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SCIENTIFIC AND METHODOLOGICAL FOUNDATIONS FOR FORMING CONCEPTS ABOUT NATURE IN PRIMARY EDUCATION

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Abstract

The article analyses the scientific and methodological foundations for forming primary school students' concepts about nature. It substantiates that concept formation is a consistent process comprising the stages of perception, representation, the singular concept, the general concept, and the composite concept, and shows how these stages correspond to the thinking characteristics of early school age. Particular attention is given to the risk inherent in an approach based on rote memorisation of concept definitions - the phenomenon of the pseudo-concept.

Keywords: Concept formation, natural science, primary education, perception, representation, singular concept, general concept, composite concept, pseudo-concept.

Introduction

A child acquires knowledge about nature primarily not through words but through direct perception and representation; words and definitions merely serve as a means of generalising and consolidating this experience. For this reason, how the process of forming concepts about nature is organised in primary education - whether it begins with direct observation or with memorising a ready-made



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definition - is of decisive importance for the student's entire subsequent scientific thinking.

The problem is that in practice the process of concept formation is often replaced by its final product - the definition: instead of observing a phenomenon, comparing it, and arriving at an independent conclusion, the student is required to memorise the ready-made definition given in the textbook. In such a case the student can repeat the name of the concept and its verbal definition, but because this knowledge rests on mechanical memorisation rather than genuine generalisation, it fails to work in practice as soon as the first non-standard situation arises.

The root of this problem lies in the insufficiently consistent application of the scientific and methodological stages of concept formation. Although the stage-by-stage development of a concept from perception and representation through the singular concept to the general and composite concept is well grounded theoretically in primary-education methodology, how each of these stages corresponds to the thinking characteristics of early school age, and how it is to be ensured in actual classroom practice, requires separate, systematic substantiation. The purpose of the article is to elucidate these scientific and methodological foundations and to demonstrate their practical significance.

It should also be noted that concept formation is not a narrow methodological problem specific to natural-science lessons alone, but a general didactic issue relevant to all subjects of primary education. Analysing this process specifically through concepts about nature, however, offers a particular advantage, because natural objects are open to direct observation, are diverse, and are close to the child's everyday experience - which makes it possible to observe the stages of perception and representation far more vividly than with other subject matter.



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Literature Review and Methodology

In his theory of concept formation, L.S. Vygotsky describes children's thinking as passing through the stages of syncretic heaps, complexes, and pseudo-concepts before it turns into a genuine - scientific - concept, and only by means of the generalising function of the word ¹; distinguishing "everyday concepts", which form spontaneously out of everyday experience, from "scientific concepts", which form through deliberate school instruction, he shows that the two mutually enrich one another - the child masters a scientific concept on the basis of representations already accumulated through everyday experience, while the scientific concept, in turn, organises and clarifies everyday representations. J. Piaget shows that children of early school age often interpret natural phenomena through their own subjective, anthropomorphic representations - for instance, imagining the sun or the moon as a living being that moves with purpose ²; in his view, it is only between the ages of 7 and 11 - at the stage of concrete operations - that the child begins to acquire the ability to order things logically, classify them, and grasp cause-and-effect relations, although this ability still relies on concrete, tangible objects rather than abstract theoretical reasoning. Together, these two theories lead to an important methodological conclusion: the process of forming a natural-science concept in a primary school student must necessarily begin with direct contact with a concrete object, and only then move, step by step, towards generalisation. Describing the modern conceptual foundations of natural knowledge, S. Mustafayev and O'. Axmedov argue that the content of natural-science education must encompass not only ready-made knowledge but also methods of cognition ³. Investigating the psychological characteristics of early school age, E. G'oziyev shows that children's thinking at this age is not yet

¹Vigotskiy, L.S. (1934/1986). *Thought and Language*. Cambridge, MA: MIT Press.

²Piaget, J. (1929). *The Child's Conception of the World*. London: Routledge & Kegan Paul.

³Mustafayev, S.M., Axmedov, O'.A. (2010). *Tabiiy bilimlar zamonaviy konsepsiyasi*. Toshkent: Aloqachi.



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abstract-logical but is rather concrete-imagistic and practical-active in character⁴; this conclusion is fully consistent with Piaget's observations and is of decisive importance in choosing a methodology for concept formation. Addressing questions of nature conservation, A. Muxammadiev stresses the need to form a student's concepts about nature in close connection with ecological responsibility⁵; A. To'xtayev and A. Xamidov, combining the foundations of ecology with the principles of nature protection, substantiate the practical and educational orientation of the system of concepts⁶. Within the theory of pedagogical technology, J. Yo'ldoshev and S. Usmonov demonstrate that active learning methods transform the student from a passive recipient into an active participant in the cognitive process⁷; N. Xujamkulova and M. Saidmudova empirically demonstrate the effectiveness of experiment- and observation-based instruction in developing functional literacy in primary-school natural-science lessons⁸. The analysis of the above sources shows that the theory of concept formation (Vygotsky, Piaget) and the practical recommendations of primary-education methodology (Mustafayev, Axmedov, G'oziyev, Yo'ldoshev, Usmonov, Xujamkulova, Saidmudova) together form a single, mutually complementary scientific and methodological foundation; however, the connection between these two layers - namely, how the theoretical stages are to be ensured in an actual lesson - requires separate, systematic substantiation. The study employed the descriptive-analytical method, generalisation of pedagogical observation materials, and the comparative-typological method. It should be particularly emphasised that this scientific and methodological foundation must be applied

⁴G'oziyev, E.G'. (1994). Yosh davrlari psixologiyasi. Toshkent: O'qituvchi.

⁵Muxammadiev, A. (1986). Tabiat muhofazasi va ekologiya. Toshkent: O'qituvchi.

⁶To'xtayev, A., Xamidov, A. (1994). Ekologiya asoslari va tabiatni muhofaza qilish. Toshkent: O'qituvchi.

⁷Yo'ldoshev, J., Usmonov, S. (2004). Pedagogik texnologiya asoslari. Toshkent.

⁸Xujamkulova, N.R., Saidmudova, M.A. (2026). Boshlang'ich sinf tabiiy fan darslarida funksional savodxonlikni rivojlantirish usullari.



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not only to the teacher's manner of working on a lesson, but also to the principles underlying the creation of textbooks and teaching manuals: if a textbook text begins directly with a definition, however carefully it is worded, it will serve only to make the student memorise the definition rather than genuinely form the concept. For this reason, textbook authors and methodologists, too, should follow the principle of presenting a suitable observation task or illustrative material before introducing every new natural-science concept.

Discussion

Forming concepts about nature in primary education can be described as a consistent five-stage process: perception, representation, the singular concept, the general concept, and the composite concept.

The perception stage. The process begins with the student's direct perception of an object or phenomenon through the sense organs: the child sees the colour of a leaf, feels its shape with the hand, hears the sound of rain. At this stage there is as yet no generalisation whatsoever - only the direct reflection of a single, concrete phenomenon.

The representation stage. The perceived images are retained in memory, and the student becomes able to reconstruct a phenomenon as an inner image even when it is no longer directly before the eyes. For example, the representation of autumn leaves now rests not on a single specific leaf but on the whole set of leaves observed. It is precisely at this stage that the risk of what Vygotsky calls the "syncretic heap" arises ⁹: if the teacher does not provide the opportunity to observe a sufficiently varied and numerous set of instances, the student may confuse accidental, insignificant features with the essential one.

The singular-concept stage. The student learns to separate the essential features of one particular object or phenomenon from its non-essential ones and to express

⁹Vigotskiy, L.S. (1934/1986). *Thought and Language*. Cambridge, MA: MIT Press.



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it in words: "this is an elm," "this is fog." At this stage the concept is still tied to the single object, and the possibility of comparing and classifying it against objects of other kinds remains limited.

The general-concept stage. By comparing several singular concepts belonging to one category, the student extracts the general, essential features common to them: observing various trees gives rise to the general concept of "tree," while observing weather changes across the seasons gives rise to the general concept of "season." It is precisely at this stage that logical operations - comparison, analysis, and synthesis - play the decisive role ¹⁰, which is the direct pedagogical reflection of the stage of concrete operations described by Piaget.

The composite-concept stage. Finally, several general concepts are combined through cause-and-effect or systemic relations to form a broader, composite concept: the general concepts of "plant," "animal," and "environment" combine to underlie a composite concept such as "nature" or "ecosystem." This stage typically begins to form in third- and fourth-grade students, once they have begun to grasp cause-and-effect relations.

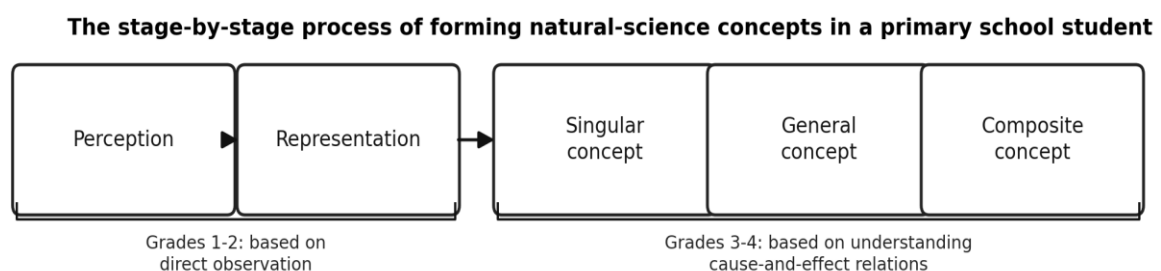


Figure 1. The stage-by-stage process of forming natural-science concepts in a primary school student

¹⁰Piaget, J. (1929). *The Child's Conception of the World*. London: Routledge & Kegan Paul.



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As the diagram shows (Figure 1), in grades 1–2 the instructional process should be aimed chiefly at securing the stages of perception and representation, while in grades 3–4 it should be aimed at securing the transition from the singular concept to the general and composite concept through an understanding of cause-and-effect relations. Confusing these stages - in particular, skipping the stages of perception and representation and giving the definition of a general concept directly - produces the phenomenon of the pseudo-concept described by Vygotsky ¹¹: the student correctly applies, in outward appearance, a scientific term used by adults, but the genuine generalising operation behind it is absent, so that this "knowledge" fails to work in an unfamiliar situation.

Furthermore, the process of concept formation can also be reinforced through interdisciplinary connections: giving an oral account of observation results reinforces speech skills, while measuring and counting tasks reinforce mathematical representation ¹²; such an integrative approach forms the concept not as an isolated piece of information but as a natural part of the student's holistic experience.

In practical terms this requires the teacher, first of all, to build the lesson plan in reverse order - starting not from the definition but from the choice of the object of observation: the student is first presented with a sufficiently varied set of concrete instances (for example, several different kinds of tree leaves), then asked to compare them and identify the common feature, and only after that is the generalising term introduced. This sequence fully accords with the principle of active learning emphasised by J. Yo'ldoshev and S. Usmonov ¹³: the student traverses, on their own, the logical path leading to the conclusion, rather than being given the ready-made conclusion.

¹¹Vygotskiy, L.S. (1934/1986). *Thought and Language*. Cambridge, MA: MIT Press.

¹²Mustafayev, S.M., Axmedov, O'.A. (2010). *Tabiiy bilimlar zamonaviy konsepsiyasi*. Toshkent: Aloqachi.

¹³Yo'ldoshev, J., Usmonov, S. (2004). *Pedagogik texnologiya asoslari*. Toshkent.



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The practical significance of this staged model can also be explained through the principle of the unity of visualisation and word: if a student only hears a verbal description of a phenomenon (for example, listening to the teacher's explanation that "in autumn the leaves turn yellow and fall"), without observing this personally, the stages of perception and representation remain incompletely formed, and the concept's definition freezes at the level of the pseudo-concept described by Vygotsky¹⁴. For this reason, coordinating word with visualisation - speech with direct observation - is a task that demands particular professional skill from the primary-school teacher: the word should be used not before the observation, but during or after it, for the purpose of generalising it.

Another widespread type of error in the process of concept formation is premature generalisation. If the teacher hurries to move to a general concept on the basis of only one or two examples, the generalisation formed in the student will lack a sufficiently broad basis and will break down as soon as the first non-conforming example is encountered: for instance, if the concept of "tree" is formed solely on examples of broad-leaved trees, the student may find it difficult to recognise a fir as a tree. It is therefore advisable to present at least three or four qualitatively different examples when forming a general concept.

At the level of composite concepts, yet another important methodological requirement arises: at this stage the student must be shown, visually, the connection between separate general concepts - for example, how the general concepts of "plant" and "animal" are connected through the "food chain." A composite concept is not simply a larger collection but a whole whose elements stand in systemic relation to one another; consequently, in forming it, revealing these connections - rather than simple enumeration - occupies the central place.

¹⁴Vygotskiy, L.S. (1934/1986). *Thought and Language*. Cambridge, MA: MIT Press.



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Results

The analysis carried out yielded the following results. First, forming concepts about nature in primary education is described as a consistent five-stage process - perception, representation, the singular concept, the general concept, and the composite concept - and each of these stages requires its own specific didactic means.

Second, in grades 1–2 the instructional process should be directed chiefly at securing the stages of perception and representation, while in grades 3–4 it should be directed at securing the transition from the singular concept to the general and composite concept; this distribution corresponds to the psychological pattern of early school age moving from concrete-imagistic to concrete-logical thinking.

Third, giving the definition of a concept without the stages of direct observation and comparison produces the phenomenon of the pseudo-concept - such "knowledge" remains at the level of verbal repetition and fails to work in practical situations. Fourth, the process of concept formation proceeds more effectively when reinforced through interdisciplinary connections (native language, mathematics). Fifth, it was established that the teacher's professional task consists in building the lesson plan in the direction "from situation to definition" rather than "from definition to situation."

The practical application of the staged approach described above should manifest itself, first of all, in the choice of lesson types. The most effective lesson format for securing the stages of perception and representation is a direct excursion into nature or practical work with natural objects in the classroom; for forming singular and general concepts, discussion sessions aimed at comparing and classifying observation results prove effective. At the level of composite concepts, working with a diagram or table that unites various general concepts, as well as organising discussion in small groups, proves worthwhile.



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Here the teacher's system of monitoring and assessment must also be reconsidered: if test tasks require only the verbatim repetition of a definition, this pushes the student back onto the path of the pseudo-concept. Conversely, tasks that require the student to justify whether a new, previously unseen example does or does not belong to the relevant concept can serve as a reliable indicator that a genuine concept has been formed. For example, by showing the student a picture of an unfamiliar plant and asking "is this a tree or a shrub, and why do you think so," one can determine whether the student is able to apply the classification criteria independently.

The role of the family and of the environment outside school in the process of concept formation should likewise not be overlooked: phenomena that a child freely observes at home or in nature create a rich reserve of "everyday experience" for the scientific concepts being formed at school. By drawing consciously on this reserve, the teacher can, through questions such as "who has observed something similar at home or in the yard," link the child's personal experience to the scientific concept during the lesson; this provides a practical realisation of the mutual enrichment of everyday and scientific concepts emphasised by Vygotsky.

Conclusion

Forming concepts about nature in primary education is not a matter of conveying a ready-made definition, but a scientific and methodological process that consistently secures the stages of perception, representation, the singular concept, the general concept, and the composite concept. Instruction conducted without regard to these stages yields only verbal, superficial knowledge, whereas its purpose is to form in the student genuine natural-science concepts that work in practice.



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The findings of the study can be applied in primary-education methodology, in the system of initial and in-service teacher training, and in developing teaching and methodological materials on natural science. A promising direction for further research is the development of a system of practical diagnostic tasks designed to identify each of the stages of concept formation.

In closing, it is worth emphasising that the five-stage model of concept formation can serve not merely as a theoretical description but as a day-to-day practical guide for the teacher: when planning each new topic, the teacher can ask "at which stage - perception, representation, the singular, the general, or the composite level - should the student master this concept," and structure the lesson accordingly. Such a deliberate methodological approach ensures that natural-science concepts serve as a solid foundation not only for examinations but for the student's entire subsequent cognitive activity.

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