of objects and of conceptions of them, which allows identical, general properties in them to be singled out. Theoretical knowledge arises on the basis of an analysis of the role and function of some relationship of things within a broken down system.
>
> 2. Comparison singles out a formally general property, knowledge of which allows particular objects to be attributed to a certain formal class regardless of whether these objects are connected with one another. By analysis this sort of

real and particular relationship of things that at the same time serves as a genetic basis for all other manifestations of the system is sought; this relationship functions as a universal form or essence of the mentally reproduced whole.

3. Empirical knowledge, underlying which is *observation,* reflects only the external properties of objects and therefore relies completely on visual conceptions. The theoretical knowledge that arises on the basis of transformation of objects reflects their internal relationships and connections. In the reproduction of an object in the form of theoretical knowledge, thought *goes beyond* the limits of sensory conceptions.

4. A formally general property is singled out as parallel to the particular properties of objects. In theoretical knowledge, however, the connection between a really general relationship and its different manifestations, the connection between the general and the particular is established.

5. Making empirical knowledge concrete involves selecting illustrations, examples that are included in the appropriate class that is formally delineated. Making theoretical knowledge concrete also requires its conversion into a well-developed theory by *deriving* and explaining a system's particular phenomena from its universal base.

6. A necessary means of establishing empirical knowledge is the word or term. Theoretical knowledge is primarily expressed in *methods* of mental activity, then in various symbol-sign systems, particularly by means of artificial and natural language (a theoretical concept can exist as a method of deriving the individual from the general, but still not have terminological formulation).

Dialectics as a Basis for Overcoming Conceptualism, Narrow Sensationalism, and Associationism

In empirical theory, which makes the classification feature of thought absolute, a conception of the general as the formally general is sufficient to explain its operation. To be sure, this necessarily leads to *nominalism* (or to its moderate aspect – *conceptualism*; see above). But the comprehending character of thought can be explained only by revealing the abstract and the general as content-related, *real-object* relationships. This is of course related to an abandonment of all types of nominalism. And at the same time it is not an appeal to *realism.* The latter has attempted to represent in real-object form the *formally* general along with its particular carriers. In dialectical materialist theory it is not the formally general but the content-related universal that is acknowledged as reality. Here the concept of the general itself has *changed,* which permits, on the one hand, showing the unsoundness of both nominalism and realism, and, on the other hand, acknowledgment of the reality of the general in the context of the process of *development* and its mental reproduction.

The formally general (abstract universality) is the pure product of a rational processing of sensory data that permits its variety to be represented and encompassed in an *abbreviated,* curtailed form, and it does not exist in the really sensory world, of course. With formal abstractions in mind, Engels wrote: "... Such words as 'matter' and 'motion' are no more than *abbreviations* in which we encompass, according to their general properties, a multitude of different sensorily perceived things" [6, p. 550]. It is known that Engels took an ironic view of empiricists' attempts at representing the products of this kind of abbreviating, abstracting activity in a sensorily-given form: "This is ancient history. At first abstractions are created by abstracting them from sensory things, and then there is the desire to come to know these abstractions in a sensory way, a wish to see time and to smell space" [6, p. 550].

The content-related general is a particular relationship of real objects that functions in the role of a genetic basis for the development of some system. Apart from the situation of development and transitions, this kind of general does not exist. But within the development process and in transformation processes it exists objectively, independently of man's thought, as a basis and essence of these processes.[57]

Both nominalism and realism cannot be overcome by staying outside the position according to which the general reflects a development process, a connection between the individual (particular) and the universal.[58] This position was alien to traditional formal logic and traditional empirical psychology – and here are the reasons for their nominalist attitudes.

In the dialectical materialist theory of a concept there is special delineation of the feature that the *integrity* of an object as a system is effected through real interconnections among phenomena, through their passages into one another – ultimately, through the development of an original, essential relationship. Consequently, in contrast to empirical theory, a clear-cut criterion for essence is introduced. This is not an "abstract," a distinctive attribute, but a relationship whose knowledge permits the accomplishment of an ascent to the concrete, from the undeveloped to the developed.

The concept of content-related generalization allows the absolutization of the role of comparison in thought to be overcome. Real generalization is produced, not by formal comparison, but by analysis of a given system, the disclosure of universal, form-developing significance of some relationship in it.

On this route one of the basic difficulties in empirical theory is resolved – one that is not capable of substantiating the appearance of a certain criterion for comparison (delineating a similar attribute presupposes knowledge of it). The real source of this criterion lies in the domain of human *practical* endeavor, for which the needs and requirements function at first as the basis for an *actual* joining of certain objects into groups or classes. Only then does man theoretically single out the criterion for forming such a class, some general property of the objects that enter into it.[59] In other words, behind formal abstraction and generalization there lies – though secretly – a *real relationship* of objects that is found in man's practical actions. The general character of this relationship determines the criterion for the subsequent comparison of the respective objects or their conceptions.[60]

The empirical theory of generalization and of the concept relies on *classical sensationalism.* Its essence is by no means that sensation is acknowledged to be the only source of cognition. This thesis is the basis for any materialism. The one-sidedness of this sensationalism consists in the thesis that in the transition from sensation to thought only the subjective form and method of expressing the raw data change – not their content. Thus the specificity of the content of thought in comparison with perception and conception is denied.

The dialectical materialist theory of generalization and of the concept overcomes this sensationalism. Underlying theoretical thought is sensory-object activity that *reproduces* and *transforms* the world that surrounds man. Thought in concepts, in the form of mental experimentation, reproduces the transforming character of the sensory-object activity.[61]

The method of tracing the connections or transitions of the particular into the general and of the general into the particular and individual, in which identification of the different occurs, the method of tracing the *origin* of objects during such transitions – all of this is accessible only to mental experimentation, which transforms an idealized object and finds its new inner relationships in this transformation. V. S. Bibler writes: "*During such a transformation, idealized objects reveal qualities and properties* (= *acquire them*) *of their own which they did not have before this transformation*" [25, p. 191].

In our opinion, the point of Lenin's well-known thesis that "not only the transition from matter to consciousness but also from sensation to thought is dialectical ..." [17, p. 256] consists in singling out the distinctive potential of thought.

In other words, transformations that cannot be made on the level of direct perception and conception are performable on the level of concepts. And if such transformations reveal the *new qualities* in an object, the latter are, in a literal sense, a specific result of theoretical thought and its *own* content.[62]

A fact from the evolution of *trigonometry* that is cited by Engels can be an illustration of this. New properties of the triangle were found because it came to be regarded, not in itself, but in *connection* with the circle. Every triangle can be broken down into two right triangles, each of which can be considered as belonging to some circle. Here the sides and angles receive altogether different interrelationships, which "it was impossible to discover and use without this relating of the triangle to the circle" [6, p. 580]. This is a dialectical technique, the technique of theoretical thought. The *connection* between the triangle and the circle can be established only on the level of an idea that presupposes the possibility of mentally transforming the triangle into a component of a circle – that is, reducing one to the other (the particular to the general). Only with such a transformation, a mental reduction of one figure to the other, might the new properties be detected in the triangle, which laid the foundation for what was new in its theory. These properties could not be disclosed by "considering" the triangle in and of itself – and establishing definite connections (reducing the different to one) requires thinking in concepts.[63]

It is useful to compare the following two theses on the sensory basis of a concept in order to discover the difference between the narrowly sensationalist and the dialectical interpretations of its meaning. Thus, previously we cited T. Kotarbin'skii's view that "understanding of a word" is a visual grasp of what *collection of attributes* is ascribed to the object of a statement. In another place we cited Kant's thesis to the effect that it is impossible to *think* a line without drawing it mentally. Outwardly they appear similar, but in fact they conceal fundamentally different epistemological positions. The former statement is typical of the narrowly sensationalist explanation of "understanding" (visual conception of a collection of attributes that are *present*). The latter is typical of the position according to which "understanding" is a distinctive action – a general method of reproducing or constructing a given object on an ideal level. The latter position overcomes the narrowly sensationalist approach to the concept. Attempts at overcoming it were even made in classical philosophy and were accomplished in detail in the dialectical materialist theory of thought.

Overcoming one-sided sensationalism in interpreting the nature of a concept permits a critical approach to the scheme for the change in the forms of knowledge which is inherent in traditional formal logic and *empirical* psychology ("perception—conception—concept"). This scheme demonstrates the general way to form only an empirical concept – passage from individual, particular facts to general ones.

This scheme did not include a link such as man's sensory-object activity – did not indicate its place in concept formation. Therefore such a scheme does not allow a grasp of the specific nature of theoretical concepts. Moreover, it closes the way to a study of the origin of theoretical thought (we were convinced of this by considering the application of this scheme in traditional psychology and didactics; see Chapters 1-3). Its first two links indicate that there seem to be especially sensory stages in cognition *before* the rational-conceptual formulation of their results. This contradicts the levels of cognition that are delineated in dialectics. This scheme does not correspond to the stages of formation of a theoretical concept.

As was shown above, particular forms of sensory activity ("contemplation") reflect the integral character of an object, its *universal* connections. This serves as a sensory basis for the theoretical ascent to concreteness (this scheme ignores the uniqueness of this sensation). By relying on this prerequisite, man can *immediately* perform an action that discloses the universal relationship of the concreteness that is being studied. This action permits the reproduction or construction of an appropriate relationship in its sensory-object form – and this will be the beginning of an understanding of some whole. Although this is a sensory form of knowing, it is a *concept* (a "sensory concept") in the *mode* of the activity.

This method or mode can acquire a symbolic-sign expression, and then the object action will become *mental.* By virtue of this it acquires the potential for disclosing the various connections of the universal relationship with its particular modifications – that is, for becoming concrete, and thereby being transformed into a *theoretical concept* proper.

As we can see, the formation of a theoretical concept occurs during the passage *from the general to the particular* (from the abstract to the concrete). It is in the passages to particular manifestations, in the establishment of connections between the initial general and its manifestations, that the appropriate concept (theory) is given shape and revealed.

At all stages in this movement, the images of perception and conception participate, but they play the role of "improvised material," whose form of *connection* specifies a certain method of activity that reproduces and makes concrete an initial universal relationship of an entity that is being studied – that is, an appropriate *concept.* In this sense it cannot be stated that man apparently passes from perception and conception to a concept that was missing before this. In fact there is a processing of the data from perception and conception in a *concept,* in its form.[64] It itself appeared – as a definite method of activity – when a universal relationship that was genetically original for the developed object of a given concept was first delineated and reproduced in sensory form.

Arising as a certain method of constructing a universal relationship, the concept subordinates all actual, sensory data to the requirements for its own concretization. It even forms supplementary images of perception and conception if it is dictated by the logic of the process of developing the original form of the concept into its specifically theoretical form.

But if the distinctive method of activity that is appropriate to a concept has not been developed in the person for some reason, then the processing of the sensory data is accomplished, naturally, not in concept form, but in the form of general conceptions that are established by words. In this instance the transition from *images of perception* to a verbally fixed general attribute is observed – that is, to a *concept* in its empirical significance.

The groundlessness of nominalism and of one-sided sensationalism in the description of theoretical generalization and of the concept undermines their psychological correlate in the form of an *associationist principle.* This principle is oriented toward thought that functions by the laws for combining certain "simple ideas" into complex groupings in relation to similarity and difference. Classifying thought "fits" this to some extent, but theoretical thought does not "fit" at all.

According to this principle, in the combination of sensations conceptions arise, and in the combination of conceptions – concepts that are entirely *reducible* to initial sensory impressions. Associationism does not explain the specific nature of the content and form of real concepts, ignoring such a basic function of theirs as the derivation of the particular from the universal.

Concepts are treated here as associations of word-terms with a general attribute; thus the question of the existence of a concept in the form of a certain method of activity is fully treated. The latter is entirely explainable since both old and new associationism in general rules out the concept of activity from the range of its working concepts.

Thus, three "whales" of the empirical theory of generalization and the concept (conceptualism, classical sensationalism, and associationism) prove to be unsound in describing the features and principles that govern the formation of theoretical generalization and the concept. This fact gives rise to consequences that are important for modern educational psychology and didactics.

8
On the Potential for Implementing the Idea of Theoretical Generalization in Solving Problems in Educational Psychology

The Connection Between Dialectical Logic and Psychology

The task of bringing public education into accord with the achievements of the scientific and technical revolution presupposes not a successive improvement in the content and methods of teaching but a replacement of the accepted methods of designing instructional subjects by other principles of selecting and developing the instructional material. Up to now these methods have been primarily oriented toward the formation of rational-empirical thought on the students' part. The new principles should be such that when they are implemented the fundamentals of scientific and theoretical thinking will be formed for all students. Developing these principles is a composite problem for all branches of psychology and pedagogy.

In this instance we are interested in certain psychological issues related to the *specific* "*technology*" of designing instructional subjects whose mastery will lead to the children's development of content-related generalization. The whole course of investigation has brought us to the need to ascertain how to develop the educational material and organize the children's activity in mastering it so that this process will lead to their formation of theoretical concepts. In this chapter we shall be treating a number of aspects of this problem, as well as some actual materials that have been obtained during experimental instruction of students.

A close connection between psychology and logic (theory of cognition) is one of the important preconditions for investigating this problem. Some psychologists (S. L. Rubinshtein, J. Piaget, and others) have had a distinct notion of the particular significance of this connection. But most investigators adhere to another view. This is not by chance: For a long time, in both psychology and logic, thought was conceived as a particular mental function accomplished by a particular individual (an "epistemological 'Adventures of Robinson Crusoe ...'"). The formal-logical description of this function quite often coincided with the results of psychological observations. This sort of logic in its "normative" language listed the same features of thought as psychology detected (we have described the existence of this coincidence in detail in Chapters 1-3).[1]

Traditional formal logic ("textbook logic") had little to give to psychology since the subjects of these disciplines and, what is most important, the methods of understanding the nature of thought developed historically on the same epistemological foundation of sensationalist empiricism.

But in the past century a substantial revolution has occurred in the very interpretation of the *subject* of logic. For Hegel and for the classical spokesmen of Marxism logic developed as a theory of cognition, as dialectic.[2] In this logic thought is understood to be the *generic capacity* of mankind functioning cooperatively. This is a special collective activity, which reproduces in knowledge (by virtue of practical experience) the universal forms of nature as objectified in science and technology (in the material and intellectual culture). Dialectical logic studies the history and the laws of this comprehending thought, whose subject is all of humanity. The object of logic is to study the concrete historical principles governing the development of *categories* of thought as a generic activity that brings man closer to objective truth. Lenin writes; "*Not* psychology, *not* the phenomenology of the spirit, *but* logic = the question of truth" – here speaking of logic that *coincides* with the theory of cognition [17, p. 156].

Psychology has not studied and cannot study these historical processes of the activity of society, the functioning of civilization. Its domain is different. In the process of upbringing and education every individual person *appropriates to himself*, converts into the forms of his *own* activity, the means and methods of thought that have been created by society at that historical epoch. The more complete and profoundly a person has appropriated the universal categories of thought, the more productive and logical is his mental activity. Psychology investigates certain aspects of the individual's process of *appropriating* generic activity – its categories, methods and means as studied by logic. Thus, various means of idealization, such as assorted sign models, are created and exist in this activity. The ways of mastering these means *individually*, and consequently the processes of the emergence and formation of idealization as capacities of the individual, are the major objects of *psychological* investigations. The investigation of ways in which particular persons appropriate these means permits discovery of the specific causes of individual variation in mental activity, the particularly subjective forms of which have different degrees of approximation to universal, generic thought.

The psychological study of the formation and functioning of thought in the individual remains particularly empirical if it does not rely on the results of logical investigations of the structure and "mechanisms" of generic thought that are assimilated by the individual and converted into the forms of his own subjective activity. Here, in our opinion, many psychologists' attempts at finding certain *particular* psychological principles and 'mechanisms" of thought itself, in contrast to logical ones, are hopeless. To be sure, "particular" can be taken to mean different degrees of mastery of the universal logical categories or different subjective forms of expressing this, but such a "particular" is, in essence, the object of psychology, which studies the different degrees to which individuals have appropriated the categories and the various consequences of this – that is, the distinctive forms of adoption of universality. The latter features are not "logical" – do not enter into the range of competence of the study of the structure of the universal, generic capacity of thought as such.

At one time I. M. Sechenov wrote perspicaciously that "*scientific psychology, in all* of *its content, can be none other than a series* of *teachings about the origin* of *mental activities*" [288, p. 256]. It is noteworthy that theoretical innovations in the interpretation of the subject of psychology have not provided significant alternatives to this thesis, while the real achievements of scientific psychology have been related to just this interpretation of its subject matter and of the respective problems.

Ignoring the logical structure of thought, paying inadequate attention or to it, has a negative effect on both theoretical research in psychology and the explanation of experimental material. Above we have already noted the confusion that arose in L. S. Vygotskii's theory because of an insufficiently clear-cut differentiation between formal and informal generalization. The one-sided conception whereby the only form of existence for a concept seems to be its *verbal* definition has "harsh" consequences for psychology (and for didactics). Another example can be cited with respect to the interpretation that V A. Krutetskii gave to his experimental data when he singled out a particular type of "on the spot" generalization. Instead of characterizing it as theoretical generalization – in accord with dialectical logic, then raising the question of ways in which students *master* this type of generalization, Krutetskii sees explanations for its uniqueness in certain *innate* peculiarities of the children's brain activity (here losing sight of the simple consideration that it is such a generalization of a higher type that is a function of mature human logic rather than a property of the nervous system in itself).

Thus, logic indicates for psychology the real structure of thought as a generic activity, as well as the tendencies for it to change during the development of industry and intellectual culture. At the some time, logic itself uses data from psychology, which can *reveal* in individual human activity the methods and means of accomplishing it that have not yet been observed by logic or explained by it as a necessary manifestation of generic activity.[6] Psychology and, in particular, the history of the intellectual development of the child were indicated by Lenin, along with certain other areas of knowledge from which "a theory of cognition and a dialectics should develop" [17, p. 314].

P. Ya. Gal'perin has recently promulgated some interesting theses related to defining the subject of psychology [72]. In particular, in stating the fact that the phenomena of children's thinking are explained by Piaget with references to a definite stage of "logical development," Gal'perin emphasizes Piaget's conception of logical rather than *psychological* development [72, p. 239]. Leaving aside the matter of the essence of the position held by Piaget himself (it has been treated above), we consider it useful to use this example to show the illegitimacy of juxtaposing the content of the terms (concepts—terms) "logical" and "psychological development." The point is that the "development of logic" in the child, which occurs during the *mastery* of categories, is accomplished according to psychological principles of appropriation, of the formation of the *individual* consciousness, rather than by the laws that are studied by logic. It is conditions and causes, modes of the child's activity by which he passes from one category to another, from one level in the logic of thought to another, that are of interest to psychology. Although this transition or shift in the individual consciousness occurs by the "steps" of logical categories, its origin and the conditions for accomplishing it are part of the area of competence of psychology rather than logic, which studies the development of categories in the history of general human cognition rather than individual cognition.

In speaking of the "development of logic" in the child, we are establishing (and must establish) what he appropriates; but how, on the basis of what actions and in what subjective forms it occurs is a special question concerning psychology rather than logic. Consequently, the use of the term "logical development" in itself does not rule out the need to explain this "development" on the basis of specifically psychological principles and concepts.

Gal'perin sees the specific nature of psychology in its study of the subject's *orientation activity* – not things and not even their images in themselves, but *orientation* in things on the basis of images of them. Gal'perin writes: "Orientation in behavior ... on the basis of an image is the specific 'aspect' of human and animal activity that is the subject of psychology" [72, p. 244]. In this general context thought is characterized in this way: "The performance of an object-related action for the purpose of finding out what will happen if such an action indeed occurs – its orientation performance – constitutes a particular act of thought" [72, p. 249].

The characterization of the mental as a "trying-on the level of images" that reveals what might happen in fact – that is, an orientation in things on the basis of their images – is, in our view, specific to the psychological approach, properly speaking, to the subject's activity.

This approach to the mental is in full accord with the interpretation of psychology as a teaching about the "*origin* of mental activities." A certain orientation in concrete situations is *not given* to man primordially. At first, appropriate object-related actions should be formed, then they are transformed into idea – and only then does "trying on" become possible. These transitions are accomplished by training.[8] Many of the studies by Gal'perin and his associates have illuminated the peculiarities of this process of training or instruction, its different types, and, accordingly, the different types of orientation that is related to this [118], [320].

According to Gal'perin's general position, all of man's mind is specified for him from without; he appropriates it [71]. Consequently, all of the *categories* of logical thought are also specified for man. The psychologist and the educator must know their structure in order to study children's thought purposefully, and then to cultivate it.

Gal'perin and D. B. El'konin give special discussion to the correlation between logic and psychology in an article analyzing Piaget's studies [75]. In particular, they write that they do not agree with him that "logic is the only or even the main criterion of thought" [75, p. 600]. From their point of view, logic represents certain general properties of reality, which is not reduced to logical relationships. In addition to them, things have mathematical, physical, chemical, and other properties. It is important for theoretical thought to have a mastery of logic (here it is a matter of modern formal logic-mathematical logic), but it is even more important to have a "sense of the process," an ability to go "beyond the logic of things themselves." The ideal of thought is not only well-organized knowledge and good methods of performing formally logical operations, but also a good "school" for work in the given area and, what is highly important, an orientation in its essential relationships. These relationships must be singled out from the mess of inessential ones, and the particular, concrete forms in which the essential relations are manifested must be taken into account [75, pp. 600-601].

It is impossible not to agree that mathematical logic does not reveal the nature of thought, but a good execution of formal logic operations is not equivalent to real thought – on this level the criticism of Piaget's aims is entirely just But at the same time the assertion by Gal'perin and El'konin by which logic *in general* is seemingly not the main criterion of thought, since reality has mathematical, physical, and other properties in addition to "logical properties," is illegitimate. Indeed, things *have no* "logical properties" proper, existing in addition to and along with the others. The mathematical, physical, and other relations of things really exist – and in each of these realms there are *their own* essential and non-essential connections, *their own* general and particular forms of manifestation, and so on, which are studied by the respective disciplines.

Only these disciplines can move within the "logic of things themselves." Logic as a particular discipline, as a theory of cognition and as dialectic, studies the universal forms (categories) of *thought* that allow man to reflect, is "logic of things," to single out the essential and the non-essential, the general and the particular, in their properties, whether it is in the study of mathematical, physical, or some other relations. It is only the sort of mathematical, physical, or other theoretical thought that emerges as *logical* thought processing its experiential material in the categories of logic which can truly reflect its own objective. Thought in the "logic of things themselves," the "sense of the process" cannot be separated out; it is all the more impossible to oppose it to logical thought, to the real mastery of logic, since only in logical forms can an idea move within the content of things themselves, in their essential relationships.[9] It is senseless to speak of some purely "logical" movement of thought in contrast to the content-related processing of experimental material in a concept – it is the same process of mental activity.

Thus, only by specifying content-related generalization for man can it be supposed that he will *orient himself* in the essential properties of a thing and dissociate them from the mass of nonessential properties – that is, that he will possess a "sense of the process." But the criterion for this sort of generalization (as in all of the other categories) is formulated by *dialectical* logic, which thus functions as the *central "criterion"* for theoretical thought as human generic activity. Gal'perin and El'konin have lost sight of the fact that as complete and skillful a mastery as possible of the criteria for this logic allows thought to be highly logical in the sense that it will move within the real connections among things, in their "logic" – that is, it allows man to have a "sense of the process."

The weakness of Piaget's position is by no means that he regards logic as the only and the central criterion of thought, but that he does not rely on the principles of dialectical logic as a theory of cognition, instead using mathematical logic exclusively, which studies only the particular aspects of theoretical thought.

Let us take a look at another question that is important for a proper understanding of the relationship between logic and psychology. The point is that man produces various content-related abstractions (mathematical, physical, and other ones) by certain object-related actions. Neither the disciplines (mathematics, physics) nor logic *studies* the objective structure of these actions, whose appropriation reveals the essential relations of things to man, providing concepts of this.

The investigation of these actions (for example, of the action by which a child discovers the general form of a number) is a task for psychological analysis. This analysis relies on data from the appropriate disciplines (mathematics, physics, linguistics, etc.), as well as on logic's teaching about categories, but in its purposes and methods it remains psychological [428], [437], [438]. Since this sort of investigation can take place systematically in *theoretical form,* it is sometimes called logical, but such a name is clearly only a metaphor here, emphasizing the analytic character of considering the objective structure of an action and not describing the content and purpose of such an investigation, which remains psychological.[10] To be sure, up till now the methods of psychological study of the objective structure of actions by the individual have been poorly developed. It is possible that the creation of such methods is a task for a particular psychological discipline bordering on logic and other branches of psychology.

Prerequisites for New Methods of Designing Instructional Subjects

Above we have presented the views of L. S. Vygotskii, S. L. Rubinshtein, and J. Piaget, in which criticism of the empirical theory of thought stands out, and in which new approaches to an understanding of its nature and of the conditions for its formation are also defined. A number of theses promulgated by these psychologists can become a firm basis for developing a *modern theory* of instruction. At the same time, in recent years, the philosophical, psychological, and educational literature has shown an increasingly frequent occurrence of works in which there is direct and at times quite sharp criticism of the established methods of designing instructional subjects. In many of these works changes in school instruction are presented by which it can be judged that their authors – deliberately or spontaneously – are striving to implement in instruction, rather extensively or partially, aims that are close to or coincident with the dialectical materialist interpretation of cognition.

Below we shall consider some of these works, but first we shall give a brief description of Hegel's position; he was evidently the first philosopher and educator to propagandize consciously and consistently teaching methods that rely on the dialectical theory of thought.[11] Let us indicate some of them that are directly related to our topic.

Hegel always stressed that in thought that comprehends, which is accomplished in concepts, an object is to be regarded first in the form of some *universal,* some abstraction, although a concrete individuality is given to ordinary consciousness as something primary (see, for example, [82, p. 269], etc.).[12] Accordingly "it is reasonable to begin [instruction] ... from the highly abstract, which can only be accessible to the child's spirit" [80, p. 92]. Here Hegel notes that in *rudimentary* instruction the children reach only "*conceptional* thought" – they do not yet understand the internal connection in the world. But a certain understanding of the world is still inherent in these children; therefore one cannot be satisfied that they get only sensory impressions. Here Hegel makes the following remark:

> Even in antiquity children were not allowed to linger too long in the realm of what could be perceived by the senses. But the spirit of recent times rises above the sphere of the sensory in an entirely different way... Therefore the suprasensory world, in our time, should be made close to the child's conception very early [80, p. 93].

With respect to instruction in particular disciplines he expresses the view that in selecting their initial, original subjects one must be guided by a dialectical interpretation of the abstract and the concrete, the general and the particular. Thus, in the study of physics the particular properties of nature should be freed "of their various interlacings in which they occur in concrete reality and represented in their simple, necessary conditions" [82, p. 270]. Instruction in *geometry* should begin, not with concrete spatial images, but with a point or a line, then a triangle and a circle.

In connection with the concept of a triangle the following must be pointed out. In treating Aristotle's philosophy Hegel singles out the feature that he distinguished between the formally general as merely an abstraction (an "empty creation of thought"), to which nothing corresponds in reality in a definite and simple form, and the real or true general, to which there corresponds a definite and simple something.[13] For example, such figures as a triangle, a square, and a parallelogram really exist. The triangle is also encountered in a quadrangle and in other figures. This *is any* figure *reduced* to its simplest state of definition. Therefore it is the first, the truly general figure. Hegel writes: "Thus, on the one hand, the triangle stands next to the square, the pentagon, etc., but on the other hand – this indicates the great mind of Aristotle – it is a genuinely universal figure" [94, p. 284].

This statement is a good demonstration of the meaning of the concept of the truly universal in contrast to the formally general. Moreover, it explains why Hegel has ascribed the triangle to the figures with which the teaching of geometry should begin. The triangle is an elementary figure, to which other figures can be reduced and from which they can be derived.

Thus, to counterbalance the narrow sensationalism and empiricism that were dominant in his day in pedagogy, Hegel consistently developed the point of view that true abstraction and a real universal (rather than the sensory concrete or the formally general) must be put at the basis of instruction oriented toward forming comprehending thought. The abstract as an element of thought should be introduced into instruction as early as it can be accessible to the child, who must not be held too long at the stage of sensory impressions, in any case. These ideas retain their significance to this day. In our opinion, even now they can serve as one of the theoretical supports for an effective design of school subjects.

Let us return to modern times. The problems of generalization and concept formation in instruction have long remained outside our special analysis from the standpoint of dialectical logic. To be sure, a number of its generally known positions have gradually entered educational psychology and didactics, but they have often been interpreted in a meaning that is unnatural for them. Thus, Lenin's well-known statement about the general dialectical route to cognition (see above) has been interpreted in a particularly empirico-sensationalist sense. In the treatment of the relationship between the abstract and the concrete its dialectical essence took the place of the traditional psychological relationship between the rational and the sensory (see, for example, [347] etc.). The connection between one of the principal categories of dialectical logic – the process of ascent – and the instruction process was denied [105, p. 74], [234, pp. 91-92].

One of the works by E. V Il'enkov, which was devoted to general issues in cultivating thinking in school [138], was a distinctive turning point in the approach to these problems. A brief description of dialectical *thought,* which seeks out and reasonably resolves vital contradictions, was given here, first of all; the connection between the development of this thought in students and the cultivation of their creative capacities was shown. Here there was a critical treatment of the traditional system of instruction, which basically gives children only bare and abstract results of scientific cognition without revealing the paths that lead to this, without indicating the internal conditions and assumptions that ascribe a really concrete meaning to these supposedly "absolute truths."[14] Such a system cannot purposefully govern the process of the students' development of an authentic creative attitude toward the scientific disciplines being studied.

Such a situation occurs, in particular, because many authors of school curricula, textbooks, and aids on methods "are at a level that has long ago been covered by science" in understanding the categories of the abstract and the concrete, the general and the individual, the rational and the sensory, and so forth. For example, they very often confuse the concrete with the sensory-visual, and visuality as traditionally interpreted – as is well known in logic – "is only a mask to hide a very insidious enemy of concrete thought, knowledge that is abstract in the most precise sense of the word – something empty, divorced from life, from reality, from practice" [128, p. 9].

Il'enkov emphasizes that the cultivation of children's capacities for creative thinking requires a decisive revision of all of didactics "on the basis of logic and the theory of cognition of modern materialism." For this there must be, above all, instruction such that "It reproduces in compressed, abbreviated form the real historical process of the birth and development... of knowledge" [138, p. 13]. The child, of course, cannot independently "acquire" what people have already attained, but he should *repeat* the discoveries of human beings in previous generations, in a particular form. With this sort of instruction the general nature of a concept should be revealed to the child – by his own activity – before the particular manifestations.

In this work Il'enkov raised the problem of a further composite study of the problems in the application of dialectical logic in instruction from the standpoint of philosophers, psychologists, educators, and scholars in different specialties. In another work he continued the analysis of these problems from an epistemological point of view and, in particular, comprehensively disclosed the immense and specific role of the imagination in the activity of our comprehending thought [139], [141].

The analysis of modern works on educational psychology which was done by A. N. Shimina showed that the concepts of the abstract and the concrete that are adopted in many of them depart from the respective categories in dialectical logic, since by tradition they have been borrowed from the empirical theory of thought – particularly from the empirical theory of concept formation that comes from Locke [339, pp. 4-12]. A view of the concrete as merely a visual-sensory datum is quite prevalent in didactics and educational psychology [338, p. 94]. Shimina has shown that in many works on educational psychology the category of "vital contemplation" and the concept of the general route to cognition are interpreted in an empirico-sensationalist sense rather than in a dialectical one [340, pp. 135-136]. She has also cited data to indicate that in declarative and superficial discussions about "activity," the leading didacticians actually do not use the *principle* of *activity* to explain the essence of instruction [341, pp. 95-96]. Shimina's works contain a valid criticism of the interpretation of "simple" and "complex" knowledge that prevents certain didacticians from properly evaluating the significance of the method of ascent for designing instruction [338, p. 96]; she also traces ways of applying the basic categories of dialectical logic in the teaching process.

A number of studies of activity as the basis for thought have been done by a group of Moscow logicians (V. M. Rozin, A. S. Moskaeva, etc.). In particular, they have called attention to the following: traditional formal logic, for reasons of its own, is such that it cannot study the *connection* between forms of mental activity and certain objective content. As a result of this, the central feature of thought falls out of its range of competence – thought's orientation toward singling out units of content from the general "fund" of reality and "movement" according to this content. In all of the traditional logical studies it has been presumed that this content is already specified. In other words, this logic does not study the *origin* of concepts, their object sources, but remains wholly in the plane of symbolic forms and focusing attention on the rules for formal derivation.

The real functions of the symbolic form in thought can be understood only when it is correlated with a certain type of objective content that is *replaced by* this form. Modeling "motions" in the plane of the symbolic form "absorbs" the experience of the initial object actions and, in an abbreviated, curtailed form, reproduces that with respect to the substitute-entity. The real structure of the necessary object actions cannot be established if only their reflection in symbolic form is considered. It is necessary to trace all of the "*historically*" available methods of solving the same problems in order to see the initial forms behind the abbreviated, curtailed thought processes, to find the laws and rules for this curtailment and then to detail the complete structure of the thought processes being analyzed.

A logic that studies man's activity in singling out definite types of content in knowledge and their formulation in historically developing, multi-layer symbol systems can be called content-based genetic logic. On the basis of its original aims, this group of logicians developed and described specific techniques of analyzing various levels of mental activity using varied empirical material (see, for example, [196], [223], [238], [273], etc.). Thus, the structure and development of the mental activity of preschool-age children when solving arithmetic problems has been studied in detail.

This group of works has demonstrated the groundlessness of the *naturalistic* interpretation of the content of knowledge, and the complex structure of a form for it such as a concept has been shown. These works legitimately stress the need to use logic in designing instructional subjects and in determining their content [273], [357].

V. S. Bibler's logical studies, in which the role of activity in concept formation and the specific function of sensory-object and mental experimentation in theoretical cognition are disclosed consistently and profoundly, have considerable significance for psychology and didactics, in our view (we have cited these works repeatedly above [25], [34]). M. K. Mamardashvili's book contains a detailed analysis of the sources of an "epistemological *Adventures of Robinson Crusoe*" and of the naturalistic interpretation of cognition and shows the community-social nature of all forms of thought and their active role in the process of comprehending reality [202].

The need for and the helpfulness of content-based generalization of educational material are a consequence, in our opinion, of a central principle in our psychology, according to which real, sensory-object activity on the part of human beings who are cooperating underlies all mental abilities, including thought (the works by L. S. Vygotskii [65], [66], S. L. Rubinshtein [277], [279], A. N. Leont'ev [192], [195], B. G. Anan'ev [20], D. N. Uznadze [308], A. V Zaporozhets [121], P. Ya. Gal'perin [72], D. B. El'konin [350] et al.).[15] An important feature that makes this principle concrete is the thesis that internal, psychological conditions for accomplishing an activity are *objectified* in the material and intellectual products of that activity.[16]

If the forms of mental activity, particularly concepts, are regarded as an idealization of certain methods of object activity, and the objectified conditions for the social implementation of the activity are perceived in the products of the activity – conditions that determine a person's subsequent behavior – then these aims inevitably lead to a negation of the naturalistic notion of mastery, and, as a result, to an overcoming of contemplative sensationalism, conceptualism, and associationism. But the illegitimacy of making formal generalization absolute – the alternative to which is content-based generalization – is thereby detected. Of course, these conclusions presuppose a realistic application of the principle of activity to the solution of problems in educational psychology, rather than a superficial declarative acknowledgment of it, which is not so seldom observed.

L. S. Vygotskii has given special consideration to the problem of the relationship between everyday concepts and scientific concepts proper (see above). The study, on the level of his general ideas in the 1930s, was continued under the leadership of A. N. Leont'ev, by the group of Khar'kov psychologists (V I. Asnin, L. I. Bozhovich, A. V. Zaporozhets, and others). The results of these studies revealed the unique role of children's activity as a basis for forming generalizations and concepts, as well as leading psychology close to discovering the *specific* activity within which *scientific* generalizations and concepts arise. These results were set forth in theoretical form in an extensive report by A. N. Leont'ev [190].[17]

First of all, Leont'ev notes the unsoundness of associationist psychology in its attempts at representing the formation of generalization according to the "classical scheme of formal logic." In fact, behind generalization there lies a particular activity, by means of which a transfer is effected, a transition or movement of thought from one content to another. Only in the *transition* of one concept into others can they, together, reproduce reality. Leont'ev states:

> Any concept, as a psychological formation, is the product of activity... One can organize or construct an adequate concept of an activity for the student after having placed it in an appropriate relationship to reality.... Conceptual activity does not arise in the child because he is mastering a concept but the other way around – he is mastering a concept because he is learning to act conceptually, because – if one can so express it – his practical experience itself is becoming conceptual [130, pp. 67-68].

Thus, to develop a concept in the child, an *adequate* activity must be found and built up in him. Underlying *scientific* concepts is the child's *discursive* activity, which permits him to "master a concept in its verbal disclosure" [190, p. 65]. But how is this activity itself constructed? Leont'ev notes that a change in the child's attitude toward reality is a general precondition for it. But he does not give a specific description of the process here.

This sort of approach to the problem of the concept has undermined its conceptualistic interpretation but has not carried this criticism to its logical end, since it has described in too general a form the activity that should be adequate to the concept. The thesis that it is discursive activity that is specific to scientific concepts, on the one hand, has made a contribution to the traditional identification of the "theoretical" and the "discursive," and, on the other hand, has contradicted the idea of the report according to which the child's practical experience itself can be "conceptual." This idea has required an ascertainment of the *object* sources of discursiveness, and, consequently, special analysis of the real object actions whose idealization forms a concept in its mental form.

As is well known, an important step on the way toward ascertaining these sources was taken by A. N. Leont'ev and R Ya. Gal'perin somewhat later, in developing the theory of internalization. However, because of insufficient attention by its authors to the *logical* aspect of the problem, this theory has not definitely answered the question of what specific content is represented in theoretical generalization and the concept, and through what actions. The specific nature of the object-related actions that reveal the general genetic basis in the material for a certain system of things remained unclarified.

More definite characteristics of these actions are included in a joint article by Gal'perin, A. V Zaporozhets, and D. B. El'konin. In particular, here there is a direct indication that an essential obstacle to improving curricula and teaching methods is the narrowly sensationalistic and naturalistic conceptions of learning that have not yet been overcome in pedagogy. Their influence on teaching practice is found, for example, in the fact that children *first* "are made familiar with the attributes or properties that can be immediately perceived and for the delineation of which a variation in the properties is sufficient" [76, p. 65]. These purely identifying attributes are altogether insufficient for us to be able to orient ourselves fully in the phenomena and objects under study.

The article stresses that it is not these empirical attributes of the material but its "finite units" – i.e., units "into which a given sphere of reality is articulated at the present-day level of scientific knowledge" [76, p. 66] – that should be taken as the initial knowledge when a certain area of knowledge is being mastered. These units are singled out by a "rational-genetic method," which is applicable to any tasks in the area.

The uniqueness of the actions that implement this method is that they *reproduce* (model) such units in a form that is new by comparison with the original but necessarily material. Determining the "finite units" and the appropriate actions for each specific area represents an independent investigative problem.

The thesis that "finite units" of material are singled out by a *genetic* method that reproduces this in a material *model* is highly essential here. Orientation in these *basic* units, which constitute a given area of knowledge, in the laws for combining them, and, most importantly, in the methods of determining both is characteristic of the Type III orientation described by Gal'perin [72, p. 271]. This orientation will give the children an understanding of how the delineation and structure of the conditions of the respective actions are substantiated. The principal means of forming it is the use of socially developed *standards* and *measures* by which the qualitatively particular aspects of an object, its basic units that are not given to man in immediate perception are singled out. By virtue of this children pass to a *mediated* evaluation of objects; "their own line of theoretical behavior" appears in them [69, p. 34].

Thus, from Gal'perin's point of view, Type III orientation is related to the child's passage to a mediated, theoretical thought, which is dictated, in particular, by the "organization of the mastery of actions in using standards, measures of these real tools of intellectual activity" [69, p. 36].

The studies by Gal'perin and his associates have revealed the internal connection between a certain type of orientation and the methods of designing instructional subjects. In their traditional design particular phenomena are studied *before* the general rules (the "inductive principle"). The formation of actions that model the basic units of the material permits revealing to the students the general rules in the very process of reproducing them – that is, permits "inductiveness" to be overcome while retaining unity in the study of the general and the particular. In turn, all of this requires a profound change in the existing methods of accommodating and interpreting the instructional material. Gal'perin writes: "Such a revision of an instructional subject constitutes the main difficulty in realizing Type III," but the exposition of the subject according to precisely this type of orientation "comes closest to a properly scientific, modern interpretation of it" [69, p. 32].

The descriptions of "finite" or "basic units" of material found in Gal'perin's works, in a logically undetailed and metaphorically indirect form, describe what we have defined above as real, content-based abstraction, as the initial "cell" in the system to be studied. Only when there is a clear-cut *logical* understanding of the features of the "units" of material does their adequacy to scientific exposition of the subject become explainable. It is also clear that such an exposition presupposes particular methods of designing school subjects that are substantially different from traditional ones. Here mastery will be accomplished, not when there is orientation "in the laws of combining" basic units (this term is pure metaphor), but by an ascent from the abstract to the concrete. The students' mastery of the initial abstraction and its application in the process of ascent are inseparable from "rational-genetic methods" of activity, by which the content of the respective concepts is singled out in a well-substantiated way.

Thus, the actual implementation of the Type III orientation and of the learning described by Gal'perin is internally related-in our view – to the students' formation of abstractions and generalizations of a *content-based* character, to their mastery of *theoretical* concepts. Taking these features into account, one can design instructional subjects in which the mastery of the content-based general forms the basis of all of the subsequent mastery of its various frequent manifestations. It is then that the "inductive principle" of developing instructional material is successively overcome.

The child's use of socially cultivated standards is an essential condition of the emergence of his theoretical thought as mediated in its form. Their real role is that, by virtue of these standards, the child *reproduces from the outset* the *universal* properties of things in his own activity. This content-based feature attaches a mediated character to the children's mental activity. In Gal'perin's works, the significance of the latter circumstance is still not being taken into account to a proper extent.

In recent years our general psychology has been doing some studies of thought whose results have a substantial significance for revealing the mechanisms in the formation of content-based generalizations and concepts in the instruction process. Above all, the works of Rubinshtein and his associates belong among these studies (their results have been presented in detail above). Let us again point out the works of M. S. Shekhter, in which the thesis is promulgated to the effect that the content of concepts, which is not visual, at the same time possesses traits of *images.* Conceptual images arise on the basis of particular actions that specify the object of a concept, not in the form of some collection of elements, but as something integral and not articulated, as *one.* Such images are formed by man through mental construction, without immediate access to the appropriate attributes of concrete things [336].

In our opinion, the specific nature of the content of a concept as "nonvisual images" of reality (in the epistemological significance of the term "image"), as well as their integral character, is legitimately stressed. Because of this, a concept reflects a very complex but internally unified structure of an entity. This kind of integrity is reproduced by a particular action, a *developed* form of which is represented in "mental construction," but whose real sources still lie in *object-related* activity.

A number of interesting data occur in a work by O. K. Tikhomirov on the study of the mental actions as searching and investigative actions. In particular, it was found that these actions can establish an *interaction* of the elements of a situation in which their attributes that are inaccessible to direct sensory reflection are revealed. It is also typical that the verbal expression of the principle for solving problems is preceded by a complex searching activity that creates "mediating products in the form of nonverbalized meanings" [303, p. 16]. In other words, the verbal recording of a certain "meaning" that is not given sensorily is merely a particular and finite form – and consequently not the only form – for expressing it in thought.

In some studies on educational psychology there has been special treatment of the difference in effectiveness of mastery of instructional material in relation to the type of generalization thus produced. Thus, in E. I. Mashbits' works instruction in solving geometry problems was done by two methods [2041, [205]. In the first instance the students solved *particular* problems in which the concrete conditions and the form for expressing a mathematical relationship varied. The generalization underlying the method of solving these problems was formed slowly and gradually, always remaining incomplete and not flexible enough. In the second method the students initially ascertained the general structure of the solution method by analyzing particular problems that were models, then rapidly and correctly applied the method to particular problems. Mashbits writes: "The students master the solution method after solving 34 model problems and traveling the path that is accessible only to the best prepared students under the conditions of instruction by the first method" [205, p. 17].

Works by V A. Krutetskii [174], and S. I. Shapiro [329] have established the fact that students who are capable in mathematics generalize a solution in a complete sense on the basis of an analysis of one or several problems, while quite a different kind of generalization is inherent in the weaker students.[18] In the study by Mashbits this difference in types of generalization-which is, in our view, a difference between empirical and theoretical generalization-forms the foundation for two methods of teaching with different effectiveness. Typically, in the second method almost all students generalized the method of problem solving in the way usually taken only by the best-prepared and most capable students.

Some interesting data on the formation of content-based generalization as a definite mode of activity are cited in works by A. I. Meshcheryakov which shed light on the development of thought in children who are blind, deaf, and dumb [210]. Here, in particular, it is clearly shown that underlying real generalization is not a formal comparison of the externally similar features of objects but a *specific, object-related action* that discloses and reproduces a certain function of things within a real system of them.

The works by T. V Kudryavsev note the usefulness of students' special development of such generalized techniques of problem-solving as might then serve as means of successfully performing actions in certain particular situations [176], [177]. A. M. Zolotarev stresses the importance of studying the students' process of developing concepts as distinctive "steps" in the ascent to concrete knowledge [129, p. 15]. N. P. Erastov especially indicates that when instruction is organized, the thought processes that are related to the ascent from the abstract to the concrete must be taken into account [112, p. 29].

Thus, in our psychology there is an increasing accumulation of data to describe the peculiarities of content-based generalization as one of the possible bases for new methods of designing instructional subjects.

In foreign general and educational psychology, only the type of generalization which we have described as *empirical* has been primarily studied up to now (see, for example, the description of the process of generalization and concept formation in one of the modern reference works on pedagogy [388, s. 17], as well as the works by R. W. Brown [365], E. Holas [376], Al. Roshka [275], and others. In almost all of these works, which are on the formation of concepts in children, empirical concepts perform the function of setting up hierarchies in objects and cataloguing them (see, for example, the books by A. Pinsent [398, pp. 162-198], G. Clauss and H. Hiebech [370, pp. 206-274], L. Kelemen [384], and others).

At the same time some foreign psychologists are aspiring to depart from the traditional formally logical interpretation of the conditions for the formation of generalization and concepts. Thus, W. Metzger notes that a rise in the "accuracy" of a concept is related to substantial shifts in its very content, in a "condensation" of it (*Einengung*) and at the same time a "broadening" (*Ausweitung*), which occurs in the process of interconnection between the given concept and others [390]. The position taken by the American psychologist Jerome Bruner is of particular interest for, in striving to find new methods of designing instructional subjects, he actually abandons certain traditional logical principles of interpreting the connection between the general and the particular [47], [366].

Above all, Bruner emphasizes that the intellectual activity of school students and more learned persons has the same nature (the difference here is in degree rather than in kind). Therefore it is useful to design instructional subjects according to the methods of presenting scientific knowledge itself. "The student studying physics is a physicist, and for him it is easier to study the science by acting like a learned physicist..." [47, p. 17]. At first students should master the basic concepts that constitute the *theory* of the subject, which provides them with an understanding of its general principles, which, in turn, permit particular phenomena to be revealed.

> To understand something as a particular case of a more general principle – this is what is meant when we speak of an understanding of basic principles or structures – means mastering not only concrete content but also the method of understanding similar phenomena which might later be encountered [47, p. 26].

It is this "method of understanding" that should be developed, above all, in students as they learn instructional material. But, in Bruner's opinion, educational psychology has begun studying this problem only comparatively recently.[19]

In these statements there is a proper grasp of the fact that the transition from the general to the particular is the modern method of presenting a science. Bruner cites some data to show the usefulness of designing instructional subjects so that the basic features of this transition are taken into account. At the same time, as in the works by many other psychologists and educators, he lacks an adequate analysis of the logical aspect of the connection between the general and the particular, an analysis of the limitations of traditional formal logic.

One work by J. Bruner, J. J. Goodnow, and G. A. Austin points out that a “true concept” is manifested in the proper *identification* of certain particular cases [367]. Here a concept is interpreted in the traditional, formally logical spirit. Bruner tries to ascertain the uniqueness of “symbolic concepts” in contrast to simple delineation of perceptual attributes. The first type of concept establishes a *relationship* between the conditions of existence of a thing. Although they are constructed on the basis of interrelationships between sensorily perceived attributes, their content itself resists immediate judgment, as occurs, for instance, during the formation of the “idea of proportion” [369, pp. 174-175]. In this instance Bruner actually abandons the traditional absolutization of empirical concepts and approaches the need for a particular logical interpretation of the type of concept that expresses relationships (more precisely, inter-connections) between sensorily perceived properties. This, however, requires a conscious and detailed use of the dialectical characteristics of theoretical concepts, which Bruner lacks.

It should be noted that recently Bruner’s ideas or ones similar to them are finding a response both among American and English experts in educational psychology and didactics (see, for example, the works by W. D. Well [405], A. N. Golett and J. E. Salder [374], and others). Some of them stress that students should primarily master the organizing ideas of a discipline, the “single sample form” for the diversified particular phenomena in a certain domain. Because of this, forms of learning by which the students master the essence of subjects can be singled out [374, pp. 130-133].

Let us dwell on another essential question. Appearing at the 18th International Psychological Congress (1966), Barbel Inhelder declared that Soviet psychologists (Leont’ev, Gal’perin) seemingly “conceive of the process of coming to know the world as a representative model, which imitates reality rather than transforms it” [142, p. 199]. According to this notion, they say, “any knowledge is an image or a reflection of reality.” From Inhelder’s standpoint, the notion according to which knowledge “still continues to be regarded exclusively as a reflection of reality is close to 19th-century empiricism” [142, p. 201]. She contrasts this conception to Piaget’s position; for him knowledge or a concept is the “result of a transformation of reality, which assimilates the subject’s activity” [142, p. 199]. Inhelder cites one of Marx’s theses, summarizing it as follows; “Knowledge is the result of the subject’s active intervention in the process of changing reality” [142, p. 201].

Let us consider the bases for and the legitimacy of these “reproofs.” First it must be stressed that the real foundation of Soviet psychology in general and of Vygotskii’s school in particular is the dialectical materialist theory of cognition, according to which a material activity that *transforms* reality underlies thought. Appropriate ideas held by Marx, Engels, and Lenin are perceived by Soviet psychology in an altogether definite and penetrating way (in the previous chapters we have set forth the basic substance of these ideas and their specifically psychological development in the works of Vygotskii, Rubinshtein, and others). In a report at the same psychological congress, A. N. Leont’ev showed that one of the central problems in Soviet psychology is the “problem of understanding internal, ideal mental activity as a derivative of external, practical activity” [195, p. 20]. In addition, one can only welcome it when Piaget’s school, in some of its initial theses, also takes account of the significance of a transforming activity in forming thought.

But in Soviet psychology the principle of activity is taken, not in itself, but in combination with the principle of *reflection.* The external and internal features of objects are discovered and reflected in sensory and conceptual *images* by means of various forms of activity, rather than simple “contemplation” (see Chapter 7). In revealing the nature of reflection, Leont’ev mentions that it “is the result of an active process,” that “the subject’s activity with respect to a reflected reality” is necessary for it to emerge. He also directly points out that “this assertion is in contradiction to the old sensationalist conceptions, as well as to certain very recent notions” [195, p. 11]. As is known, the old sensationalism had not mastered the principle of activity, and some very recent notions, by making this principle absolute, divorce it from reflection and are unable to combine the two internally.

In Inhelder's position one of these "very recent notions" shows itself; according to it an understanding of knowledge as "exclusively" reflection seems to be an anachronism. Here "reflection" and "image" are taken *in advance* in their traditional sensationalist sense, apart from any connection with historically developing forms of transforming activity on the part of man as a social being. However, acknowledging the abstract principle of activity without simultaneously understanding – as Leont'ev has accurately noted – that the very "activity must be subordinated to the independent properties of objects" [195, p. 15] inevitably leads to operationalism and ultimately to idealism.[20]

At the same time Inhelder's "reproof' has certain real grounds. The point is that in our psychology (particularly educational psychology) the principle of activity and its connection with reflection are often formulated declaratively or in an undeveloped fashion. But the actual description of the concept-formation process most often occurs according to classical sensationalist schemes. This fact is being noticed by "adherents" of the theory of activity in their polemic with our psychologists, who do not always find a clear expression for the specific characterization of a concept as an image and at the same time as an action.

The development of new methods of designing instructional subjects can now rely both on ideas in the psychology of logic and on proposals that emanate from educators whose opinions are close to the dialectical interpretation of the nature of a concept. On this level a book by N. Izvol'skii is particularly valuable; from his point of view man possesses a real concept when he is able to understand the *origin* of the appropriate subject and is capable of designing it.[21] Izvol'skii writes: "Only when the origin of an object or a conception is clear to the student does it become possible to assert that the desired clarity has been achieved, that the student has a concept of that object" [133, p. 47].

When the method of constructing a thing and the method of understanding its essence coincide, this thing should be obtained in an unalterable and necessary way, in certain conditions. For example, for an appropriate formation of the concept of a square, one must establish "the process (or construction) which would illuminate the question of the angles of a square so that the angles of a square ought always to be right angles (and not just in the square which we see drawn, or as the face of a wooden cube)." In the study of a triangle it is important "to investigate a process of forming the triangle so that the inevitability of the property is made clear from it" [133, pp. 21-22]. Relying on these aims, Izvol'skii constructed an original methodology for teaching geometry, which retains its fundamental significance to this day if it is approached from a dialectical point of view of the process of forming theoretical concepts.

An interesting book by M. V Pototskii on mathematics teaching is imbued with the important idea that:

> a true understanding of mathematical ideas is possible only on the basis of a knowledge of their origin, a knowledge of their sources in actual reality, in its problematics, which, as a result of abstraction leads to the respective mathematical theories [257, p. 62].

Pototskii uses a series of examples to discover the great possibilities opened up for students by mastery of *general* methods of solving problems or proving theorems. Thus, in elementary geometry three theorems to the effect that the median of a triangle, the bisectors of its interior angles, and its altitudes intersect at one point are proved by three different techniques having nothing in common with one another. But in projective geometry all of them are proved by a single method as particular cases of one theorem. [257, pp. 178-183]. Clearly, preliminary mastery of this method essentially simplifies the proof of "particular" theorems. But for this to happen one must find other methods of constructing the instructional subject and teaching methods other than those adopted by the traditional system.

At present these new methods are being sought and developed by many experts and practicing educators. A. M. Myshlyaev's experience in designing a ninth-grade mechanics course by developing material according to the principle of "from the general to the particular" is of interest [216]. In ordinary physics instruction students study a multitude of particular questions without using general thesis – here theory does not function as a means of making the mastery of the instructional material easier. All of this reduces learning effectiveness substantially. Myshlyaev believes that using the idea that authentic knowledge is acquired by the method of ascent from the abstract to the concrete is a major way to overcome the dominance of the one-sided inductive method of teaching. Introducing this method in instruction requires that the *general* principles of a certain section of material be given to the students before they become familiar with the assorted particular questions. This author writes: "Then, in return, when the students master a general law, they will be able – entirely consciously, with minimal aid from the teacher – to arrive at proper conclusions, to explain a multitude of particular questions by treating them as manifestations of a general governing principle" [216, p. 63].

Relying on these theses, Myshlyaev has designed and experimentally verified a corresponding course, in which three principles were delineated and initially mastered: the law for retention of an impulse, the law of the conservation and conversion of energy, and the rule of moments. Many other questions were studied as corollaries of these initial principles. "By using a basic principle as an initial formula, students ... learn to think and reason" [216, p. 67]. This course differed significantly from the ordinary one in the content and sequence of the topics studied.

The need for a substantial increase in the role of theoretical knowledge in learning, the usefulness and possibility of teaching it in the first sections of an instructional subject, the significance of general principles for the mastery of particular questions, and the like – all of this is to some extent acknowledged, supported, or even used in practice by many methodologists and teachers (see, for example, the articles by P. E Atutov [27], V Fedorova, D. Kiryushkin and I. I. Logvinov [312], P. lvanov [132], E Klement [161]. M. Andrushenko [23], and others). The well-known English educator, B. Simon, directly indicates that a *revision* of the well-known didactic principle of instruction by the "particular-to-general" scheme is currently occurring. When mathematical concepts are being formed, for example, "It is more fruitful to begin instruction with familiarization with the more general concepts, since they simplify the learning process, and then to pass to the study of particulars" [286, p. 68].

We note that some didacticians are beginning to take a critical approach to the visuality principle in its one-sidedly sensationalist interpretation. Thus, I. A. Yarmolina rightly notes that traditional visuality does not promote the development of abstract thought. At present it is important to make qualitative changes in the very character of the sensory aids in instruction. These supports should be models reflecting "essential connections and relationships in a definite sensory-visual form" [358, p. 21]. Models and schematic sensory aids are a means of forming abstract concepts, and by no means "concrete images." With an intensification in the role of theoretical knowledge (particularly in the upper grades) the significance of this *kind* of visuality, naturally, not only does not diminish – it increases.

The unsoundness of the empirical theory of thought is becoming increasingly clear to didacticians. Thus, in one of the recent texts on didactics there is a preoccupation with the fact that "in didactic and methodological works the route of ascent from the concrete to the abstract is usually created, while the concrete is both the beginning and the end point in cognition" [234, p. 110]. The need to study ways of mastering the mental concrete for didactic purposes is also noted here; an attempt is being made to overcome the purely sensationalist interpretation of the visuality principle [234, pp. 225-226].

The very fact of an acknowledgment of the didactic significance of these problems is highly symptomatic, although their formulation has too general a form, and positive development is only beginning. This process is inhibited by the entrenched uncritical attitude of didactics to its own established principles.

The features of theoretical generalization and its role in thought are described in a number of works that are not directly related to problems in instruction, but that presuppose them in one way or another (see, for example, the books by I. Lakatos [182], G. Polya [250], among others).

In the book by Lakatos there is a parallel treatment of the history of the development of the concept of a polyhedron in mathematics and its rational reconstruction in the process of imaginary discussions between students and teacher when proving a simple theorem on the relationship among the number of vertices, edges, and faces of a polyhedron. In trying to prove this theorem, students became persuaded of the difficulty in defining a polyhedron itself. Particular aspects of the latter do not fit into the original generalization, and therefore a question about the character of the correlation between general and particular arises. Thus "truth" functions for students, not as some ready-made formula, but as mental *movement* toward the concrete content of a concept, where a *method* for such movement and a method of treating concepts must be mastered. During "proofs and refutation" of a *single* theorem, students master this method of handling hunches and ideas that arise intuitively by the method of mathematical logic – a method that is applicable in analyzing many analogous situations.

Lakatos gives a picture of an education process where students are not memorizing *ready-made* formulas – setting aside the real conditions of their origin – but are introduced by the teacher to the intellectual workshop for constructing them, where unexpected difficulties in attributing a concept that has been developed to reality are constantly arising.[22] But then, through a statement of the problems and their solution by the students themselves, they cultivate a *comprehending* thought, an ability to treat theoretical generalizations, a method of constructing the concepts themselves.

From the standpoint of the design of instructional subjects, many ideas in Polya's book are of interest. Let us point out only one of them. For example, one is required to find the area of the orthogonal projection of a polygon if its area is equal to A and its plane forms an angle *a* with another plane. The polygon's shape is not given – it can be of any form. But which of these are considered first? It is particularly easy to deal with a rectangle, since its base is parallel to the line of intersection of the plane of the projected figure with the plane of the projection. Some uncomplicated computations show that the area of the projection is equal to A cos *a*. But it turns out that other cases follow from this particular case – it is the *leading particular case*. The formula for the area of the projection established in it can be extended by a certain method *to all other* figures. Polya writes: "*Solving a problem in the leading particular case includes the problem's solution in the general case*" [250, p. 43].

It was noted in Chapter 7 that in theoretical abstraction and generalization a particular relationship of things that still has the property of universality is delineated and considered (other particular relationships are deduced from it, as well). Polya's mathematical example is exactly characteristic of this case. Apparently, it is by this route that students should be taught general methods of solving a certain class of problems.

Thus, the materials in many logical, psychological, and pedagogical studies allow the following two theses to be formulated. *First*, students' development of content-based generalization serves as an important condition for bringing teaching methods closer to the level of modern science. *Second*, in teaching practice the presentation of knowledge can occur according to the "general-to-particular" principle (from the *content-based* general to *mentally* derivable particulars). The problem is to develop specific methods of appropriately designing instructional subjects in a comprehensive way.

Features in the Implementation of Content-Based Generalization in Instruction

The application of dialectical logic in the design of the process of teaching students, in the development of their theoretical thought, requires the elaboration of many complex scientific problems. At present we consider it legitimate to advance a *hypothesis* to the effect that students' mastery of certain content in instructional subjects can be a basis for their formation of theoretical thought, which is accomplished, as was shown above, *first*, by creating content-based abstractions and generalizations established by concepts about "cells" of systems; *second*, by an ascent from the abstract to the concrete. At the first stages in substantiating and verifying this hypothesis the question of methods of constructing *content-based generalization* in the students' process of mastering instructional material is particularly important.

The basic features of this kind of generalization have been indicated above. If they are *combined* and the basic principle of content-rich generalization and of the concept that is related to it is delineated, the *construction of a universal, unified* form for a diversity of particular phenomena is typical of them, an *elucidation of the origin* of a certain concept content.[23] Introducing this principle in *instruction* requires that the children use specific object actions to reproduce, and models to establish, a particular relationship among things that will simultaneously function as a general basis for the particular manifestations of the system being studied. Breaking down an initial relationship in a certain way and making it concrete, students are to trace these connections of the general with the particular and the individual – that is, to operate with a concept.

The mastery of the educational material encompassed by the concept will be accomplished during the transition from the general to the individual.

The students' development of generalizations and concepts according to these principles undermines the epistemological and psychological aims of the traditional theory of instruction. Since a *specific action* that reproduces a certain generality from the very start is the foundation for a concept, the type of instruction that is related to the conceptualist scheme for concept formation is thus overcome. When the *connections* among the universal, the particular, and the individual are revealed, the concept receives only its inherent content, which is not reducible to sensory data.[24] Therefore the narrowly sensationalist restrictions are removed from the formation of concepts in instruction. Here, of course, the associationist interpretation of concept formation as a "stratification of images" with a gradual manifestation of the similar loses its meaning; on the contrary – a delineation of a certain universal by means of an *action* serves as a basis for mastering the particular.[25]

In the experimental development of the hypothesis that has been advanced we took account of the circumstance that modern instruction should be oriented toward those peculiarities in culture and science that characterize it as an integral system, which has already revised and "gathered" into itself the basic attainments of the past, including all of the methods of cognitive activity that are intrinsic to the period of accumulating and cataloguing empirical facts about the surroundings: "Gathering" means preserving in the form that is specific to a higher stage in development. Here something "gathered" within a more developed system has a different significance and a different specific weight from when it was only emerging.

This circumstance is not taken into account at times in determining the content and methods of instruction in our historical conditions. Ya. A. Komenskii, in his day, called on educators to teach their charges "from the sky and the earth, from oak trees and beech trees." A knowledge of the surrounding natural things, developed by empirical natural science, had to be conveyed to the students in its immediacy. The gap between methods of everyday observation of things and the scientific approach to reality had not yet made itself felt acutely in any way then – in any event not so much so that they could be contrasted. And much later Pestalozzi asserted that "man's contemplation of nature itself is the only true foundation for instruction" (we note: the "only true one"!). In the previous chapters we showed that in the theory of educational psychology these views are quite tenacious, although, as is well known, scientific knowledge has taken on its own specific nature and formulated its own particular "reality."

A particular person who is mastering modern scientific knowledge has no immediately uncontemplatable nature before him (see the substantiation of this thesis, for example, in K. Holzkamp's book [377] and elsewhere). Now, as M. K. Mamardashvili writes, the very "object of cognition is mediated by science as a social formation, by its history and experience ... – in it are delineated certain aspects that are given to the individual who takes up science, in the form of *generalized, abstract content* of his thought" [207, p. 21]. If the school wishes to introduce students to scientific knowledge, it not only should not conceal the generalized and abstract character of it[26] – it is obliged to specify these abstractions and generalizations at a wholly contemporary level, as described by dialectical logic.

In other words, psychology and didactics can now no longer speak of "knowledge" in general. To be rid of *naturalism* in the interpretation of the object of learning, they should take account of the uniqueness of the form of scientific cognition, of the scientific approach to reality. The scientific character of educational material is determined by the method of formulating the knowledge communicated to students, in which it becomes the content of specifically theoretical thought. Therefore students have to be given material whose mastery, from the outset, assures their development of *content-based* abstractions, generalizations, and concepts. Here the role of experimental and factual data ("empirical facts") is in no way infringed upon. To be sure, these data do not receive an independent significance, since taken *immediately* in the function that attaches to a universal character – the form of content-based abstraction and the quality of generalization.

Of course, in the traditional instruction system most facts are given to children in a "mediated way," as it were – through books, as well as on the basis of various experimental practices. But, as has been shown above, this mediation most often remains at the level of descriptive and formal generalizations, which do not disclose real abstractions as a source of *development* of a system of phenomena, or the contradictions that are resolved along the way in the ascent to the concrete.

The worthy striving by traditional psychology and didactics to differentiate instruction in every way possible from the process of general human cognition, from its generic logic, has led to the opposite result – to an ignoring of the specific potential of instruction as a particular and unique way of accustoming students to *modern* methods of theoretical thought.[27] In teaching practice a tendency toward naturalization of the objectives of mastery, toward reinforcement of empirical generalization that is peculiar to the past epoch of cognition, is being retained. Methods of designing instructional subjects which correspond to this type of generalization are now becoming simply odious. The same ironic characterization as the eminent Soviet mathematician and educator A. Ya. Khinchin has given, for example, to arithmetic teaching practice can be applied to them:

> Is this not as if a soldier had been compelled to master the guns, say, of pre-Petrine Russia in his first year of service, and only then was a modern model rifle put into his hands? [323, p. 167].

The students' process of appropriating scientific knowledge (instruction), of course, is not identical to the cognitive-investigative activity of scientists, and the content of an instructional subject is not identical to the totality of achievements in the science. At the same time there are many facts to indicate that there is a certain *coincidence* between the student's mental activity and the scientist's.[28] Its specific degree and form must still be investigated, for they are far from clear. Here, in our opinion, it is important to take account of the meaning of the distinction in methods of scientific activity that has been made by Marx:

> Of course, from a formal point of view, the method of exposition cannot fail to be differentiated from the method of investigation. The investigation should be learned in detail with the material, the various forms of its development analyzed, their internal connection traced. Only after this *work* is completed can the real movement be represented in the proper way. Once this was succeeded and the life of the material has received its ideal reflection, it can be shown that we have before us an *a priori* construction [7, p. 21].

Thus, *investigation* proceeds from the sensory-concrete diversity of particular types of movement to a discovery of their universal, internal base. *Exposition*, which has the same objective content, *begins* from this universal form of mentally reproducing concreteness, a form that has already been found and that is historically and logically the initial one – begins from a logical derivation of the particular manifestations of that concreteness.[29] In our opinion, the content and method of developing *instructional* material should be similar to the *exposition* of the results of investigation – that is, they should show students the real movement, which begins from some simple universal form of it.[30] Revealing this form allows students to trace the development of the studied material, its particular features, immediately, in "pure" form.

The instructional subjects designed according to the method of scientific exposition of the material should provide for students' development of content-based abstraction, of generalization, and of the concept – only in this instance will the preconditions for a theoretical approach to reality appear in their *own* thinking.

Existing instructional subjects also contain the results of science. But the issue concerns what results and how they are set forth in them. It is *primarily* the results of an empirical stage of cognition, the data from a classifying natural science, that are communicated to the children in school instruction (particularly elementary). At the same time the subjects in the intermediate grades contain many facts describing the laws in an area (physics, chemistry, biology, among others). On the whole, however, mastery of these facts requires only mental activity that is accomplished by the principle of formal identity. On the basis of *rational* thought students establish genus-type relationships using things and single out their rule-conforming connections. The activity in this kind of thought consists chiefly in abstracting, in separating the incidental from the essential, the particular from the general.

In the design of school instruction oriented toward rational thought there is no special problem in determining the internal connection between the specified content and the appropriate forms of thought. At the same time such thinking is abstract, separating the essential from the random features and attaching formal generality to it. All of this creates the *appearance* of a theoretical character to this thought. It is for just this reason that the "theoretical" is a synonym for the "abstract" in traditional psychology and didactics, and the development of abstract thought (in the sense of rational thought) is promulgated as a major task of education.

Existing methods of designing instructional subjects do not reproduce the "real movement" of material for two basic reasons. Above all, these methods do not rely on the conception of an ascent within which the general and the particular are identified. Therefore, if scientific materials that set forth the "real movement" of an object are put in the hands of didacticians and methodologists who profess traditional views, they still are unable to attach to them an adequate form of development in the instructional subject.

The second reason is related to the fact that traditional methods do not rely on the idea of the basic role of object-related activity in instruction. The "real movement" of the material is reproduced in a higher, theoretical form of the *ideal.* The ideal representation of an object includes complex aspects of generic human activity. Mastering this representation requires that the individual reproduce adequate types of activity. E. V Il'enkov writes: "The ideal as a form of subjective activity is mastered only by direct activity with the object and with the product of that activity ..." [136, p. 226].

But according to the one-sidedly sensationalist, contemplative-naturalist conceptions, the ideal functions as a "natural" result of the object's *influence* on man, which provides appropriate images. Here the question of the subject's *specific* activity in transforming and reproducing the object on an ideal plane is bypassed (this ignoring of activity is a consequence of conceptualism). On the basis of such conceptions it is *impossible* to guide students' mastery of the picture of reality that is given in an ideal-theoretical exposition.[31]

A full-fledged mastery of this picture presupposes students' *development* of the forms for their own activity that are adequate to the production of the corresponding theoretical knowledge.[32] This, in turn, is related to the systematic introduction of the pupils to the realm of activities that reveal the origin of all of the elements of the mental construction of the concrete.[33] Therefore, on the level of logical psychology, the content of instructional material should be specified for students in the form of structures for their activity [351].

The origin of the elements of concreteness is traced in *investigation* – and we are seemingly arriving at the need to include this method of activity as well in an instructional subject. However, in our opinion, things stand differently. If a scientist is doing an investigation in order to obtain data for an appropriate presentation, which he does not yet have, then students are in quite a different situation. By virtue of scientific work that has already been done before, they have before this a complete and accomplished exposition of the "real movement" of the material. And they can begin to learn the knowledge on the basis of such an exposition; it is what dictates the very content and order for singling out the elements whose conditions of origin the students are to establish through certain types of activity. Performing this activity is not real investigation, but a distinctive *educational model* of it (a "quasi-investigation"). Here, in *compressed, curtailed form, students* reproduce the operations that lead, for instance, to delineating an abstract element in a system that is to be studied, and so forth. One of the problems in modern psychology and didactics involves, in our opinion, studying the features and principles governing the structure of these instructional actions, which repeat or reproduce in a unique form the real investigative and searching actions.

Consequently, instructional objects should be constructed according to the method of scientific *exposition* of the material. But when students are introduced to an activity that reproduces the movement of this material, the situations and actions that were intrinsic to the investigation of the object are retained in a distinctive instructional form.

In the scientist's nature theoretical thought these operations are done on an intellectual level, of course. But for students the instructional variants of these actions must be developed by beginning at the level of objects.[34] A. N. Leont'ev writes:

> ... Mastery of the mental operations that underlie the individual's appropriation or "inheritance" of the knowledge and concepts developed by humanity necessitates the subject's passage from actions detailed outside to actions on a verbal level and finally gradual internalization of the latter, as a result of which they

take on the character of curtailed mental operations, intellectual acts [192, p. 283].

The performance of an action with objects has a *specific* significance, since it reveals the material content of concepts. Only particular object-related actions permit an object or situation to be transformed in such a way that a person can immediately single out in them the relationship that was a *universal* character. [35] One of the basic difficulties in the appropriate construction of any school instructional (mathematics, physics, etc.) is that at times it is necessary to conduct a lengthy psychological investigation in order to find these "particular actions" that reveal the content of the abstractions, generalizations, and concepts that constitute the given area of knowledge or some essential section of it, for the child.

Experiments in Designing Courses in Mathematics and Grammar on the Basis of Content-Based Generalization (Materials from Experimental Studies)

At present, in terms of experimental instruction (with a gradual introduction into mass school practice), it is possible to implement the principles for designing instructional subjects whose bases in logical psychology are related to children's formation of *content-based* abstractions, generalizations, and concepts. We have described some of the actual prerequisites for these possibilities above. Especially organized studies in educational psychology which rely on experimental instruction done on the basis of appropriate curricula assume particular significance.

A group of psychologists and educators in the cities of Moscow, Tula, Khar'kov, and Dushanbe, under the general leadership of D. B. El'konin and V. V. Davydov, has been working in this area for several years according to a unified plan. The studies done by this group are being performed as experimental instruction for students in grades 1-8. The basic task of the studies involves disclosing the structure and conditions for the formation of students' through *educational activity*. At the same time, as our experience has shown, solving this problem presupposes a substantial change in the content and methods of traditional instruction, and presupposes the development of instructional subjects that design students' mental activity of a properly *theoretical* type in students.

The distinctive nature of the method of our studies involves *constructing* and *reconstructing* instructional curricula (in our experiment these were instructional curricula in mathematics, grammar, and vocational training). The purposes of the studies were as follows. *First,* the general methods of designing instructional curricula of the basis of the principles that had been set forth had to be determined. *Second,* the intellectual age potential for mastery of the respective content by students in the various grades had to be established (in this instance the problem of discovering the children's *stores* of intellectual development arises). Third, it is important to study the principles of the formation of students' initial structures in theoretical thought – particularly children in the primary grades.

The hypothesis underlying our studies was as follows: With the introduction of instructional material in mathematics and grammar, students could develop content-based generalizations and concepts about the "cell" of these areas. The subsequent mastery could be accomplished by ascending from the abstract to the concrete.

The principle of content-based generalization and of the formation of a theoretical concept involves singling out a *general* form for a variety of phenomena and ascertaining the origin of the concept's content. Consequently, instructional subjects must include, not ready-made definitions of concepts and illustrations of them, but problems requiring the ascertainment of the conditions by which these concepts originated.

In the design of an instructional subject, the structure of the normative *generic* activity on the basis of which appropriate concepts are *introduced* must be established, above all. This is a particular investigative problem, whose general methods of solution in psychology have still had almost no development Particular examples of the study of this activity are presented in our works on the analysis of the origin of the concept of *number* (integer and fraction) and of the *multiplication* operation [424], [428], [437], [438]. Research by D. B. El'konin [475], [76], [477], L. I. Aidarova [408], [410], [412], [413]. and A. K. Markova [444], [445], [466], [448] has involved a study of activity to disclose the content of the concept of a phoneme and a morpheme and the concept of a *syntactic connection*. Works by F. G. Bodanskii [417], [419], [420],

G. G. Mikulina [450] [452]. G. I. Minskaya [455], [456], L. M. Fridman [466], [468], and R. A. Atakhsnov [414], [416] have described the essential components of normative mental activity related to solving simple mathematical word problems by composing *letter formulas and equations.*

The results of all of these works have served as a basis for experimental programs in grammar and mathematics whose content differs substantially from the generally accepted system of instruction. The basic *difference* is that students' process of tracing the conditions and laws for the *origin of the concepts* that are specific for the area of knowledge which they are proceeding to study has become the principal component in the experimental instruction. From the very start the essential difference between the reflection of objects in the form of *concepts* and their description as accepted in immediate everyday use and in daily observations is demonstrated to first-graders. Every significant topic in the curriculum begins with a specially *detailed introduction* of the children to the situations within which the need arises for the respective theoretical concepts.

In doing certain object-related operations as indicated by the instructor, the pupils detect and establish the essential features of objects such that orientation in them permits the solution of any problems in a given class that are connected with some similar situation. These operations are initially performed in a material or materialized form, and then are converted *step by step* into mental operations that are done with symbolic substitutes for the material objects (the general route of these transformations is substantiated in works by Gal'perin [681, [69], [70] and El'konin [477], [479], among others).

As studies have shown, the instructional reproduction of the method of introducing a *new* concept has the following basic stages: 1) students' orientation in a problem situation (a mathematical or linguistic problem or some other), whose solution requires a new concept, 2) mastery of a model for the sort of transformation of the material that discloses in it a relationship that serves as a general basis for solving any problem of the given type, 3) establishment of this relationship in an object-related or symbolic model, which permits its properties to be studied in "pure form," 4) disclosure of properties of the delineated relationship by which to deduce the conditions and methods of solving the original problem.

The key features here are the object-related *action* that establishes the internal relationship of objects and the *model* that fixes this relationship. This model differs substantially from the ordinary means of visuality that illustrate only the external features of objects. A model is a distinctive "fusion" of visuality and concept, which expresses a general, internal relationship in an object, one that is subject to further breakdown (the model should provide for this breakdown – that is, derivation and study of various particular forms of the original general relationship).

Detailed description of the problems in our group's research, of the methods by which it is done and of the results requires special and rather "voluminous" effort. At the same time we note that a certain part of this work has been done in the publications by ourselves and our associates on the problem under discussion here (see the list of publications at the end of this book). Its novelty and complexity are such that the resulting materials function only as first "attacks" in the effort to make its component questions concrete. These materials indicate the direction to be taken by future in-depth developments of methods of designing instruction on the basis of students' formation of content-based generalization, of material, such generalizations as would create a good soil for the children to develop *theoretical* thought.

Because of this it will be possible to solve a long-range problem of practical significance such as the creation of unified, linear or systematic courses in the basic school disciplines, starting with first grade (it is a familiar fact that courses for the primary grades now have a propaedeutic character, retaining a relatively closed concentric-circle form). But what do the systematic courses represent?

The curriculum for these courses, particularly their first sections, should reveal the constituent features of the subject being studied (grammar, mathematics, etc.) to children, the specific nature of a *theoretical* approach to it. The theoretical material should form the basis for children's development of thorough-going skills (orthographic, computational, and other skills), and the mastery of it should promote a cultivation of independence in schoolwork. The content of those courses is subordinated to the *logic of the subject* (with the laws of mastery assuredly being taken into account), rather than to the narrow requirements that ensue from the need to form a certain set of practical skills. This kind of curriculum design assures theoretical coherence and a systematic quality in the exposition of the instructional material.

Sometimes the “systematic quality” of a course is understood to mean developing it so that it ostensibly rules out the return to previously learned material, greater depth and revision of previously mastered concepts and skills. Such returns are interpreted as the concentric quality of instruction. This interpretation is ill-founded from the viewpoint of both logical cognition and educational psychology. Systematic development of knowledge about a subject does not rule out a constant saturation of the initial concepts (of the abstract) with new features or peculiarities – a return to the previous material from the standpoint of the later material (movement from the abstract to the concrete); rather, this is presupposed.

The concentric principle in its specifically historical significance involves not recurrence and more profundity but, primarily, a design for the instructional subject where the elements of theoretical facts are given to students only with respect to what is needed to develop narrowly practical skills. Here there is a violation of the logic of development of the subject itself and of the mastery of the theory, since fragmentary and superficial facts about a subject are often sufficient for skills. And if there is still a need to give students a more or less systematic course, it must begin from the beginning again. Therefore the initial facts prove to be merely preparatory and concentrically closed.

We understand that from a general pedagogical point of view and from the standpoint of conducting school, introducing systematic courses in the primary grades is problematic. But on the level of *educational psychology* this idea is now in need of serious development presupposing *investigative* studies of the potential for learning the content of systematic courses on the part of children between the ages of 7 and 10. These studies have already begun. A number of concrete issues arise here. One of the central ones is the question of how to design the instructional subjects and the activity of learning them so that children will develop techniques and skills in thinking in theoretical concepts much earlier than they do now.

By way of an example, let us stop to consider the particular features of the Russian course that illustrate, on the one hand, the uniqueness of systematic instruction in the primary grades and, on the other hand, the level of primary-grade students’ cognitive potential as manifested in the mastery of this course.

In first-grade Russian, information on the *phonetic* structure of the language (vowel and consonant sounds; hard and soft consonants; voiced and voiceless consonants; stress in the word and its role; the relations between sounds and letters in Russian; etc.) that is needed for the later mastery of morphology is given. In second grade the children begin learning the systematic course in *morphology* (the morphological structure of a word; the basic word categories; the connection between change in the morphological parts of a word – prefixes, suffixes, endings – and change in the character of the messages contained in the word). In third grade there is a systematic exposition of information about *nouns* (the functions of the case forms, a paradigm of declension, types of declensions), and then about the structure of a *simple sentence*. In fourth grade, on the basis of an analysis of the intonation structure of sentences, the children master the structure of a *compound sentence* of various types. On this basis further systematic information is given about *verbs* and the *forms* of their changes.

It should be stressed that the curriculum has specially included particularly difficult sections of grammar. For example, in second grade, when the children are becoming generally familiar with the verb, not only number, person, and tense are explained to them, but also aspects (perfective and imperfective), moods (indicative, subjunctive, and the imperative), and voices of a verb (reflexive and passive). When working on case changes in third grade, the children learn to differentiate the cases by their functions and, in grammatical analysis, indicate the significance of each case (for example, the instrumental; the prepositional; etc.); during work on the structure of a simple sentence they are taught to distinguish all of its types. We often include complex grammatical phenomena in our curricula, but for experimental purposes, without resolving beforehand the issue of whether they must be introduced into a systematic grammar course as such. It was important for us to ascertain *whether students in the primary grades can master this kind* of *material and under what conditions.*

The linguistic concept of an internal connection between communication and certain significant word parts (morphemes) formed the basis for these curricula (L. I. Aidarova, V N. Protopopov, and A. K. Markova, authors). This is the concept of an initial "cell" in an integral language system. The changeable particles of noun, verb, and adjective. whose modification correlates with modification in word meaning, function as a particular form of expressing this *general connection* from the outset. By acting with words in a certain way (changing and comparing them, singling out particles) second graders discover the relationship between communication and the "anatomy" of a word and begin to use this relationship as a general means of penetrating the grammatical structure of language. Many properties of this structure they *derive* during instruction as particular manifestations of a general relationship that has been found earlier. Here students in grades 2 and 3 develop a specifically linguistic approach to the word.

It is noteworthy that these children completely lack both "naive semanticism" and the confusion of words in different grammatical categories that is typical of students in the regular classes (see Chapter 4). Our children did all word classifying only on the basis of delineating a system of grammatical attributes of the given word. Therefore, according to L. I. Aidarova's data, there were almost no mistakes in classification [410].

We note that according to the traditional curriculum the children first become familiar with many empirically particular properties of words (primary grades) and only then do they come- and frequently in very incomplete form – to a conception of the connection between communication and word parts (grades 5-6).

The new curriculum design required introducing new work methods in which mastery of the content was possible. It is a basic feature of these methods that the instructor teaches the children to *produce an operation* with the material, changes in it, by which the children *themselves will discover* the properties being studied. The task of investigation in educational psychology is precisely to find, describe, and provide children with these operations.

Thus, in the study of morphology in our course the students produced a particular system of operations words in various categories. First, they changed the initial word in meaning and wrote down a new one under the original one; second, they compared the new word with the original in meaning and in morphological structure, discovering that part of the word that carried the meaning; third, they singled out this part; fourth, they established just what was being communicated in the original word, and through which parts.[36]

Let us use an elementary example to show how a child uses these operations when he first singles out the elements of a word and establishes their internal relationships. The teacher pronounces a word ("*kniga* [book]," for example), and asks the children what it communicates. Second graders' responses indicate, of course, only the word's "material" significance. Then the teacher changes the original form of the word "*kniga-knigi* [book-books"] and asks the children to compare these words and ascertain what each word communicates. The children single out the significance of number and the formal difference (—a - —i) with which it is linked. These two features were established in this way: The delineated parts of the word were boxed, and the significance of the morphemes was noted by arrows, near which there was a brief notation of the communications transmitted by the morphemes.

By working with other words, the children learned to change and compare them in order to detect formal and semantic differences, and then to represent morphemes in the form of graphic schemes. At the next stage particular morphemes were removed from these schemes – and a pure *model* of the word remained, reflecting only the sequence of its morphemes and the *general* significance of each of them.

To single out the various morphological parts of a word and to establish their functions in the different word categories, the children worked with sets of words that were different in their composition. For example, to determine the functions of an ending in nouns, they made changes in the number and in several cases, but to determine the functions of the ending in verbs they needed a large collection of mutually comparable words.

The children who worked on the experimental curriculum were systematically taught *how to operate* with a word and a sentence in order to discover their structure and the function of each part. This was the essence of the method which we applied in the instruction. The child was to perform particular operations to *change* words and sentences (or, in other disciplines, entities that were appropriate to them). By virtue of these operations, previously concealed properties and relationships become evident and can be established in the form of a graphic three-dimensional or symbolic *model*.

On the basis of the theoretical concept of a “unit” of linguistic analysis which the second graders formed, the Russian course was designed in a certain approximation to the meaning of an ascent from the abstract to the concrete. An important link in making this concept *concrete* was the derivation, on its basis, of the grammatical content of categories such as the parts of speech. Each of them functioned as a combination of the system of morphemes and the system of communications (meanings). Thus, noun form functioned as a system of communications, including a root meaning, an auxiliary meaning (it might be null), and the meanings of number, case, and gender, verb form – as another message system, containing the root meaning and the meaning of number, person, tense, mood, aspect, and voice (adjective form had corresponding content). Here the children themselves (but under the teacher’s guidance, of course) derived the content of the grammatical categories on the basis of combining different types of meanings, with a clear awareness of both the purpose and the point of their own actions. This, properly speaking, is the theoretical method of work, relying on a previously created concept about an initial general connection between form and meaning in a word.

The unitary principle of making a concept concrete and enriching it was retained during the subsequent study of morphology according to the experimental curriculum. Thus, third graders ascertained the relationships between the categories themselves and their forms. During their analysis the children created a distinctive general chart of the morphological structure of the language. This chart modeled the internal relationships among the language units and the modes of operation that were appropriate to them.

Experience in experimental work is evidence that students in the primary grades manage the material in the new Russian curriculum successfully. Let us cite a few examples. At the end of second grade the children were given a written assignment of classifying words by parts of speech. An analogous problem was given to students in grades 3, 4, and 5 who were taught by the ordinary curriculum. Thirty-three words were given (12 nouns, 14 verbs, and 7 adjectives). The students in the experimental second grade made a total of 42 in 957 possible mistakes, or 4.4 percent; the students in the ordinary third grade made 72 mistakes in a possible 891, or 8 percent; the students in grade 4 – 2.9 percent mistakes; the students in grade 5 – 10.7 percent mistakes. Here it should be borne in mind that the second graders were guided only by grammatical attributes (that is, by the nature of the word change) when attributing words to a certain part of speech, while the students even in the ordinary fifth grade used these attributes only in 34 percent of the cases.

In another assignment a morphological analysis of seven words was done. The students in the *experimental* second grade made 5.6 percent mistakes (of all possible mistakes), and the pupils in the ordinary third grade – 20.9 percent. Separating suffixes from endings was the hardest: here there were 15 percent mistakes in second grade, and in grade 3-4, 8 percent (that is, three times as many).

By virtue of considerable work on word-change and word-formation during morphological analysis, the students in the experimental grades significantly expanded their store of words. In one assignment the children from the experimental second grade and from the ordinary second and third grades were asked to write down as many related words as possible for five words. The students in the experimental class wrote down an average of 5.1 words for each one given; the students in the two ordinary second grades wrote down 1.9 and 2.1 words each; and the students in the ordinary third grade – 3.7 words. This shows that the students in the experimental class had a broader active vocabulary. Here it was ascertained that the very concept of related words was more profound and more correct among students in the experimental class than for children working by the ordinary curriculum. Thus, the former made only 7.7 percent mistakes, including among related words changes in the same word; the students in the two ordinary second grades made this kind of mistake in 35 percent and 31 percent of the cases, and in the ordinary third grade – in 20 percent of the cases.

These data, as well as other numeric data at our disposal, show that instruction in Russian by a *systematic* course program can be started even in second grade. In grades 3 and 4 the children also learn material in such a curriculum successfully. As a result of the mastery of the new material there is a significant increase in the children's potential for understanding more complex and profound grammatical phenomena. It is also important that during the instruction the children show a heightened interest in studying the language, developing a subtle language "instinct."

The concept of the relationship between form and meaning was made even more concrete during fourth-graders' study of a *syntax* course in which they had different aspects of this relationship before them. Here they developed a series of operations in correlating the semantic and constructive properties of a sentence, by virtue of which they began to regard it as a *meaningful form.* Composing generalized graphic diagrams of the formal structure of a sentence had a special role in the mastery of this material. By relying on them, the children learned to construct and reconstruct sentences, not on an intuitive basis, but according to strict, specifically linguistic reference points. According to the extent to which there is this mastery of syntax there is the possibility of starting – and continuing in grades 5 and 6 – the study of the relationships within the language's semantic structure itself. That is, delineating stylistic level as the highest branch of syntax, in which the meaning of a sentence depends not only on the combination of words within the sentence and their formulation but also on the context (in written discourse) and on the situation (in oral discourse). An approach to the analysis of the semantics of linguistic and literary facts permits the study of language to be brought closer to the study of literature in school [446], [448]. Special investigation showed that when these students were oriented in linguistic material, the typical mistakes and the confusion that usually exists for those who are studying by the ordinary curriculum were not observed (see Chapter 4).

This method of designing the Russian course indicates the fundamental potential and usefulness of developing instructional subjects on the basis of content-based generalization and the theoretical concept. Actually, a *general* connection, having an altogether particular form of expression, was singled out here on the basis of specific actions (that is, a *real* abstraction was performed). This connection as a "cell" in a linguistic whole was studied in "pure form," by virtue of which the children mastered the concept of the connection between form and meaning. Then the initial relationship was *made concrete* by *deriving* the particular features of the morphological and syntactic structure of Russian.

New content for instruction in the course in Russian, mathematics, and other subjects requires a serious revision of traditional didactic and methodological principles. Let us use one example to demonstrate this. The entire traditional Russian curriculum is built up on *observations* of language. One can only observe what can be directly perceived. A word's meaning is such an external element in language. The curriculum and the methodology are constructed precisely on observations of word meanings. Hence the definition of the parts of speech according to word meanings, and the recognition of sentence elements, and the familiarization with case and verb forms. This is a distinctive aspect of the visual principle in the teaching of grammar.

However, when faced with the task of *discovering* in language aspects that are not immediately given, the students can no longer use observation in its ordinary, everyday form. They must be given means of making a directed, practical *change*, and *analysis* of language, by which the more profound connections and relationships that typify language as a definite structure can only be revealed.

In general, where the external properties of things function as the content of instruction, the visual principle justifies itself. But where connections and relationships among objects become the content of instruction, visuality is by no means sufficient. Here, in our view, the principle of *modeling* comes into force.

When we designed a mathematics course, we proceeded from the fact that the students' creation of a detailed and thorough conception of a *real number,* underlying which is the concept of *quantity,* is currently the end purpose of this entire instructional subject from grade 1 to grade 10. Numbers (natural and real) are a particular aspect of this more general mathematical entity. Thus is it impossible to familiarize the child with this *general entity* from the start, and only then derive the particular cases of its manifestation? Can this be done, and what will it provide for the further mastery of mathematics?

Experience in special experimental work has shown that this presumption can be put fully into practice. To be sure, the curricula and teaching methods become unusual in this way. Thus, according to the course we developed, in the first semester of first grade the children do not "meet" numbers at all. All of this time they are mastering facts about quantity in a rather detailed way: they single it out in physical entities and become familiar with its basic properties.

More concretely, this is the result. While working with real things and delineating the parameters of quantities in them (weight and volume, area and length, etc.), the children were taught to compare these things according to a certain quantity, determining their equality or inequality (more-less). These relationships were recorded by signs. Then they passed to writing the result of a comparison by a *letter* formula – that is, they passed to a *general* form of representing the relationship of any quantities. Here there were two stages. At first the children learned to represent a relationship of quantities (weights, loudness of sounds, volumes, etc.) by correlating lines drawn on paper. Thus, if the teacher proposed representing a relationship of weights that were put on scales, a short line was drawn on the left and a long line on the right, since the weight on the left was lighter than the one on the right. From this form of notation the transition was made to letters, for now the child clearly understood that when *any* quantities are compared, only their *relationships* are singled out and taken into consideration. Entities themselves can be designated by letters, and the result of a comparison can be written by a formula if letters are connected by a sign ($a = b$, $a > b$, $a < b$).

Singling out an equality-inequality relation in "pure" form (writing out a formula) allows the transition to be made to considering its own properties – reversibility and irreversibility, transitivity, etc. It has been found that for many seven-year-olds mastering the transitivity of equality-inequality presented special difficulty. And this is natural, since here the child has had to construct beforehand a conclusion of a type that is not habitual for him: "If ..., if ..., then." But this difficulty is entirely surmountable, and by the end of October (the second month of instruction) the children are able to orient themselves excellently in this property of quantities.

The next stage involves teaching the children to write *changes* in quantities using the "plus" and "minus" signs. Here two stages were delineated: 1) "If $a = b$, then $a + c > b$" and 2) a new equality is possible only if "$a + c = b + c$." This knowledge is learned well by the children, and thus they are allowed to solve highly diversified problems related to the need to consider the "equilibrium" feature and the conditions for preserving it.

Special attention is not given to the property of monotonicity in the ordinary curriculum for the primary grades, although later on it is the basis for identity transformations, as well as for solving equations. Experience in experimental mathematics instruction from grade 1 to grade 5 shows that the child's earlier mastery of this property in *general* form substantially simplifies the subsequent mastery and understanding of its particular manifestations and applied significance (for example, in computation technique).

Analysis of changes in a quantity and their notation by "plus" and "minus" signs open up the way toward introducing elementary *equations.* Actually, if $a < b$, one can pass from the inequality to the equality: $a + x = b$. 'Re direction of the change in quantities is determined by the problem's conditions (if $a > b$, then $a – x = b$ when the requirement is to equate *a* according to *b.* Since the size of the change is still unknown, it is designated by an "x," which is a function of the correlation of a and b.

In our curriculum the students spend November (the third month of the first year of instruction) learning methods of passing from inequality to equality – that is, they learn to compare and write out equations ("If $a > b$, then $a + x = b$ or $a = b – x$"), and then to determine x as the function of other elements in the formula. The children gradually learn various techniques of composing equations in one unknown and of determining it according to specified conditions. Thus, they manage the following assignments: "Given $a > b$; $c > k$; write an equation, find x, and substitute the value you have found in the original formula." The children do this assignment in this way:

$a < b$
$a = b – x$
$x = b – a$
$a = b – (b – a)$
$c > k$
$c = k + x$

$x = c - k$
$c = k + (c - k)$

The next step in instruction is familiarity with the commutativity and associativity of addition: $a + b = b + a$; $a + (b + c) = (a + b) + c$. Mastery of this topic, as of the previous one, is related to some difficulties, which we do not have an opportunity to discuss ways of overcoming here. Let us merely note that when there is a certain organization of the lessons all of the children in our classes learned the meaning of these properties of the addition of quantities and acquired skill in demonstrating their applicability when operating with assorted object material, and later with specific numbers as well.

Thus, letter symbols, appropriate letter formulas, and their inter-relationship establishing the basic properties of quantities are entirely accessible to a seven-year-old even before familiarity with the numeric characteristics of objects. This sort of instructional curriculum makes greater demands on the child's intelligence. When there is a proper organization of the instruction, children are capable of mastering this curriculum. Then the preconditions for forming the capacity for reasoning theoretically emerge for them earlier than usual. This is a powerful impetus toward the development of the child's intellectual strengths, toward increasing his ability to evaluate abstract relations in objects, a quality that is detected in the study of subsequent sections of the curriculum – during familiarization with number, for example (the second semester of first grade).

In our course the teacher, relying on the knowledge previously acquired by the children, introduces number as a particular case of the representation of a *general relationship* of quantities, where one of them is taken as a measure and is computing the other. A number is obtained by the general formula

$$^{A}/_{C} = N,$$

where N is any number, A is any object represented as a quantity, and C is any measure. Clearly, by changing the measure one can change the number pertaining to the same object. The number depends on the relationship contained in the *original method* of transforming it. This method must be known and one must be able to evaluate this relationship when working with the concept of number (either natural or real). The children who are trained by the experimental curriculum have a thorough mastery of this circumstance. Incidentally, this makes it significantly easier for them to pass to working with the number axis (grade 1) and with fractions (grade 3). This "alleviation" is entirely explainable because the method of introducing a number's form, which relies on familiarity with quantities, is *common* to both integers and fractions. We also note that the first graders transferred to the number series the general properties of quantities that they had learned previously (transitivity, monotonicity, etc.).

Earlier we cited a description of the basic stages in the introduction of a new concept in instruction. In the example of the formation of the concept of number for first graders these stages function altogether distinctly. Thus, the children initially study the difference relationship of quantities and its properties. Then they are placed in the situation of a problem that cannot be solved by a difference comparison of quantities that is known to them. For this purpose a *new* method is needed – multiple comparison, where one quantity is a measure for another of the same kind. With the teacher's help the students find and learn the pattern for performing this problem-solving method that has been developed by society. In their own activity with objects they *reproduce* the basis of this method – the specific action to determine the *multiple relationship* of quantities by establishing its result through abstract verbal units. This is the *general* form for obtaining any integer or fraction. Object-related texts demonstrating similar relationships, and abstract units are *models* for obtaining this general form. Changing the measures and the material of the units, the children use this model to study the properties of the relationship that has been delineated – particularly the distinctive reverse relationship between the size of the measure and the number. Orientation in this relationship allows the child to derive the principle for constructing the number series by working with some one quantity (with a changing measure). Then on this basis particular conditions and techniques for obtaining an integer and a fraction are found in succession (a negative number as well in a certain situation). By virtue of this the initial general relationship and the method of revealing it are made concrete.

In this system of instruction the children's development of the concept of number occurs by disclosing to the children the necessary conditions for its *origin* (that is, by content-based generalization). The concept that was formed by this method did not have the essential defects that are observed in the concept of number that is formed in an empirical way (these defects are described in Chapter 4).

In this example, we believe, the uniqueness of the new approach to designing instructional curricula can be seen. The practical advantages of such an approach are now visible – in particular, the possibility of overcoming altogether or significantly lessening the gap between "arithmetic" and "algebra" that is typical of traditional school courses. This permits a reduction in the time the children spend on learning instructional material.

Some of the theoretical consequences are no less important. Thus, Piaget makes a distinct separation between the effects of traditional instruction and the child's intellectual development (the organization of operator structures). Here it is the level of development that should be the basis for regulating instruction. The following statement of Piaget's apropos of this is typical: "... Didactic mathematics must be founded only on a progressive organization of operator structures" [243, p. 29]. In the periodization of intellectual development, according to Piaget, a level of concrete operations that are related to actions on objects and to certain elementary "groupings" (definite operations on classes and relations) is typical of the age between 7 and 10 years. Only at 11-12 years do verbal or formal operations that rely on sentences rather than objects develop (operations on judgments).

The experience of our experimental work and the materials that have been collected permit us to conclude-although on a preliminary basis – that when there is an essential change in the content of instruction a transition to the level of formal operations can occur significantly *earlier* than 11-12 years. In many students even by the end of grade 1 and the beginning of grade 2 (8 years) we detected systematic reasoning about rather complex mathematical relations, about their connection, and all of this was done without objects, on a purely verbal level or by relying on letter formulas. Thus, at the end of first grade the children have managed, for example, to successfully evaluate the relationships between numbers and quantities in the following assignments:

Given: ${}^{A}/_{C}\ 5$

${}^{A}/_{K}\ 3$

Find: C ... K

Given: ${}^{B}/_{K}\ M$

${}^{E}/_{K}\ T$

$M < T$

Find: B ... E

In the first assignment, in evaluating the relationship of the numbers, one has to find the ratio of the measures for the same quantity being measured (here C < K). In the second assignment, considering the relationship of the numbers written in letters, one must find the ratio of the measurable quantities being measured, for the same measure (here B < E).[37]

As has already been noted, we introduce elementary equations as early as the first semester of first grade. And from this time onward, for four years, the students solve all word problems only by setting up equations – that is, with no access to an arithmetical method. The system of developing the algebraic method of problem solving in the primary grades and its psychological substantiation have been developed in detail in studies by F. G. Bodanskii [417], [419], G. G. Mikulina [452], and G. I. Minskaya [456]. Their materials indicate that this method, in the first place, is entirely accessible to children of 7-10 years (incidentally, in grades 2 and 3 the children become familiar with the system of equations); second, it substantially simplifies all of the instructional work on problems; third, it largely favors the children's development of skill in independently solving “new” problems, ones encountered *for the first time* (and this is an index of theoretical generalization).

Now there are grounds for stating that working according to the experimental curricula provides a number of advantages with respect both to the quality of the knowledge the children develop and to the level of their thinking that is oriented toward rather abstract relationships of the elements of language or of quantities – relationships that are concealed from direct observation. The children who work according to these programs are operating more freely with material that is expressed in the form of *theoretical reasoning* by the end of the second or third year of instruction than do their peers. For example, in studying the structure of letter formulas and comparing them in order to draw a conclusion, the children become accustomed earlier than usual to a substantiated conclusion and to analyzing the premises and conditions of a deduction.

These children, according to the material from Ya. A. Ponomarev’s research, have a more highly perfected inner (mental) plan of action than do their peers, in a number of indices. It is known that the volume of information retained by the child on a mental level and needed to perform operations “in the mind” is an important index of his intellectual development. No less important is how freely and accurately the child solves problems without relying on an external interpretation of the conditions. It has been established in research that some essential indices of the level at which an internal plan of action is formed among children in the experimental classes are higher, on the average, than for children being taught by the ordinary curriculum [4621, [463].

This question is legitimate: Do our students themselves form the rudiments of *independent* theoretical thought if they systematically perform instructional assignments that use the principles of theoretical generalization? Now there are data that allow a positive response to this question, in our opinion.

Thus, children and adults might be offered a series of particular assignments. Five markers, numbered from 1 to 5, are on six squares in a certain order. Shifting them into the one free square allows any previously specified new sequence to be found in a certain number of moves for example, the sequence

1 2 3
4 5

is converted into

5 4 3
2 1

To every initial position of the markers for obtaining a specified sequence there corresponds an optimal (least) number of moves. But the same sequence can be obtained with a much larger number of moves if the “wrong tactics” for the shifts are chosen during the game. In other words, here it is important to find the *principle* for the optimal transference of the markers as rapidly as possible. Tests were done involving adults and children in which they were given a series of 16 assignments of the game of “five” where, for instance, it was possible to translate all of the various 16 initial sequences of markers into previously indicated new sequences in *eight* moves (the optimal variant). But for all of these variants of the initial and final arrangement of the markers there was a single principle or an order for shifting them (V I. Pushkin’s study [265a]).

The subjects fell into three basic groups according to their method of activity. It was typical of group C that in all of the assignments the subjects made many superfluous shifts. In the last assignments the number of moves was able to surpass their number in the previous cases – these subjects displayed no tendency to optimize solutions whatsoever. In group B such a tendency was observed – the number of moves was gradually reduced from assignment to assignment, although it could rise quite unexpectedly. The subjects in this group somehow singled out the solution principle but were unable to give a verbal account of it (the use of the principle was unstable). Group A was distinguished by the fact that its subjects, who had somehow solved the first (or at least the second) assignment, singled out and formulated the principle (the order) for transferring the markers, and then were able to do all of the other assignments *immediately*, correctly, rapidly, and without extra moves (without “mistakes”). The following is worthy of note:

Most of the subjects were usually in groups B and C. An *empirical* generalization of the solution (gradual, slow, and unstable discernment of the general order for transferring the markers) was typical of group B. Group C could not even produce this kind of generalization. But the subjects in group A revealed an ability to do a *theoretical* type of generalization independently, for which the following is typical: In the analysis of the solution to any *one* problem the essential connection of its elements is singled out, and then the orientation to this connection allows the person to solve all problems in the given class correctly at once, "on the spot," as though their conditions had not been differentiated externally.

We used this game and the method of applying it repeatedly in tests with first graders in both regular and experimental classes (at the very beginning of the school year). The distribution of children by groups A, B, and C was almost identical in every class (14, 24, and 62%, respectively, in the ordinary classes, and 10, 26, and 64% in the experimental ones). In a study done together with V N. Pushkin and A. G. Pushkina [441a] we applied this methodology in experimental second grades that had worked for two years with special curricula (see the description of methods of designing them, above), in a regular second grade and a regular fourth grade (at the end of the school year). The distribution of students (in %) according to groups A, B, and C is shown in Table 6.

Table 6

	Group		
Grade	A	B	C
Experimental (2)	75	15	10
Regular (2)	20	33	47
Regular (4)	30	22	48

Most of the students in the experimental classes solved these assignments by a *theoretical* method. In the regular grades 2 and 4, group A was 4-2.5 times smaller (here half of the students were unable to produce even an empirical generalization).

According to these data, experimental instruction that is organized in a certain way has a positive effect on the development of theoretical thinking in students in the primary grades. This fact makes it possible to treat hopefully the hypothesis of the basic prospects for developing students' thought. These prospects involve developing the fundamentals of theoretical thought in children as early as the primary grades.

Relying on new psychological data, one can indicate the possibility of *overcoming* the point of view by which so-called "concretism" is supposedly necessarily and inevitably intrinsic to the thought of primary-grade students. In fact, when there are a certain content and certain teaching conditions, students can develop concepts which, as operations are done with them, reveal a rather high level of generalization and abstraction, an ability to master *theoretical* knowledge, in the primary grades.

All of this creates realistic psychological preconditions for overcoming concentricity in primary instruction, for converting it into what is really the first level in an integral school education constructed on the basis of systematic course curricula. Of course, considerable painstaking investigative and practical work in experience is still needed for these possibilities and preconditions to be converted in mass education – but it is along just this route that we must move.

Conclusion

The treatment of the basic logical, psychological, and didactic questions in the design of instructional subjects as conducted above allows a number of conclusions to be drawn, as follows.

Solving the essential problems in contemporary school education is ultimately linked to *changing the type of thinking* that is projected by the goals, content, and methods of instruction. The entire instruction system must be reoriented from the children's development of rational-empirical thought to their development of modern *theoretical scientific thought.* Study of this problem presupposes the comprehensive use in psychology and didactics of the dialectical materialist doctrine of cognition and of the role of man's object-related activity in it.

This problem cannot be worked out by way of traditional educational psychology. Following classical formal logic, the latter makes an absolute of rational-empirical thought and its role in learning. It cannot reveal the real causes of the difficulties students experience when mastering scientific knowledge. These difficulties stem from internal restriction on empirical abstractions, generalizations, and concepts that are cultivated by children primarily in terms of the accepted system of teaching. But it is these empirical forms of thought which traditional psychology recognizes as the only possible and allowable ones in mass school education.

Guided by the empirical theory of thought, this psychology is obliged to profess its interpretation of the nature of abstraction, generalization, and concept formation, whether voluntarily or not: *conceptualism, narrow sensationalism, associationism.* But these aims are incompatible with an interpretation of object-related activity as the basis of human thought, with an acknowledgment of the specific content of theoretical generalizations and concepts in contrast to other forms of reflection.

At the same time the formulations of certain ideas that have been adopted in traditional educational psychology are similar to the theses of the dialectical materialist theory of cognition (for example, the theses about the general route taken by cognition, about the mediated character of thought, etc.). However, as analysis shows, this is only an *external* similarity. In fact, a meaning that is not inherent in dialectics is attached to many concepts in educational psychology. In essence, they are used in the spirit of the empirical theory of thought. Special study is needed to clarify this factual circumstance. Such study shows that our psychologists and didacticians will still have considerable difficult work in prospect in order to master the secrets of designing instructional activity that develops children's thought in complete correspondence to its dialectical materialist theory of cognition.

In the exposition of this theory we have particularly singled out the feature that it formulated an interpretation of generalization that differs essentially from its empirical interpretation. This concerns primarily the thesis of the objective, real existence of a *universal* connection as the basis for developing an integral subject. Acknowledgment of the real, content-based character of the universal, which is revealed by appropriate actions by the subject, allows educational psychology to substantiate ways of designing instruction that develops theoretical thought proper in children.

The "technique" of forming content-based generalizations is quite different from the one that is peculiar to empirical generalizations. A *transforming*, object-related action and an analysis that establish essential connections in an integral entity, its genetically original (universal) form, rather than observation and comparison of the external properties of objects (traditional visuality), serve as the basis for this process. Here discovery and mastery of the abstract and universal *precedes* mastery of the concrete and particular, and the concept itself as a certain method of activity serves as a means of ascending from the abstract to the concrete.

An instructional subject designed on the basis of the principles of this kind of generalization corresponds to a scientific *exposition* of the actual material being investigated. But mastery of its content should be accomplished by the students through *independent* instructional activity, in the abbreviated, "quasi-investigative" form of a reproducing situation and material-object conditions for the *origin* of the concepts being studied. The teaching of instructional subjects that organize and provide for this sort of instructional activity can be a foundation for the students' development of the fundamentals of theoretical thinking.

At present some experience in the experimental utilization of new principles of designing instructional subjects or particular sections of them has been accumulated. Let us list these principles:

> 1) all concepts that constitute an instructional subject or its basic sections should be learned by children through consideration of the material-object conditions by which they *originated*, by virtue of which they become *necessary* (in other words, the concepts are not given as "ready-made knowledge");
>
> 2) mastery of general and abstract knowledge process familiarity with more particular and concrete knowledge – the latter should be *derived* from the former as from its own single basis – this principle follows from the aim of ascertaining

the origin of concepts and corresponds to the requirements for ascent from the abstract to the concrete;

3) when studying the material-object sources of certain concepts students should, above all, detect the genetically initial, universal connection that determines the content and structure of the entire entity in the given concepts (for example, the general relationships of quantities serve as this universal basis for the entity of all of the concepts in traditional school-mathematics; and the relationship between form and meaning in a word does the same for the entity of concepts in school grammar);

4) this connection must be reproduced in particular object-related, graphic, or symbolic *models* that permit its properties to be studied "in pure form" (for example, children can represent the general relationships of quantifies in the form of letter formulas that are convenient for the further study of the properties of these relationships: the internal structure of a word can be represented by particular graphic schemes);

5) students must develop special *object-related actions* by which they can disclose in the instructional material and reproduce in models the essential connection in an entity, then study its properties (for example, to disclose the connection underlying the concepts of integers, fractions, and real numbers, children must develop the action involved in determining a multiple relation of quantities for the purpose of making a mediated comparison of them);

6) students should pass gradually and in good time from object-related actions to performing them on a mental plane.

This sort of design for school subjects allows the organization of instruction during which even students in the primary grades master concepts and skills that usually are attributed to an older group. Mastery of this educational material promotes the formation of the children's theoretical thought.

It is a task for the near future to use *composite* logical, psychological, didactic, and methodological investigations to develop comprehensively the specific techniques of designing instructional subjects through content-based generalizations of material and of the theoretical concepts about it. These studies should be done in the inseparable combination of experimental instruction and study of the principles governing the development of students' thought.

Passing on to such studies signifies a new stage in the development of child and educational psychology. Until very recently these have been primarily descriptive disciplines, ascertaining the empirical features of a certain historically evolving system of instruction and of children's mental development. These experimental facts have considerable cognitive significance, but they do not reveal the real mechanisms of learning and mental development.

In the works by L. S. Vygotskii and his followers different routes for psychological studies are charted, ones determined by the *causal-genetic* method (this method can also be called the *genetic-modeling* or the *experimental-genetic* method). Its basic feature is active modeling, the reproduction in particular conditions of the emergence processes themselves and of the stages of mental development for the purpose of discovering their essence. The basic principles for the development of the forms of appropriating knowledge among children, for example, were discovered by this method (studies by A. N. Leont'ev, P. Ya. Gal'perin, and others).

In our opinion, the most far-sighted method for psychological research at present is the experimental-genetic method, which permits the mechanisms of mental development to be revealed by the active formation of certain aspects and qualities in the human personality. Educational and child psychology have arrived at a new stage, in which study of the principles governing mental activity occurs *on the basis of and in the form* of *experimental instruction.* One of the principal tasks of our investigative group is to develop principles for this new method and to discover the optimal conditions for its application.

Notes

Notes to the Preface

1. Naturally, we could not encompass the entire content of the problem of abstraction, generalization, and concept formation, and we have confined ourselves to the comparison of their different types that is essential for determining the initial methods of designing school subjects.

2. By "traditional" educational psychology and didactics we mean to refer to the single system of views on pupils' learning processes that is set forth in the manuals and textbooks that are most widely prevalent now and that guide students and young instructors, particularly, as they become familiar with the fundamentals of these disciplines.

3. The intention and preliminary results of our experimental work in this area are presented in last chapter (see also the series of publications listed in the general description of bibliographic sources).

Notes to Chapter 1

1. "When we generalize, we reveal *what is* common in *isolated* objects and phenomena in reality" [253, p. 243]; 'When a person singles out what is common, he designates it with a word, connecting it with the objects and phenomena that have this common element. The word 'tree' is linked with all trees, regardless of their species, regardless of the features that distinguish each of them, since all of them possess certain common attributes ... something in common" [253, p. 242].

2. In the literature on educational psychology and methods, the generalization processes are quite often characterized as a fundamental way of forming concepts [see below]. The term "generalization" is often used as a synonym for "concept." Therefore when describing the features of generalization it is legitimate to use the characteristics of concept formation that exist in the appropriate branches of this literature.

3. These impressions can be obtained either directly from the objects or on the basis of a verbal description of them or a representation in diagrams, drawings, etc.

4. "The child masters a certain general thesis by comparing observable facts and phenomena, by disclosing the features of similarity and difference in them" [209, p. 26]. The basic role of comparison in forming a generalization is noted in many works (see, for example, [173], [2971, etc.).

5. "After the work on particular elements of knowledge, these must be linked, united with one another according to general, similar attributes. The unification occurs in the form of a generalization ..." [266, p. 13].

6. Here we are not treating the question of the nature of generalization that is accomplished *without* abstraction (for instance, "generalization in perception"). Since the literature on educational psychology concerns primarily the mastery of knowledge that is expressed in conceptual form, generalization itself is also considered only on this plane. "Abstraction is the constructive component in the students' generalizing mental activity" [330, p. 120].

7. The delineation and abstraction of what is common is *isolating* abstraction; the act itself of juxtaposing what is common to the other qualities of an object some authors call *dismembering* abstraction (see for example, [144, p. 27]).

8. "The transition from the concrete and isolated to the general and abstract finds its expression in generalization" [266, p. 13].

9. "To spell a word properly, the speller should be able to analyze its structure, its formal attributes. If the student is able to recognize the parts of a word... then he can more easily and better understand the orthographic rules and learn to apply them in practice" [149, p. 300].

10. "Only by comparing objects and phenomena with one another does the person get a chance to orient himself properly in the world around him, *to react identically to what is similar in objects* and to act differently in relation to the differences that are in them" [263, p. 249]. (Emphasis ours. -V. D.]

1]. “Every concept can be characterized by the collection of attributes of the objects that are represented in the concept.... The collection of basic attributes of the objects encompassed by the concept is called the content of the concept” [226, pp. 14-15].

12. Sometimes this sort of “essential” is described as something “characteristic,” “typical”: “The essential, characteristic, typical attributes of a concept are emphasized in the generalization process...” [266, p. 131; “... A major condition of the generalization process is the establishment of the general characteristic features and connections among the objects being studied” [101, p. 96].

13. In one of the works especially devoted to questions of defining mathematics concepts in the intermediate-school course, “essential” is described as “necessary,” and at the same time the latter is itself characterized through the “inseparable”: “*Essential* attributes of a concept are what we call attributes each of which is necessary, but all together are independent and sufficient to differentiate objects of the given type from other objects” [226, p. 371; “... We shall encounter facts where students pay principal attention, not to the essential attributes of a concept, but to the secondary (separable) ones” [226, p. 115].

14. We note that verbalization, although major, is not the only basis for generalizing conceptions. It can also be related to the translation of conceptions from one modality to another-for example, to the translation of auditory and motor conceptions onto the plane of visual, graphic schemes [20, pp. 284-286].

15. “When there is multiple perception of similar objects in the image that arises as a result of their influence, the individual peculiarities of each of them are effaced, and only the most general peculiarities of the given group of objects are singled out. Such,

for example, are the *general*, or *schematic, conceptions* of a tree, a house, a person, etc., which usually appear in the form of outline images of objects, accompanied by their names” [263, pp. 228-229].

16. Specific examples of the formation of the grammatical concept of a “root,” the geometric concept of an “angle,” etc., corresponding to the indicated sequence, have been cited above. A detailed description of the features of the work according to this scheme is contained, for example, in one of the fundamental methods manuals on the teaching of Russian [149, pp. 312-313].

17. A direct connection between the route “from the top down” and the *classification* operation is pointed out in the following statement; “Such a *classification is* expressed: 1) in the delineation ... of general concepts ... ; 2) in the *subsequent attribution of individual objects to the appropriate general concept* [330, p. 236]. (Emphasis ours. – V. D.)

18. The following state of affairs is typical of students’ work with mathematical material: “A significant number of the mistakes students make in arithmetic instruction occur precisely because they ... operate from analogy ... in those instances requiring a change in the mode of operation, or, on the contrary, do not use methods that are known to them where needed, since they have not grasped the similarity” [235, p. 48].

19. “After the students have become familiar with the general essential features of a concept, ... it must be ascertained whether they are able to apply the concepts in practice” [330, p. 226].

20. Some authors discover within this transition the existence of a particular, “secondary” type of *abstraction:* “Here we are dealing with a second type of abstraction, which acquires the significance of an independent process, since it occurs separately from generalization. A generalization has already been formed; one must merely find this general principle, dismembering it in the new concrete conditions” [235, p. 50].

21. Older schoolchildren’s generalizations, of course, differ substantially from the elementary concepts of younger students. In this sense this scheme is fully realized only for adolescents and older students.

22. Such qualities are often designated as *essential* general qualities of objects, properly speaking, the delineation of which is possible only on the basis of complex investigations; “Essential attributes are those that characterize the general relationship of an object or phenomenon to other objects and phenomena. They cannot be perceived directly by the sense organs. They can be known only as a result of comprehensive investigation of the connections and relations between

objects and phenomena.... This is how ... the highest level of concept formation, the level of the formation of scientific concepts, is characterized" [108, p. 75].

23. This circumstance serves as a real foundation for the fact that many elements of information that was formerly a traditional subject in elementary school instruction

(information in arithmetic, for example) have entered the curriculum of compulsory school studies that have been introduced into our preschool centers.

24. In some cases it is pointed out that "the students' cognition is always being enriched both with respect to the content of their knowledge and with respect to their mastery of increasingly complex forms of thought" [234, p. 110]. But here there is not even a hint of what kind of "more complex forms" these are and whether, for example, the increasing complexity of the forms of generalization and of the concept might be implied here.

25. With respect to the physics course, the following general methodological statement is typical: "The teaching of physics should not be bookishly verbal. *The teaching of physics should be experimental throughout the course.* It should rely on the *teacher's experimentation,* expediently combined with the *students' independent laboratory work.* It should proceed from practical situations that the students confront in their daily lives" [128, p. 19].

26. This feature of visuality completely corresponds to the *functional* role of the "perception-representation-concept" scheme.

Notes to Chapter 2

1. In recent decades, manuals and textbooks by G. I. Chelpanov [325], V. F. Asmus [26], M. S. Strogovich [2991, N. I. Kondakov [166], and D. P. Gorskii [96] have received wide distribution in our country.

2. By *attributes* some authors mean only the properties by which objects differ from one another [325, p. 13], [96, p. 15].

3. "As a person compares objects and phenomena, he singles out their common properties, the ones that belong to a whole group of objects" [96, p. 15].

4. The following are appropriate definitions of this technique: *"Generalization is* the mental delineation of certain general properties belonging to a whole class of objects and the formulation of a conclusion that extends to every particular object in the given class" [166, p. 457]. *"Generalization is a mental transition from the attributes of particular, individual objects to attributes belonging to whole groups of these objects"* [299, p. 82]. The term *generalization* often designates, not just the process of singling out common properties, but its result as well, which is contained in the general concept [325, p. 91, [26, p. 37].

5. "Abstraction means segregation. Singling out particular aspects or attributes of the object being studied, we abstract ourselves, segregate ourselves, from its other aspects, leaving them outside our attention-we eliminate them from consideration" [299, p. 81].

6. "... A *concept is an idea reflecting the general and essential attributes of objects and phenomena in reality"* [96, p. 17]. We form every concept only along with the word corresponding to X' [96, p. 17].

7. "In this concept ... only what is *common* and *essential* for all objects of the kind is delineated" [299, p. 781; "In forming concepts of objects and phenomena in reality, we reflect their *common* and *essential* features ..." [96, p. 4] (emphasis ours – V. D.).

8. "After having singled out a certain range of objects and noticed what is similar in all of these objects and what is distinctive, our thought then singles out the group of attributes that make up the content of the concept of the objects under consideration" [26, p. 35].

9. "These attributes that necessarily belong to objects of a certain kind and that distinguish them from objects of other kinds are called *essential attributes"* [299, p. 84].

10. Formal logic also describes another technique, in which a method by which an object originates or is formed is indicated. In this sort of *genetic* definition the attributes of the object that is being set forth by the concept are regarded as conditioned by the very method of forming the object (thus, a circle can be defined as the figure resulting from rotating a straight-line segment about one of its endpoints in the plane) [26, p. 58]. Some authors believe that the concept re-

vealed by a genetic definition nonetheless contains an indication of the closest genus and typical difference [166, p. 337].

11. In a number of manuals on normal logic, the term *generalization* means precisely this operation of *generalizing a concept* [325, p. 17], [26, p. 60], [96, p. 22]. However, in some manuals the term *generalization is* used, as was shown above, to designate a particular logical technique that is geared toward singling out the common attributes of a group of objects [166, p. 1501, [299, p. 82].

12. "Concepts ... are obtained from comparisons of similar conceptions" [325, p. 131; "Anyone who does not have conceptions on the basis of which a concept is created has not mastered the concept" [166, p. 279].

13. Bela Fogarashi expresses the following view on this score: The theory of cognition has hitherto been developed in systematic form only in traditional logic, in formal school logic" [317, p. 146].

14. The comparison of such autonomous entities as a plate, a flat *lampshade, and* a *wheel* can therefore be reduced to the concept of a *circle* (this example of the formation of the given concept is cited in a logic text for teachers [226, p. 1321).

15. Let us call attention to the following feature in the logical description of the formation of a class: having found that a number of bodies have as a common attribute, for example, a spherical shape, "in the future we call all bodies having the same shape . spheres... [160, p. 195]. It is what we "call" them, since we are not establishing real commonality of these bodies.

16. In traditional, formal, school logic the general is interpreted only as the similar or the identical in a series of objects. "Generalization is a technique by which we combine particular *objects on* the basis of identical properties inherent in them into *classes of objects.* The result of such a combining is a concept" [160, p. 191].

17. The position of the medieval nominalists is described as follows in one of the works on the history of logic: "In opposition to the realists, the nominalists taught that only individual things really exist, while genera and types are merely subjective concepts (*conceptus*), by means of which we think about many similar objects, or else they are reduced to general names *(nomini Voces),* by which we designate similar objects" [201,

p. 269]. In essence this position has been shared by other eminent nominalists of later epochs – Ockham, Hobbes, and Condillac, among others (see [201, pp. 285-286, 359, 413]).

18. In analyzing the problem of defining concepts, D. P. Gorskii makes the following characteristic remark: "We note that distinguishing between an essential and a nonessential concept, between a less essential distinguishing attribute and a more essential one (or property or relationship) makes no sense when it comes to the disciplines of mathematical logic. Here it is sufficient merely to differentiate ambiguously the object to be defined according to certain properties by means of definitions... " [100, p. 3 5 2]. Some authors generally regard divorcing "distinguishing" and "essential" attributes as illegitimate-in a certain respect the former are always the latter [327, pp. 19-30].

19. "... The choice of properties by which the comparison of objects is made is regarded as conditioned by the point of view of the subject. It is this point of view of the subject, his notion about what attributes of objects should be regarded as essential in the given conditions, that determines the very range of the objects to be identified with one another" [187, p. 227].

20. Substantiation for the feature that the presence of "essential attributes" is not a criterion for a concept is given in an article by A. A. Vetrov [58]. He proceeds from the fact that, when essential attributes are lacking in a concept's definition, the concept is simply incorrect. Including an essential attribute (refining the same definition) makes the concept correct, but this of course does not mean that a transition from the sensory level of cognition to the rational level has occurred during this refinement.

21. D. R Gorskii gives the following description of such properties: "The properties directly perceived by our sense organs ... and the properties perceived by our sense organs only through an instrument and various kinds of technical devices both pertain to sensorially perceived properties" [98, p. 219].

22. This is how T. Kotarbin'skii describes "understanding": "A given word is understood only by the one who clarifies for himself, at least visually, what it means; consequently, a given name, for example, is understood only by someone who is aware, at least visually, of what collection of attributes is ascribed to the object about which this word is being uttered" [172, p. 637].

23. Bain, a classical representative of English associationism of the 19th century, describes the possibilities for including a specific thing in a class as follows: "Every concrete thing is part of as many classes as it has attributes; attributing it to one of these classes and representing the respective attribute is the process of abstraction" [51, p. 201].

24. Yu. A. Samarin describes this principle of associationisrn as follows: "Failure to understand the specific nature of the logical as it relies on the sensory has led to an attempt to regard both perception and thought as a simple sum of sensations, to an attempt to negate the distinctive nature of complex formations by reducing the complex to the simple, without seeing in them a new quality that makes them fundamentally different from mental formations at a lower level" [284, pp. 45-46].

25. S. L. Rubinshtein writes: "With respect to associationist theory, we note ... that it wanted to explain thought by the connections among given elements or formations.

For example, T. Tsigen described a concept as an association of conceptions ..." [278, p. 16].

26. At the same time, some logicians interpret the mechanisms of thought on the basis of the concept of association. Thus, A. A. Vetrov [59] has reproached S. L. Rubinstein for not having proceeded from the associationist nature of thought see S. L. Rubinshtein's response with Vetrov's objections [280]).

27. The use of the term "association" in its empirical significance is by no means accidental-it is often used in other contexts, too (see, for example, [41, pp. 121, 129, 165].

28. This term, which precisely describes the essence of formal generalization and its function, we have borrowed from a work by V. S. Shvyrev [332, p. 123].

29. Clearly, the points in such determinants are the "definitions" of empirical concepts, which permit objects to be differentiated from one another according to their degree of generality. "A definition [a formal-logic definition – V. D.] should include only the attributes that are necessary and sufficient for differentiating a given concept from all others that are included in the given class (genus)," B. M. Kedrov notes [157, p. 48].

30. "Thus, there is no basic difference between 'ordinary' and scientific concepts in their form. The difference may be merely in the degree of precision and depth of the reflection" [64, p. 128].

31. The Polish philosopher L. TondI' describes the limitations of one of the initial principles of the formal-logic scheme of concept formation in this way: "A concept of a particular, isolated object is merely a construct of our thought, completely sufficient only for the routine needs of everyday thought, for 'domestic use'; as for science, it is sufficient for it only in the elementary stage of its development" [304, p. 129].

32. "In popular expositions of the abstraction process, particularly in school logic textbooks, we encounter, as a rule, the theory of abstraction that has its roots in the empirical theory of cognition. Such a theory of abstraction is usually expressed by a simple scheme.... The simple abstraction scheme that is thus constructed is usually linked with the name of John Locke" [304, p. 130].

33. The basic tenets that are typical of the first point of view were later reproduced in a book by Kopnin [170, pp. 122-128].

34. "... Formal logic, in contemporary terms, has been transformed into a special field, which analyzes the 'technique' of inferential knowledge" [170, p. 126].

35. Here it is a matter of mathematical logic in its "pure form." At the same time, as is well known, the apparatus of this logic is used by neopositivists for a subjective-idealist solution to a number of epistemological problems, including problems of correlating the empirical and the theoretical levels of knowledge. The founders of neopositivism (for instance, M. Schlick [401] and others) have relied on a number of ideas developed by the empirical theory of abstraction (an analysis of the origin and a criticism of neopositivism are contained in a number of modem

works, such as [218], [2951, [332], and others). The neopositivists misconstrue the problems and the goals of real formal logic.

36. “In formal logic the concept is studied from the standpoint of its structure and is treated as if ready-made, having been formed... ; moreover, the concept in formal logic is investigated primarily from the standpoint of its scope. Such an approach to the analysis of a concept fully meets the needs of the development of the theory of formal deduction” [99, p. 24].

37. “Formal logic treats the attributes of a concept only from the standpoint of the function of differentiating one class of objects ... from another [199, p. 33].

38. It should be taken into account that “the methods of operating with developing concepts are different from those used to ascertain the relationships among ready-made, developed concepts” [99. p. 24].

39. For example, A. A. Zinov’ev indicates the following among several restrictions from which modem logic proceeds in the study of scientific knowledge: “All social, psychological, and other connections, within which the acquisition, retention, and use of knowledge occurs, are left unattended here.... It is presumed that the sensory apparatus of reflection is necessary for obtaining, retaining, and using knowledge. But its activity is not considered. Everything that goes on in the brain and in the human organism generally (within any reflecting being or mechanism) does not play a role here” [127, pp. 5-6]. Clearly, under such a broad assumption, the traditional problem of “sensation” and “thought,” of the reducibility or irreducibility of the latter to the former, simply loses its meaning.

40. M. M. Rozental’ takes a similar position on this point [271, pp. 105-106].

41. Kopnin and Tavanets note: “The absolutization of formal logic, its conversion into a single science of forms of thought, is erroneous, however”; “Formal logic studies only the rules and forms of deducing one judgment from others, while dialectical logic studies the conditions of the truth of our thinking ... the development and interconnection of the forms of thought ... “ [17 1, pp. 9 and 62].

Notes to Chapter 3

1. W. Whewell, criticizing Baconian-Millian induction, points out the following: “Induction is usually discussed as a process by which we establish a *general statement* on the basis of a certain number of *particular cases,* and it is often imagined that the general statement is obtained only from a comparison of cases.... But if we observe the process more carefully, we will understand that this is incorrect. Individual facts are not simply taken together.... There is a certain mental concept that is introduced into the general statement, which does not exist in any of the observable facts” [406, p. 72].

2. Investigators who take the positions of the materialist theory of cognition naturally own the objective existence of objects as a coherent whole (it is another matter that they can consciously abstract themselves for a certain purpose from the connections that yield real unity for an object). At the same time, in the mainstream of positivistic philosophical theories there is a denial of the objectivity of the “unity of things.” Thus, Bertrand Russell’s *logical atomism* “asserts that there are many particular things and denies whatever unity is made up of these things” (cited in [295, p. 2581).

3. The proponents of this scheme quite often discuss the necessity of representing the essence of things in a concept. *Essence is* often interpreted as an internal connection. in itself, it is a proper requirement for a concept. But the limits of the empirical scheme it *cannot* be realized. Therefore such a requirement is either simply declared or is realized by an *unconscious* “switching on” in the cognition process (and instruction as well) of techniques and means that go beyond the limits of the possibilities of the consciously adopted scheme, actually by abandoning it.

4. Analyzing the historical fate of this concept. T. Kotarbin’skii writes the following: “In scientific circles, among naturalists and representatives of the philosophy of the natural sciences, the positivist position gradually became established. Its slogan was to treat facts that are accessible to observation and not to get into idle conjectures concerning the inaccession internal questions of being ...” [172, p. 78]. As we can see, in the “scientific circles” adhering to positivism, the position in which the popular economists took pride became dominant. To be sure, Kotarbin’skii also notes that “we are turning out to be witnesses of a certain return to this con-

cept, which a half century ago was still quite unpopular in scientific circles" [172, p. 72]. (He wrote the article in 1956.)

5. E. K. Voishvillo notes that Mill discarded "real essence" altogether and stated directly, "referring to the authority of Locke, that the essence of classes are the significances of their names" [64, p. 144].

6. Here and later on we shall mean by "sensationalism" its empirical, Lockean form, which we shall call classical or one-sided sensationalism, to distinguish it from the form in which it has been adopted in the Marxist-Leninist theory of cognition.

7. Discussing the comparative significance of the different conditions for the application of visuality for students' mastery of the school curriculum and for their mental development, I. F. Svadkovskii has noted the following: "All of the advantages are on the side of the natural situation, on the side of nature" [3 1, p. 5].

8. The "purity" of this tendency is violated in the upper grades, where the students receive knowledge that is borrowed from scientific disciplines. But this is done, so to speak, "with preliminary permission," without a theoretically adjusted refraction in psychology and didactics.

9. A book by D. N. BogoyavIenskii and N. A. Menchinskaya notes the pendence of mastery of new instructional material, *above all,* on the correspondence of its content to a student's experience [41, p. 96].

10. There is a detailed consideration of this question in Chapter 7.

11. The French mathematician and educator A. Lichnerowiez describes the features of the reconstruction of mathematical concepts having, incidentally, a direct relationship to teaching methods, as follows: "By virtue of the very generality of mathematics the understanding of the rudimentary concepts and theorems is subjected to inevitable and complete revision. What was the initial stage on the way to searches is converted into a simple exercise in new points of view" [197, p. 56].

12. In recent years there has been considerable work towards significantly improving instructional curricula in our schools. Important changes, reflecting certain features of modem scientific knowledge, have been introduced into them. However, in our view, the basic methods of curriculum design have stayed the same.

13. The facts about the retention, in protogenic form, of the content of early periods in the formation of the sciences are noted in modem school subjects, which at times leads to paradoxical results. Thus, N. Ya. Vilenkin writes, concerning the question of school mathematics problems: "Many problems that are now solved in the primary grades have come down to our times from antiquity. They are differentiated from the problems solved in Babylonian schools only in external form, not in mathematical content... . An *excessive enthusiasm* for *arithmetic leads to a poor knowledge of mathematics"* [6 1, p. 19].

14. A. Lichnerowicz writes on this subject: "We need ... to achieve a kind of teaching which would be closer to the life of our science from the very start.... I do not think that we must construct teaching on an historical plane in order to achieve this goal" [197, p. 55].

15. A critical analysis of the empirico-pragmatic principle of delineating the content of elementary instruction has been made, for example, in works by D. B. El'konin [4771, [4791, L. V. Zankov [120a], and in our works [4251, [435].

16. Some problems that arise in this process and the basic directions of their development are analyzed in Chapter 8.

17. L. Tondl' correctly writes that "the empirical theory of abstraction proceeds from the proposition that the attributes of objects can be compared with one another. Comparison in general plays an important role in this theory, although it is indubitably a question of an indefinite and unclear operation" [304, p. 132].

18. D. N. BogoyavIenskii and N. A. Menchinskaya approvingly cite K. D. Ushinskii's thesis to the effect that "comparison is the basis for any understanding and thought" (cited in the book by these authors [41, p. 102]). At the same time they advance the following general thesis: "Thus, comparison functions as a *mandatory condition* for *any* abstraction and *any* generalization" [41, p. 103] (emphasis ours – V. D.) This conclusion, which ensues from the empirical theory of thought, demonstrates the absolutization of the role of comparison in mental activity.

19. Analyzing die internal limitations of the formal-logic theory of generalization that comes from Locke, I. S. Narskii especially indicates the following circumstance: "Forming the general by first singling out identical attributes does not assure the revelation of the principles of development, for the principles as such are not reducible to what is observable in sensory form, but the attributes of a purely external property can rum out to be identical" [217, p. 52].

20. A. N. Leont'ev regards the possibility of externalizing certain operations, of transmitting their execution to machines, as an index of these operations' formalization: "... The content of human activity that can be formalized is capable of being externalized, of being 'exfoliated' from the activity, and being done by machines" [191, p. 55].

21. The question of the functions of a concept in the content-based movement of thought is treated in a special paper by us [422] (see also the analysis of this problem in V S. Shvyrev's book [332, pp. 127-132], etc.).

22. Here Hegel had in mind not *any abstraction* but the one that interested traditional formal logic ("rational abstraction"). This is how he described the "general" that underlies such abstraction: ---Thegeneral is a barren definition; everyone knows the general but does not know it as an essence" (cited in [17, p. 2411).

23. Hegel's description of this kind of abstraction is interesting up to this point; let us cite it from Lenin's extracts in *Philosophical Notebooks:* "Abstraction takes on ... the sense that a certain attribute is removed from the concrete for our *subjective use* alone, so that, even with the omission of so many other qualities and properties of the object, it loses nothing of its value or its merit; ... and, according to this view, only the *infirmity* of reason leads to the impossibility of its absorbing all of these riches and having to be content with barren abstraction" (cited in [17, pp. 151-1521).

Notes to Chapter 4

1. "A word is an internal, constructive unity of lexical and grammatical significances" [62, p. 15].

2. "Grammatical meanings have a certain independence and thereby countervail (sometimes contradict directly) the lexical meanings, although they are inconceivable without the latter" [116, pp. 14 -15].

3. *Translator's Note:* This confusion would occur more readily in Russian as the ending for the infinitive, -t', can also be a noun ending.

4. Confusion of categories also occurs because children have stated morphological questions improperly. But the latter itself occurs because words designating visual facts stimulate the children to state semantic questions rather than morphological ones [116, pp. 171-172].

5. The definition of a *subject* in the school textbooks includes elements both of form (the subject answers the questions *Who?* and *What?)* and of content (it shows *whom* or *what* the sentence is discussing).

6. Similar data have been obtained in a study by T. V Fomicheva [318], to indicate that for many students in grades 3 and 4 the form of a word did not play an essential role. They oriented themselves primarily to the lexical meaning of words, and therefore took competing words to be the subject and predicate.

7. Above we have cited data to the effect that younger students are poor at differentiating words as linguistic phenomena from facts in reality -and yet such a distinction is the basis of grammar.

8. We have cited the appropriate facts above. Let us merely add that these features are found most clearly, in particular, when students are unable to rely on grammar in written discourse.

9. A system of appropriate facts connected with syntax is contained in A. M. Orlova's work [233] and in works by other authors (we have cited them above, in part).

10. ".. With the traditional organization of the pedagogical process," S. F. Zhuikov writes, "at the initial stage in the study of language, when the students are actually encountering the need to pass from a practical use of the means of language to their analysis, to master grammatical operations and concepts, special work on forming these operations and concepts is not done" [116, p. 292].

11. “The differentiation and correlation of the two aspects of a word (the content aspect and the formal).” S. F. Zhuikov notes in summarizing his investigative data, “is not usually the object of attention for either teachers or students. And this gives rise to difficulties in mastering other grammatical operations and certain concepts” [116, p. 280].

12. This feature is expressed clearly, for example, in the following thesis of Zhuikov’s: “Students need abstraction of certain attributes of a certain part of speech in order to apply grammatical concepts in the analysis of verbal material, especially in identifying and grouping it by definite categories” [114, p. 98].

13. Bogoyavlenskii’s views, cited above, on the need for students to form grammatical thought as cognition of the principles or the essence of language enter just this kind of pragmatic limitation of the goals of studying grammar, which is typical of the traditional methodology.

14. A. M. Orlova’s book [233, pp. 154-1551 cites a lengthy fist of grammatical concepts most often confused by students in various grades. She writes: “...The number of possibilities for confusing similar phenomena in the study of grammar and for a negative effect of such similarity on the process of learning it is very great, in general” [233, p. 155].

15. S. F. Zhuikov has given a detailed description of the difficulties experienced by students in the primary grades when differentiating between prefixes, prepositions, and adverbs. The following conclusion of his is typical: “Knowing the grammatical attributes of prepositions ... and prefixes ... might facilitate their differentiation. But these attributes are not an object of study in the primary grades under the usual organization of the education process” [117, p. 342].

16. *Translator’s Note:* In Russian the verb is *bezdeistvovat’*, which is formed from the same root as *deistvie* (“operation,” “action”).

17. To identify linguistic phenomena properly, avoiding “provocations” either from the standpoint of the object meaning of a word or its external form, one must be guided by knowing the meaning of a *morpheme* as a grammatical category (see, for example, D. N. Bogoyavlenskii [39, p. 1291).

18. One of the basic defects in the textbooks that have been adopted, in the opinion of A. M. Orlova and D. N. BogoyavIenskii, is an extremely monotonous selection of the verbal material, seldom confronting the child with the need to analyze “unexpected,” “unique” linguistic phenomena [233, pp. 167, 207],[39, p. 129].

19. S. F. Zhuikov, as was noted above, has shown that students in the primary grades do not use the *system* of grammatical attributes of parts of speech as an indicator of those parts of speech. A. M. Orlova (see above) has described the one-sided use, by students in grades 5-8, of the *What?* question in determining the subject (the noun’s case was ignored here). This fact also indicates the absence of an orientation to the system of attributes. Only one indicator-the question-was practically sufficient for working with basic instructional material. Clearly, the students must be confronted with particular instructional problems presupposing a theoretical analysis of language, during which use of an integral system of attributes is objectively required.

20. In instructional material the child perceives, not particular examples and *models* of grammatical connections, but merely combinations of letters or sounds that are subject to the same connection and disconnection. In other words, the same approach to linguistic phenomena as to any other things is detected here. But is a real understanding of grammar possible with such a precondition?

21. S. F. Zhuikov makes special note of the feature that students’ ordinary instructional vocabulary is basically oriented toward designating visually perceived objects and phenomena [116, pp. 149-150, 279]. The following recommendation is given in one prevalent methods manual in Russian: “In the study of parts of speech-the noun, the adjective, the verb-pictures of objects, pictures with a theme, and landscapes can also be a valuable visual aid” [149, p. 326].

22. This sort of description of lexical visuality does not rule out the need for grammatical concepts to rely on *sensory* elements of linguistic “matter” (phonetic and literal) – that is, on a distinctive *linguistic visuality*, in Bogoyavlenskii’s terminology [38, p. 94].

23. Extensive materials for this topic can be drawn from many works especially devoted to problems in the mastery of mathematics in school (see, for example, [110], [1741, [207], [209]. [323], [382], [355], [373], [403], etc.).

24. We are not talking about brain teasers requiring special ingenuity, inventiveness, and a breakthrough in one's habitual views about a situation, but about problems that are close to ones that have already been solved, but whose features do not allow them to be attributed precisely to a certain familiar type.

25. The author of the study points out that the differences between the numbers 81 and 59, 73 and 56 are statistically reliable.

26. The problem "A notebook is 4 times as expensive as a pencil. A pencil is 30 kopeks cheaper than a notebook. How much do the notebook and the pencil cost each?" will take on the form: "We have to find the number that is 4 times as large as the given number and 30 more than the given number."

27. As N. A. Menchinskaya notes, the need to use the "technique of abstracting" in mathematics teaching is recognized by practicing teachers [207, p. 360]. In particular, A. N. Bogolyubov has done some work in this area [36].

28. With respect to the sphere of arithmetic, N. A. Menchinskaya and M. I. Moro write the following: "A *necessary condition for the students' formation of proper generalizations is the variation (change) of the nonessential attributes ... while preserving the essential ones as constant, unchanged"* [209, p. 24].

29. For the time being we are merely ascertaining the impropriety of absolutizing empirical generalization. At the same time the different types of generalization and the place occupied among them by generalizations of a theoretical nature must be given special consideration. In particular, it is important to correlate generalization of this type with that delineated by V. A. Krutetskii and other authors and called generalization "on the spot" (This question will be treated in Chapters 7 and 8.).

30. In his work Krutetskii relies on the results of his own research and on materials from other psychologists who have observed significant differences in the number of exercises students need for generalization to occur. Thus, in the formation of the concept of a solution of a certain type of physics problem, this number will fluctuate between 2 and 88 *for different students* [1481; during the formation of an algorithm for solving certain mathematics problems – between 1 and 22 [2051; during the formation of a generalized method of solving arithmetic problems of a given type-between 2 and 19 [209].

31. This concerns students with a *relative* incapacity for learning mathematics (studying it comes to them with considerable difficulty, despite their diligence and zeal). Students who are average in ability spend much time and effort in order to work successfully, experiencing their greatest difficulties in problems of a new type (for the criteria for delineating these groups, see [174, pp. 175-1791).

32. These tests still involved complications related to introducing special assignments on differentiating the formula for the square of a sum from other formulas, as well as variant assignments, but here we are indicating only the pivotal scheme for the methodology.

33. An interesting problem involves ascertaining the nature of the capacity for "on the spot" generalization itself. It is given special consideration in Krutetskii's book [174, pp. 262-263 and elsewhere]. We shall return to an analysis of it in Chapter 7, where we shall be describing in detail the features of this kind of generalization. For the time being, however, it is important for us merely to delineate and compare the different types of generalization observed in students.

34. Similar facts indicating the sixth graders' difficulties in operating with letter data are contained, for example, in a work by V A. Aleksandrov [19].

35. Up to now the well-known descriptions of "on the spot" generalization have concerned problems in physics and mathematics. Theoretically, it can be presumed that it is also possible with other material (here certain experimental data have already been obtained [441a]). At the same time it should be borne in mind that some theoretical approaches to the analysis of the mechanisms of this method of generalization have already been outlined in the general psychology of thought (see Chapter 6).

36. Recently another textbook [2151 is being introduced, but the method of becoming familiar with number has remained the same in principle here.

37. A description of the mathematical experience of children who are entering school is cited, for example, in the work by Ya. F. Chekmarev [324].

38. "... School tradition," A. I. Markushevich writes, "takes from all of the rich mathematical experience that the child brings to school with him only what pertains to counting and elementary geometric figures..." [203, p. 29].

39. The first graders with whom the work was done almost a month later had already moved on to doing the *multiplication* operation.

40. In this instance we mean of an altogether independent, error-free execution of the assignments. But correction of mistakes with help from the investigator (the second group of subjects) occurred when there were any instructive influences from him.

41. We note that the requirement to "give one" followed obtaining the number "5" by the subjects themselves and was accompanied by an emphasis that "one of *these* five" was to be given away.

42. In auxiliary tests of the state of counting in several other first grades (end of the school year), data analogous to those described were obtained (but a fluctuation in the number of children that were "amenable" or "not amenable" to help from the investigator was observed). As a study by E. V. Agiyants has shown [407], first graders working on the new textbook [215] show the same basic defects in the concept of number that we have indicated above.

43. Similar features in the historical knowledge of students in the primary grades are described in detail in a work by L. M. Kodyukova [162].

44. Red'ko attributes these stages in the mastery of historic concepts to the concrete conditions in which the investigation was done. The sequence of mastery, in his opinion, can be different when there is a more highly perfected teaching methodology [268, p. 112]. In our opinion, the materials obtained reflect the typical picture.

45. All of this, of course, does not rule out the students' familiarity with the particular prerequisites of scientific concepts properly speaking (for example, formations) that have an increasing effect on the character of knowledge from grade to grade (see, for example, [268, p. 1081, etc.). It should also be kept in mind that in the very selection of educational material, in determining its orientation, the authors of textbooks and aids are guided by certain scientific considerations (for example, an exposition of information that in one way or another indicates modes of production and production relationships stands out in our textbooks).

Notes to Chapter 5

1. The descriptive nature of many of the facts conveyed to students in different countries in courses in mathematics, grammar, biology, etc., has been noted repeatedly by authors of a number of foreign studies (see, for example, [258], [403], etc.). The American psychologist J. Bruner calls attention to this circumstance in one of his recent works [366].

2. In our theoretical analysis we are using some of Hegel's statements on problems of abstraction, generalization, and levels of thought. It is known that the classic exponents of Marxism-Leninism placed a high value on Hegel's dialectical approach to logical problems. Unfortunately, many profound ideas that exist in Hegelian dialectics have not been perceived to a proper degree by psychology and didactics in their treatment of the processes of forming human intellectual activity-we believe that a return to Hegel's opinions will be useful in developing contemporary issues concerning the connection between instruction and the person's mental development.

3. "This identity is what most immediately conditions the transition from one definition to another in cognition.... In geometry, according to this, figures are compared with one another by giving prominence to what is identical in them" [79, p. 131].

4. By a "definition" Hegel means an isolated and fixed property of an object or of its condition, not merely a formal definition consisting, for example, of an indication of the genus and of the specific difference.

5. The general problem of correlating "intellect" and "empirical thought" is not treated here. The former apparently has a broader application than the realm that is designated by "empirical

thought" does. But it has the basic features of rational activity and does not extend beyond those limits.

6. Our psychologists, didacticians, and methodologists take dialectics to be a general method of scientific cognition and use it in their research. The problem is to interpret and express the principles of dialectical thought in the "technique" of developing instructional material, in methods of forming students' concepts, and in means of organizing their own mental activity.

7. This work treats the theoretical aims of traditional educational psychology and didactics on the problems of concept formation, on the whole. Although Chapter 4 is especially devoted to certain practical results of instruction based on these aims, this aspect of the problem still requires further detailed investigation.

8. Numerous assertions to this effect can be found in the works of Jean Piaget and his associates [245], [247]. [397].

Notes to Chapter 6

1. The works of R P. Blonskii have played a considerable part in the development of Soviet psychology of thought. As an analysis of his fundamental work in this area shows [35], he himself adhered to the positions of the empirical theory of generalization. This research has collected and described a wealth of material to characterize the actual peculiarities of children's rational-empirical thinking.

2. The methodology and experimental data from these studies are set forth in detail in the works by Vygotskii and his associates [651, [66], [342]. Here we shed some light primarily on the theoretical aspect of the matter, with a minimal exposition of empirical materials.

3. An expression of Hegel's, which pointed out a similar circumstance in vivid form, is well known: "... A moral dictum from the lips of a youth, even though he has understood it altogether correctly, is devoid of the significance and scope that it has for the mind of a mature man whom life has made wise, who expresses in it all of the force of the content that is inherent in it." V I. Lenin valued this idea of Hegel's highly: "A good comparison (a materialist one)" [17, p. 90].

4. Here Vygotskii did not at all detract from the role of object reference in all forms of generalization. Thus, he particularly stressed its role in the materialist explanation of a concept: "What is most essential for a concept is its attribution to reality..." [65, p. 149].

5. It should be emphasized that it was the careful study of these different processes that allowed Vygotskii to establish the identity of their objective content.

6. Here Vygotskii constantly emphasized the fact that a new type of generalization arises on the basis of a "lower" one and remains in a constant interrelationship with it (in particular, scientific concepts arise by virtue of the foundation laid by the everyday ones).

7. Vygotskii categorically objected to reducing the qualitative features of the mind to certain "common denominators." Thus, he saw a major defect in Gestalt psychology in its erasure. through its own "structural denominator," of any boundaries between "thought in its best forms and the most elementary perception" 165, p. 328].

8. Zh. I. Shif writes: "The concepts children acquire in school ... we agree to call 'scientific'..." [342, p. 33].

9. Recently attempts are again being made to characterize movement to a concept "from the word" as a distinctive method of mastery [145]. There is a distinctive quality here since, in principle, all concepts specified in school are taken by the children in that content which is already *determined* by the teacher (more broadly-by the instructional subject). But this still says nothing about the type of such concepts.

10. "The thought process is above all *analyzing* and *synthesizing* ... ; this, then, is abstraction and generalization, which are derivatives of them. The principles governing these processes in their interrelationships with one another are the *basic internal principles of thought*..." [278, p. 28].

11. The movement of thought, taken as a whole, takes the route from unanalyzed concrete reality that is given in direct sensory contemplation to the revelation of its laws in concepts of abstract thought and from them to explanation of reality..." [277, p. 109].

12. “... It is just in this way-by the inclusion of the epistemological, cognitive relationship to being in its definition, in the internal characteristics of the mental-that the subjectivist interpretation of the mental is overcome” [277, p. 172].

13. “... The theory of generalization by means of comparison.. is at best the theory of elementary sensory generalization, which does not go beyond the limits of the sensory and does not lead to abstract concepts, rather than being a general theory of generalization, including its higher scientific forms” [277, p. 141].

14. “*Generalization is* a necessary prerequisite of *theoretical* cognition. Solving a problem theoretically means solving it not only for a given particular case, but for all homogeneous cases as well” [277, p. 153].

15. “...Scientific abstraction, which characterizes abstract scientific thought, is not an act of the subjective will. Scientific abstraction is objectively conditioned” [277, p. 140).

16. Rubinshtein writes: “One can ... distinguish between the different levels of thought in relation to how high the level of its generalization is, how profoundly it passes from phenomenon to essence, at the same time... . Such different levels of thought ... are visual thought in its elementary forms and abstract, theoretical thought” [276, p. 362].

17. Rubinshtein has made a direct connection between the notion of an empirical generalization and the point of view of *traditional* psychological theory, “which has depended on formal logic.... From this standpoint the general is received, properly speaking, merely as a repeating individual element. Such a generalization clearly cannot exceed the limits of sensory isolation and therefore does not disclose the genuine essence of the process that leads to abstract concepts” [276, p. 356].

18. But in a number of cases Rubinshtein connects the “theoretical nature” of thought with certain *methods* of activity in problem solving (a theoretical solution is a solution to a problem for *all* homogeneous cases [277, p. 153], and so on). In speaking of the emergence of theoretical activity, he stresses the significance in this process of the method of the activity (analysis) and the content (essence), rather than the external means of establishing them, rather than words; “Singling out cognitive activity from practical activity is related to the emergence of generalization as a result of analysis, which singles out the properties that are essential for a problem” [278, p. 64].

19. The development and refinement of theoretical theses are an altogether legitimate process in the scientist’s activity. Here we are comparing Rubinshtein’s approach to thought, as expressed in the *Fundamentals,* with his later theses because, for the present, it is the *Fundamentals* that is having the greatest effect of our psychology (particularly child psychology and educational psychology) in interpreting the nature of thought.

20. Rubinshtein writes: “A conception, a visual image, expresses primarily the individual, and a concept expresses the general. They reflect different but necessarily interconnected aspects of reality” [276, p. 359]. Hence it is clear that the reflection of these “interconnected aspects” in thought presupposes an “interconnection between concept and conception” – conceptions are internally combined with concepts. This nature of the mental process serves as a basis for the well-known didactic principle of visuality [276, p. 359]. At the same time, in the book *Being and* Consciousness [Bytie i *soznanie*] Rubinshtein formulates another thesis, according to which *general properties* come to be known by sensation and perception, “but only in thought does the general function as such-in its relationship to the particular” [277, p. 104]. In this thesis the relationship (connection) between general and particular is legitimately perceived as the content of thought properly speaking and, consequently, of a concept.

21. In one of his recent works Rubinshtein has written the following: Skill in *singling out the essential is, in general, a basic attribute of the mind”* [278, p. 40]. But the “essential” is singled out by analysis and abstraction, which yield a *“theoretical* generalization” – it also proved to be a “basic attribute of the mind” in general.

22. It is noteworthy that Rubinshtein directly notes the possibility of the existence of a *concept in an* operation-the basis, the “root and prototype” of a concept proper as a conscious generalization [276, p. 356]. The term “consciousness” is vague, but in principle it is legitimate to say that a “concept in an operation” is a prototype of a concept that has *symbolic* form.

23. ‘Re essential by no means always functions as the general in the sense of the similar, and the similar is by no means always an indicator of the essential. In this matter Rubinshtein – in our opinion-has not carried his analysis to its logical conclusion.

24. Thus, Rubinshtein writes: “Including a given element (object) in new connections in which its new properties are revealed, and especially the definition or description of these newly revealed aspects of an object by a new concept, is the actualization of knowledge” [279, p. 82].

25. Rubinshtein writes: The relation of psychology to logic and cognitive theory, to philosophy, shows up distinctly in the history of psychological teachings about thought. Thus, associationist psychology proceeded from the standpoint of English empiricism.... Our Soviet psychology of thought proceeds from dialectical logic, from materialist dialectics” [276, p. 343].

26. The psychological literature currently contains some serious works in which both the experimental data of Piaget’s school and his theoretical positions are set forth

and analyzed (see, for example, [751, [188]. [223], [3161, etc.). We are considering only those aspects of his theory that are connected with problems of concept formation in children.

27. Piaget notes especially that empiricism and positivism in psychology are related to acknowledging an object only as independent of the subject’s actions [244, p. 43].

28. As Flavell notes, for Piaget reversibility is “the core of cognition, which is formed into a system, a property, with respect to which all of the rest are derivatives” [316, pp. 252-253].

29. For example, the formation of such a logical structure as classification, which contains the inclusion of a part in the whole, presupposes an algebraic structure, according to Piaget [243, p. 18].

30. The development of *seriation* as a logical structure is a process of the child’s “discovering” the type of relationships that underlies an order structure.

31. We shall return to the matter of the sources of coincidence between mathematical structures and operator structures of thought somewhat later on.

32. The investigator first establishes that the child has a good understanding of the following fact: All of the brown beads are wooden, but not all wooden beads are brown (there are some white ones).

33. Piaget notes: “The psychology of associations regarded a mental image as an extension of perception and as an element in an idea, but thought is ostensibly included in the ‘association of images’ with one another and with perception” [244, p. 39].

34. This circumstance clearly functions in a comparison, for example, of the following two statements by Piaget: “Mind is disclosed, in essence, as a coordination of actions” [243, p. 14], and “ ... Mathematics ... is not an abstraction of physical experience but [is V.D.] an abstraction of general coordinations of an action...” [244, p. 51].

35. For example, the well-known physicist M. Born writes: “. _Invariants are concepts in which natural science speaks in the same way as one speaks in ordinary language about ‘things,’ and on which it confers names just as if these were ordinary things” [44, p. 283].

36. Hegel notes: “The vantage point of essence is the vantage point of reflection. We reflect about an object, or (as is usually said) we *meditate* about it, since it is here that we do not recognize the object in its immediacy-we wish to come to know it as mediated” [79, p. 192].

37. We recall that this is the source of an important distinction between the essentially general and any other formal generality that is singled out by comparison.

38. “In all forms of thought used by modem science,” P. V. Kopnin writes, “die intellect and reason act in unison” [168, p. 73].

39. “... To some extent the intellect’s reflection of reality is lifeless. ‘Re main function of intellect is to break down and to calculate.... F. Engels has noticed a very important feature of intellectual thought – operation according to a rigorously specified scheme, a pattern.... This feature can be designated ‘automatism of reason- [168, pp. 69-70].

40. “The most vividly characteristic feature of man’s intellectual thought are expressed in so-called ‘machine’ thinking, where reason’s automatism is reduced to a nature and classical form” [168, p. 70].

41. “Every form [of thought – V. D.] is intellectual in the respect that it has its own rigorous structure and allows within itself movement according to certain formal rules” [168, p. 73].

42. Mathematical logic, as a branch of mathematics, investigates the mathematical methods that assist in studying certain questions in “philosophical logic,” Kh. Karri notes, for example [153, pp. 17-18]. Mathematical logic is related to the analysis of thought in the same way as geometry is related to the science of space, but geometry, as we know, is not the only discipline that studies space (there is physics as well) [153, p. 18].

43. At present a tendency for mathematics as a subject to “reach” beyond the limits of spatial and quantitative relationships is being noted; it is presumed that it is dealing with certain structures that express explicitly *qualitative* features of reality (Piaget also adheres to this position). Such a tendency is entirely legitimate when it is a question of the one sided conception of quantity as a “number” and a “figure,” which classical mathematics violated. The dialectical tradition in philosophy has always taken the position that quantity and quality occur in indissoluble unity, “turning” around one another, that quantitative relationships have a very rich *qualitative* distinctiveness, which can be established by concepts of appropriate structures. But in any concrete extension of the subject of mathematics, its chief category remains the *quantitative* determinacy of qualifies of matter expressed in the forms of their space-time diversity (see a detailed analysis of this problem in E. V. Il’enkov’s article [137]).

44. J. Flavell writes: “Piaget’s system not only does not encompass the development of cognition through the entire life cycle-it clearly also does not cope at all with the entire totality of phenomena from birth to maturity which might be called ‘cognition”‘ [316, p. 571].

45. In analyzing Piaget’s works, Gal’perin and El’konin note that the “transition itself to a mental plane and the optimal organization of intellectual action on this plane fall out of this investigation” [75, p. 607].

46. As we have shown in the last section of Chapter 4, the concept of number functions, for Piaget, as a synthesis of classification and seriation. But here he does not indicate the real action of the child *himself*, by means of which this synthesis can occur. Consequently, the transition to number is characterized merely as a formal, self-actualizing synthesis (“coordination”) of structures. This is a particular example of Piaget’s general approach to this problem.

47. Gal’perin and El’konin legitimately point out that in Piaget’s works the basic question concerning “why the child begins to take into account that which he did not formerly take into account ... and why he is no longer satisfied with an explanation which formerly satisfied him completely” [75, p. 604] is solved unsatisfactorily.

Notes to Chapter 7

1. “Up to now all psychological teachings about thought (and the methodologies based on them) treat its structure and content extra-historically. Experimental assignments, tests, and interviews are designed with a view toward thought ‘in general.’ The historical character of the category system and of programs for intellectual activity are not taken into account” [361, p. 127].

2. “For a person’s intention or purpose to be embodied in a real product, the actions should conform to the nature of the objects, conditions, and tools of activity. Constructive activity is also a condition and method of deepened cognition of the surrounding world: by acting on objects, correlating them with one another, the person comes to know their properties” [24, p. 79].

3. “‘My activity’ with an object functions as a form of *self-motion* of the object, and revolves according to laws independent of my will” [34, p. 193].

4. “An internal connection is realized only in motion” [221, p. 251].

5. “Labor by means of tools puts the person, not in direct confrontation with material objects, but in confrontation with their interaction, which he himself creates, reproduces, and monitors. In this process the person also comes to know them” [191, p. 90].

6. “... The measure of a thing, which in ‘natural’ form-that is, in nature in and of itself-never functions in a pure expression, in all of its ‘placidity,’...; it is detected only as a result of a person’s activity, in the crucible of civilization-that is, in ‘artificially created’ nature” 1141, pp. 261-262].

7. ".. Since in principle man can make everything the object of his labor, he produces universally ..." [170, p. 142].

8. S. L. Rubinshtein writes: "Man as subject should be led inside, into the structure of the real, and the problem of the knowability of the real and of the knower happens within him.... The problem of relating man to being as a whole includes a relationship to man, to people, since it includes both things and subjects, people's personalities" [28 1, p. 351].

9. "Man in his practical experience singles out his own form and measure of a thing and is oriented toward it in his activity" [141, p. 261].

10. "... Social being is impossible without (social) consciousness. Consciousness is not art external adjunct," S. L. Rubinshtein writes [281, p. 361]. "... The ideal exists as the opposite of the material. But not in the form of particular things-rather as a feature in the actual interaction between subject and object, a form of the subject's activity"[170, p. 158].

11. Likhtenberg has wittily observed: "To see the new, one should do something new" [198, p. 59].

12. S. L. Rubinshtein notes: All of the inner content and structure of the perception of things carries the imprint of the fact that these things are the objects ... of activity.. ." [277, p. 98].

13. "The basic, generalized, and stabilized significance of a thing, which it acquires in a system of community practice, is established by the word' [277, p. 100].

14. ". ..There arises a specifically human form of contemplation-the ability to see everything that, for me personally, as such, is of absolutely no mercenary interest but is very important and interesting from the standpoint of the combined interest of all other people, their common development, from the standpoint of the interests of the species" [141, p. 241].

15. G. A. Kursanov writes: "Only the objective properties of objects become necessary for these purposes-that is, objective, not only in the sense of their independence of man in their very existence, but also in the sense of their objective significance for human beings' social practice, independently of the subjective will or the random selection of certain properties by a particular person" [179, p. 29].

16. "Man functions secondarily as a subject of cognition, of social theoretical conscious activity; primarily he is the subject of actions, of practical activity" [281, p. 365]. "For a thing to function for human consciousness, it should function as an *object of activity"* 103, p. 307].

17. ". . Internal, mental activity is not only a derivative of external, practical activity-it has fundamentally the same structure as practical activity," A. N. Leont'ev writes [191, p. 93].

18. V. I. Lenin copied out and gave a positive evaluation ("Very true and important...") of the following passages from Hegel: "... They (natural scientists – V. D.) unconsciously transform what is directly seen with the aid of a concept.... This is how it occurs with any verbal expression of perception and experience; since man talks, a concept is contained in his words ...!" [17, p. 236].

19. "A scientist's activity as embodied in real experimentation, in material actions, in devices, in artificially created situations, in organizing testing procedures, etc., here should take the form of mental experimentation, which is expressed in different sorts of abstractions, assumptions, abstract illustrations, in selecting material for observation, etc., and all of these mental actions should be substantiated by deductions, references to practical needs and empirical data" [125, pp. 259-260].

20. "... Every essence is a *rule* for reproducing an object, or, expressed in Hegel's language, a *measure*" [45. p. 35].

21. Lenin noted the following thesis of Hegel's as *true: To* understand it [motion – V. D.] means to express its essence in concept form." Copying down this statement, Lenin repeats it, but this time in generalized form: "To understand means to express in concept form" [17, p. 231]. This statement, in our opinion, keeps its point completely in the following formulation, too: To express an object in concept form means to understand its essence.

22. It is not difficult to notice that Spinoza's example of the definition of a circle has the same point as the aforementioned example of Engels's on proving the causal connection between the solar rays and heat through a practical action using an implement such as a curved glass. In both

instances the universal, necessary character of the event is proved by its real reproduction or construction in object-related activity.

23. According to the Kantian doctrine, Yu. M. Borodai writes, “every object-related, universal concept is not merely a phantom – it is a schema (method) of producing and reproducing an object” [45, p. 100].

24. Kant has the following description of the schema for the concept of a dog: “The concept of a dog designates a rule according to which my imagination can draw a four-legged animal in general form without being confined to any individual, particular aspect given to me in experience, or to any possible image whatsoever *in concreto*” [151, p. 223].

25. “The *theoretical*, in the proper sense of the word,” I. B. Mikhailova writes, “is the state of knowledge in which an object is given in its historical formation as an integrity whose level of self-development is determined causally by all of its particular manifestations, features, and qualities” [214, p. 27].

26. N. N. Semenov notes;”... The revolutionizing role of experimentation was able to be accomplished only when it was inseparably connected with the development of theoretical thought” [287, p. 52].

27. “Human experience in general, in the sense of man’s immediate, sensory-experiential contact with the environment, has proved to be sufficiently ‘theoretical’ – that is, constantly directed by the logical structure of the forms of common human activity, of which a preposition of purpose is a highly essential feature” [214, p. 25].

28. “The logical form of theoretical knowledge, its construction, is an expression of the nature of the object, which is understood not only as being but also as an internally reflected object, as essence” [221, p. 252]. In other words, theory does not leave out “being;” it considers both its existence *and* its essence.

29. “Experimentation can be defined as the reproduction of phenomena in man’s practical experience for the purpose of coming to know them scientifically,” R V. Kopnin writes [169, p. 245].

30. According to the ideas of some logicians, signs perform a special role in constructing an idealized object. This object functions as a hierarchical system of substitutions of an object by signs included in certain operating conditions. These substitution systems really exist as entities of a particular kind [196], [2731, [274].

31. Therefore the sensory-object experimentation of the ancient Greeks of course had features that were not observed in the experimentation, say, of the science of more recent times, when the forms of theoretical thought developed substantially and changed, and, most importantly, were particularized.

32. “... The empirical and the theoretical levels of scientific knowledge and scientific (cognitive) activity are divided, not according to object (sensorially-perceived and idealized objects), but according to the method of its logical reconstruction in the forms of societal establishment of the methods of activity, *according to the method of movement of thought in any of its objects”* [214, p. 26].

33. Here it should be taken into account that theoretical work relies on *symbols* as a means of expressing the content of things. But the use of symbols with their meaning preserved means correlating their significance with the connections of the *entire* system. E. V. Il’enkov writes as follows about this: “. . The significance [of a symbol – V. D.] still remains outside its immediately perceived aspect, in different sensorially perceived things, and is detected only through the entire system of relationships between other things and the given thing or the other way around-between the given thing and all

others” [136, p. 224]. Clearly, tracing the -entire system of relationships” is a long and highly intricate process, which, in principle, is not *represented by* sensory images.

34. A similar point of view is typically presented in philosophy, as well as in psychology and didactics (see, for example, the argumentation related to this position in O. A. Ladorenko’s article [181]. At the same time this position, which was formulated as long ago as ancient times, when the philosophy of empiricism was active, should not be confused with the tendency to-

ward modeling of objects, toward a visual-object representation of hidden processes. Modeling is a special means of symbolizing concepts in theoretical-scientific thinking.

35. In discussing the question of the processing of sensory data in thought and describing the transition from them to theory, V. S. Shvyrev notes altogether correctly: “This transition is precisely the discovery of qualitatively new types of reality, the isolation of a fundamentally new type of content, rather than simply a combinatorics and summation of knowledge at the same level of content” [332, p. 199].

36. Here the reference is to the speed of light as the maximum speed of any possible motion.

37. This fact has an importance for the construction of school subjects corresponding to the contemporary level of scientific knowledge.

38. In some instances abstract and concrete knowledge are described in this way, for instance: “... The former,” A. A. Zinov’ev writes, “is obtained and is true under conditions of an abstraction from some connections between a given object and other objects having significance in the study of the given object, and the latter-on conditions of enlisting these connections” [125, p. 261]. In our opinion, this description coincides, in principle, with those cited in the text, since abstract knowledge can be true only when its object remains a real object, even if “extracted” or “removed” from certain connections – that is, it has relative independence from these connections.

39. Lenin copied down the following statement of Hegel’s: “Thus, law is an essential relationship” – and repeatedly notes the following as important in parentheses: “Law is a relationship”[17, p. 138].

40. “An explanation from a single beginning of all aspects of an object under investigation, their representation in a natural interconnection and interdependency, is none other than cognition of the essence of that object” [32, p. 293].

41. The role of imagination in the processes of theoretical thought was noticed long ago. Recently this question has again come to be the subject of special development and discussion [25], [48], [141].

42. Hegel has particularly stressed the role of such images of vital contemplation in scientific investigation: “The talented historian, for example, has before him in vital contemplation a *whole of* states and events that are subject to his description; on the contrary, the person who has no talent for representing history lingers over particulars, and behind them the substantial is let out of sight” [80, p. 251].

43. “The general which is not synthesized with the unitary and the particular ... is not the essence of these unitary phenomena; it is not the unity of the general and the diversified” [271, p. 420].

44. “... Scientific generalization ... is generalization that comes to know the essence, the guiding principle of the development of things.... The general is a law, the essence of individual phenomena – that is, something qualitatively different in comparison with a simple sum of the attributes of particular things” [271, pp. 216-217].

45. In describing the role of idealization in the cognition process, for example, B. M. Kedrov writes: “This sort of idealization is completely legitimate and is none other than the generalization of experiential data for the purpose of discovering a law that is inherent in W’ [25, p. 309].

46. A criterion for the fact that analysis singles out what is general is an answer to the question whether “a particular phenomenon is ... at the same time the universal genetic base from whose development all of the other particular phenomena in the given concrete system can be understood in their necessity” [134, p. 45].

47. “The essence of things is disclosed by generalization. A concept is the result of the generalization of a mass of individual phenomena; it is the essentially general, revealed by thought in particular things or phenomena” [27 1, p. 211].

48. Concepts become the tools of cognition of a changing reality” [271 p.

237].

49. . A concept functions ... as a tool of mental activity, a means of reflection, a method of explanation...” [25, p. 33].

50. “A concept reflects the individual through an interconnection of individuals, and the form for this interconnection is the universal” [103, p. 325].

51. “A working concept always functions in the form of a theory. Only after having considered a theory attentively ... can we detect the concept that yields the real unity in the theory ...” [25, pp. 183-184].

52. “The entire process of intellectual understanding of an object’s essence,” M. I. Bakanidze writes, “... assumes the certainty of the process of a *concept”* [29, p. 88]. Describing the features of operating with the concept of motion in works on mechanics and geometry, V. S. Bibler notes: “... The concept of motion functions as a method of understanding, as a theory, as a process, and can be grasped and ‘located’ only in the process of its own operation” [25, p. 184].

53. “To understand a phenomenon means to ascertain the method of its emergence, the ‘rule’ by which this emergence is accomplished with a necessity that is laid down in a concrete aggregate of conditions ...” [134, p. 159].

54. “A concept functions as an activity, as the process of transforming an idealized object” [25, p. 51].

55. The drawing of straight lines and circles indicated by Newton can take place either on paper or mentally. But the mental operation is an image of an action with objects which is done on paper.

56. In Chapter 5 we cited A.N. Kolmogorov’s statement to the effect that ascertaining the material content of mathematical concepts is very important both for the development of science itself and for the effective teaching of it.

57. “The general exists in the form of development, of an ‘uneasy’ alternation of various particular phenomena” [271, p. 237].

58. The fact that overcoming nominalism and realism presupposes acknowledgment of the development process and of the special role of the universal in it is singled out, for

example, by Ch. Novin’skii, who writes: “Only in the sequential development of the thesis on the evolving character of all fragments of nature does dialectical materialism avoid both the restrictions of nominalism and the dangers of realism in concepts” [228, p. 71].

59. This circumstance has been singled out especially, for example, by S. L. Rubinshtein: “... Practice breaks the vicious circle that appears in the theory of empirical generalization, where it, like cognition in general, is regarded as divorced from life or practice” [277, p. 141].

60. The role of discovery of the relationships of objects in practice for subsequently delineating their general properties is noted, for example, in the following statement by D. R Gorskii: “... We operate with these objects in a practical way, we single out those of their relations to other objects that are affected in the process of our practical experience .... The general that exists between objects that have entered into a given relationship will also be the content (general property) that is being sought and abstracted by us” [95, p. 74].

61. The purpose of thoughts – A. Vallon writes – “always involves reproduction, realization, creation” [53, p. 228].

62. V. S. Shvyrev notes: “... Mental activity at the highest level permits the discovery of new, ‘hidden’ – from the standpoint of the possibilities of a lower level – aspects of an object. The form of expression of theoretical knowledge functions as a ‘model’ of the object here in the unique sense of this ... term, that actions with it permit disclosure of certain aspects of an object that cannot be disclosed by operating. .. directly with it” [332, p. 131].

63. At the same time the properties they reveal are not, of course, the products of “pure thought” – it constantly depends on sensory data, on the analysis of actually observable properties and relationships among objects.

64. This circumstance is well expressed by A. Vallon, who wrote: “Images and concept *contain one another reciprocally.* Potentially some of them occur in others. The movement of thought within them is not a *real displacement;* it is a series of *supplementary* orientations. The figurative aspect is thought’s reliance on the sensory or *material* aspect of things. The conceptual aspect is reliance of the sensory *on the principle* of things, on what goes beyond the limits of their instantaneous appearance and makes this exist” [53, p. 2281 (emphasis ours – V. D.).

Notes to Chapter 8

1. In discussing the state of the modem psychology of thought, P. Ya. Gal'perin notes:

. Up to now the chapter on thought in its theoretical part is chiefly a periphrasis of elementary logic..." [72, p. 239].

2. The history of the development of the subject of this kind of logic has been traced, for example, in E. V. Il'enkov's work [140].

3. The totality of the *pedagogical* disciplines studies the process of appropriation in its entirety. Psychology singles out and studies particular aspects of this process that are related to the origin of man's mental and intellectual functions themselves, the basic purpose of which is to *orient* him in surrounding reality on the basis of images of it.

4. Thus, K. Buhler has introduced the concept of an "anticipatory scheme" for a psychological explanation of problem solving. After treating the features of this scheme, P. Ya. Gal'perin rightly points out that its content is *logical* rather than psychological [72, p. 238].

5. The term "logical" often designates verbally or graphically formulated schemes of activity (that is, the results of an "awareness" of it). In our opinion, such an interpretation is unacceptable, since a differentiation of the subjects of the sciences occurs according to their *content* rather than the form of description.

6. In psychology certain features of the *creative* development of knowledge that do not yet have logical definitions have best observed and described. It is a problem for modem logic to attach the characteristics of universal, object-related activity to these peculiarities (see an analysis of this problem in V. S. Bibler's work [341).

7. In Gal'perin's works the transformation of "object -related action into idea, of an object-related phenomenon into a psychological phenomenon" is traced [72, p. 251].

8. "... To use to object-related action for the purposes of thought, one must know how to perform it and therefore one must learn this first" [72, p. 249].

9. M. K. Mamardashvili notes: "Since in dialectical, content-related logic, 'logical form' means the general that exists in the activity-of creating the conditions for truth and for monitoring the changes in these conditions-occurs in constant correlation with objects-therefore object-related content is involved in dialectical logic" [202, p. 95].

10. Logical analysis deals with the characteristics of categories and their connections, as well as (in particular) with the definition of types of thought related to a certain "set" of categories. To the extent that it becomes more profound before study of the structure of the individual's concrete actions, disclosing certain cognitive categories, it becomes-in our opinion – a logico-psychological analysis of the activity.

11. Unfortunately, there are still no works on Hegel's views on educational psychology; Hegel, moreover, had considerable experience in pedagogical endeavors when he held the post of director of a gymnasium. An analysis of Hegel's works shows that a number of his ideas retain an essential significance for modem psychology and pedagogy.

12. "The abstract should everywhere constitute the principle and the element in which and from which the particulars and rich images of the concrete are developed" [82, p. 271].

13. Here Hegel is finding in Aristotle the sources of the interpretation of the general as real, in a particular form of existing formation, which was then developed comprehensively in the history of dialectics and especially for Hegel himself (it is this general that is the object of comprehending, theoretical thought).

14. This idea of Il'enkov's is a good illustration of L. Lichnerowicz' remark about the nature of the teaching of classical arithmetic, which, in his words, "is a type of ludicrous worship of operations, whose hidden meaning does not depend on the numbers

on which they operate. Our students, as we receive them, believe in the existence of an addition and a multiplication that function in an absolutely infinite universe" [197, p. 55].

15. A theoretical analysis of the problem of activity is contained, for example, in L. I. Antsyferova's work [24].

16. This circumstance has been well formulated by L. I. Antsyferova: "The inner conditions are taken outside, as it were, into the products or results of the activity. It is in this quality-the ob-

jectified internal conditions-that the results of the activity are included in the subsequent determination of the person's behavior" [24, p. 80].

17. This report was made on 17 March, 1935, at the Khar'kov Scientific Research Institute of Pedagogy. With Leont'ev's permission we are citing particular statements from this report according to the verbatim record as revised by the author.

18. Shapiro writes that among mathematically capable students, "the development of generalizations occurs from the first examples, at the initial stages of learning. Transfer in the general form is almost merged in time with generalization and is actually accomplished immediately for a whole class of problems of a single type.... Among less capable students generalizations ripen gradually and are manifested at later stages or do not develop at all" [329, p. 95].

19. "...In the first four decades of our century," Bruner writes, "there were relatively few works by American psychologists on the study of the methods by which pupils can be trained in mastering the internal structure of knowledge and its significance for further activity" [47, p. 10].

20. In our opinion, Piaget's theory underestimates the significance of the principle of reflection, which is particularly manifested in its operationalist interpretation of the nature of mathematical knowledge.

21. V. S. Bibler was the first to pay special attention to the logical aspects of this forgotten methodology of teaching geometry; he gave an appropriate interpretation to it [25, pp. 78-80].

22. In the traditional system of instruction this sort of "introduction" is frequently not observed. This circumstance has been clearly expressed, for instance, in the following view by W. W. Sawyer: "Generally speaking, in the instruction process it is facts about objects rather than the vital train of thought that is being transmitted" [296, p. 7].

23. G. A. Kursanov writes: 'Ye ... would like to emphasize especially the unity of the *origin* and the *essence* of a concept-these are not isolated or independent categories in the evaluation of a concept, but are inseparably connected, and the essence of a concept is manifested in its origin, in the process of its formation as a concept, as an abstraction" [479, p. 212].

24. M. K. Mamardashvili notes: "An analysis of knowledge that is taken from the standpoint of its construction and origin-that is, from the standpoint of reflection -presupposes a study of the active nature of thought, of the subject's cognitive operations with an object [202, p. 32].

25. "The practical and theoretical unsoundness of naive associationist conceptions of instruction," A. N. Leont'ev writes, "is a result of the fact that a central link and principal condition of the learning processes is overlooked: the formation of the actions that form its real base..." [192, p. 382].

26. We have cited J. Dieudonne's statement about how long the real abstract character of mathematics is concealed when it is taught (R). And this is by no means an accidental phenomenon-the power of the traditional foundations of instruction in logical psychology is so great that up to now they have appeared to be entirely "natural" even in the teaching of mathematics, *par excellence,* which is an abstract discipline.

27. For example, in one text on didactics it is especially noted that a method of scientific cognition such as movement from the abstract to the concrete cannot be applied in the instruction process [105, p. 74].

28. "... Between the thought of the schoolchild and of the scientist," writes P. V Koprin, "there exists something in common which is stored in familiar, firmly established epistemological and psychological categories" [169, p. 14]. "... The laws of cognition in instruction," notes A. N. Shimina, "are linked very closely with the laws being established by the Marxist theory of cognition" [340, p. 125].

29. We note that Marx describes the features of investigation and exposition in the content of a general description, which he provides for the *dialectical method* of cognition [7, p. 21].

30. D. P. Gorskii writes: "The general in the cognition process can function as a primary determining fact with respect to all of the particular results of a science only on the level of an exposition of the results in the science" [97, p. 234].

31. As E. G. Yudin notes, as a result of a misunderstanding of the role of activity, "there occurs a distortion of the very meaning of instruction, which, willy-nilly, is condensed to a simple transmission of knowledge and is not regarded as an introduction to an activity" [357, p. 19].

32. A. N. Leont’ev writes: The effect of concepts, knowledge, in itself is not capable of evoking adequate actions in the child: he still has to master them.... [192, pp. 382-383].

33. “... It is the introduction to an activity that constitutes the essence and the foundation of instruction, treated in its social function” [357, p. 19].

34. E. V. Il’enkov stresses: “If an ideal image is learned by an individual only formally, only as a rigid scheme and order of operations, without an understanding of its origin and connection with authentic (not idealized) reality, the individual turns out to be incapable of treating the ideal image critically-that is, as a particular object distinct from himself” [136, p. 227].

35. A. N. Shimina notes: “The epistemological function of activity is that it immediately introduces the child to the sphere of the general, the sphere of abstraction ...” [340, p. 136].

36. A detailed description of this system of operations and of their execution by the children is contained in a series of works [410], [412], [413].

37. A detailed exposition of the results of the performance of analogous assignments by first graders is contained in G. I. Minskaya’s work [454].

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