CHAPTER 5

From the abstract to the concrete: Creating conditions for the development of theoretical thinking in children in early education

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Abstract: Theoretical thinking is a complex cognitive activity; it is rational thinking aimed at the creation of concepts. Knowledge and theoretical thinking (in contrast to empirical knowledge) are created in the process of cooperation between a child and an adult under certain conditions, in which specific developmental tasks are carried out. The aim of this article is to share with a wider audience the author's personal experience gained in an experimental attempt to develop theoretical thinking in children in early school education by means of the ascending teaching strategy, from the abstract to the concrete. The project, which was aimed at changing the learning culture, draws on the theories developed by Vygotsky, Davydov and Elkonin. The studies in the project showed that there is substantial intellectual potential in children in this age-group which is not developed in traditional education. Contemporary schools do not seem to create learning conditions that match the children's specific stage of development or their learning strategies. Opening school culture to new concepts that create the right conditions for developmental change requires changes in teachers' understanding of the nature of thinking and of the child's theory of mind.

Keywords: learning activity, theoretical thinking, higher mental functions, Davydov, Elkonin, theory of developmental teaching, Vygotsky's cultural-historical theory, design experiment, change in learning culture

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Introduction

Vygotsky's enabling theory-method[1] has exerted a significant impact on contemporary views of the nature of children's development and learning. It brought new theoretical tools for the description and interpretation of these processes, and new ways of understanding what happens in the classroom and in pupils' minds. It also opened the door to new methodological perspectives, namely educational experiments and the (microgenetic) double-stimulation method (Filipiak, 2018a, 2018b; Hedegaard, 2008; Shotter, 1994).

Since the 1990s, the author of this article and her research team have conducted theoretical and empirical studies related to the application of Vygotsky's cultural-historical theory in educational practice. The result of the empirical work related to the cultural-historical activity theory (CHAT) is the cycle of publications by Filipiak (2008, 2011, 2012), entitled *Rozwijanie zdolności uczenia się. Z Wygotskim i Brunerem w tle* [Development of the ability to learn. Against the background of Vygotsky and Bruner]. The cycle presents an original conceptual framework that has been employed in subsequent research projects. In these publications, the key categories of CHAT have been subjected to critical analysis, in particular, through a theoretical discussion on the assumptions derived from Vygotsky's approach, centering on learning and development, development of the ability to learn and theoretical thinking (Filipiak, 2008, 2011, 2012). The author's cycle of publications also focused on exploring the possibilities of applying the original, cultural-historical methodological approach to both research and the creation of scientific knowledge on children's development and learning (Filipiak, 2018a, 2018b). A key element in the research was the preparation and implementation of a teaching experiment inspired by the approach of Vygotsky, Elkonin, and Davydov. The results of the experiment were published in Filipiak (2015a, 2015b). The preparation of the experiment and the subsequent work with teachers revealed the presence of barriers and limitations in the teachers' own thinking, as well as their lack of readiness to "(re)think" school anew. The participating teachers had difficulty implementing the new approach based on Vygotsky's concept in their everyday educational practice (Filipiak, 2020). In developing children's knowledge

1 Vygotsky's dialectic approach enabled him to devise an "enabling theory method", that is "a way of research in which someone's theories, if they are to have any circulation, must be embedded in practical, social and historical, everyday context" (Shotter, 1994, p. 27).

in early education, teachers preferred the traditional path: from the concrete to the abstract. This path runs counter to that proposed by Vygotsky, Davydov, and Elkonin in their conceptions (cf. the Elkonin-Davydov system).

The aim of the present article is to draw attention to how (and why) it is important to apply the strategy "from the abstract to the concrete" in working with children during early education. The article contributes to new knowledge as it provides a summary of research related to introducing an original study method – a teaching experiment aimed at developing theoretical thinking. As such, the article brings together findings and theoretical perspectives that have been addressed separately in earlier publications. In this way, the article sheds light on the conditions for enhancing the pupils' theoretical thinking in a broader perspective.

An essential feature of the educational (design) experiment is the active modelling of a child's activity, shaped under special conditions and modified in the process of direct interaction between a researcher/interventionist and a respondent (Davydov, 1996). Such a procedure results in creating conditions conducive to developmental changes in everyday practices; it creates an opportunity to observe active forms of a respondent's activity and participation in solving tasks and ways of using assistance. It also enables the discovery of the potential of this development inherent in the evolution of the child's functioning (Smykowski, 2000). The objective of the experimental-genetic methodology is not the measurement of the current performance level, but the ways of reaching this performance (Shotter, 1994). By taking part in the experiment, the child learns something new by means of employing mental tools. The content of the designed experiment is related to the form of activity referred to as *the most important* (Vygotsky, 2002a; Karpow, 2014), *leading* (Leontiew, 1962) or *dominant* (Bozhovich, 1968). According to Vygotsky, the most important developmental activity is an activity which, at a particular stage of development, engages a child in a specific manner. Through this kind of activity, the most significant developmental trends (needs) of this period are realized and thus become the most central lines in the child's development. Around the activity, all partial new developmental forms related to separate aspects of the child's personality are grouped, with each developmental stage having its own unique structure (Vygotsky, 2002b). From the developmental perspective, for kindergarten children aged 3–7 such activity is play and it is fun (Vygotsky, 2002c; Hakkarainen & Bredikyte, 2008), whereas for school children

aged 8–12, such activity is related to building foundations for the development of higher mental functions. Vygotsky's assumption is that each developmental period is characterized by a specific and unique relationship between the child and its surrounding social environment, which he calls a social situation of development (Vygotsky, 2002c). The child constitutes part of a social situation and their attitude to the social environment and vice versa is reflected in the child's experiences and activities. The social situation of development is the starting point for all dynamic developmental changes taking place within a given period; it determines the form and path of this development. This poses a crucial question concerning the appropriateness of the social situation of development created at school, and the conditions conducive to cognitive change typical of this developmental stage.

Within the framework of problems outlined in this way and with Vygotsky's cultural-historical theory of development and Davydov's theory of developmental teaching in the background, this article addresses the issue of how to create the conditions and the social situation of development to enhance theoretical thinking in school children. The structural framework of this article is defined by answers to the following questions:

- What happens in the zone of proximal development at school age?
- What is theoretical thinking and why is its development so important for building independence in thinking and acting (the Elkonin-Davydov system)?[2]
- In what ways can a teacher support the development of theoretical thinking in children (with a focus on the role of formative instruction through joint activity in the sphere of development, selected case studies of teaching experiments in practice and research studies on the properties of theoretical thinking)?

2 B. Elkonin and V. V. Davydov emphasized that the development of children's thinking at the stage of early education is a key to their mental development. Particularly important is the development of theoretical thinking and theoretical knowledge through mental operations such as analysis, reflection, and planning. It is necessary to develop a learner's autonomy and sense of causality. Elkonin and Davydov elaborated on the concept of developmental teaching based on Vygotsky's cultural-historical theory and introduced it experimentally, first in School No. 91 in Moscow and later in many other schools in different regions of Russia, Ukraine, Lithuania, Kazakhstan, and Belarus. Thanks to studies conducted since the 1950s (e.g. the longitudinal experiment; Zuckerman & Wenger, 2015) new teaching curricula were devised for primary schools, as well as handbooks, tools, and pedagogical instruments for teachers. What followed was extensive internationalization of the theory, with the creation of the International Association of Developmental Education of the Elkonin-Davydov System.

- What are the difficulties and limitations of developmental teaching in educational practice and what direction of change do they imply (conclusions and recommendations)?
- Why is change in learning culture indispensable? (Klus-Stańska thesis[3]).

What happens in the zone of proximal development in school age children?

According to Vygotsky:

> […] school age is an optimal period of teaching, that is a period sensitive to such subjects which maximally appeal to realised and volitional functions. Thereby, teaching these subjects warrants the best conditions for the development of higher mental functions, lying in the zone of proximal development. This is why teaching can interfere and exert a strong impact on the development of functions which are not yet mature at the beginning of school age. To some degree, it can organize the further process of their development and thus determine their fate. (Vygotsky, 1989, p. 259)

As Vygotsky observes, the developmental achievements of school age children are realization, will-driven activity and self-regulation, enabling children to be self-steering and independent in the learning process. The main challenge and the task for developmental elementary education is to create the conditions for the development of higher mental functions and build good foundations for the method of scientific discovery and theoretical thinking as a route to cognition. The development of thinking in school children is key to their overall cognitive development. Much of Vygotsky's research, which was a breakthrough in thinking about children's

3 D. Klus-Stańska (2008), a Polish researcher in the field of knowledge construction at school, stated that the type of education provided in the early stages of school is inconsistent with psychological knowledge. Being subjected to this type of educational culture for several years may lead to changes in a pupil's mind which are not necessarily favorable. In Klus-Stańska's opinion, at school, children are often faced with learning conditions that are incompatible with their developmental specifics and mechanisms of learning. As a result, school is often developmentally unreadable and regressive (it hinders children's development and does not create challenges) or even deformative. Functioning in such a culture of learning, children are affected by schemata of perception and thinking that stereotype reality, and are worn out by learning and cognizing. The strategies applied and the path of learning offered at that stage suppress the pupils' exploratory activities and the confidence to disclose their own views, suppress their "appetite for knowledge", and, consequently, instead of supporting the pupils' mental development, neglect and limit the development of competencies important for the pupils (Klus-Stańska, 2008). An alternative to such schooling is a school culture of learning based on Vygotsky's cultural-historical theory and Davydov's theory of developmental teaching, promoting the development of the pupils' rational thinking, independence in thinking and acting, internalization of the learning process and tools (Zuckerman, 2003), and creating the conditions for developing theoretical thinking.

development and education, was devoted to the development of concepts in a child's mind and their relation to the emergence of higher mental functions. In his opinion, "future studies will probably prove that a child's spontaneous concepts are the same product of kindergarten teaching as scientific terms are products of school teaching." (Vygotsky, 1971, p. 407).

The process of the development of concepts requires the engagement and development of the higher mental functions, particularly arbitrary attention, logical memory, abstraction, comparison, differentiation, and generalization. These processes cannot be memorized; they cannot be learnt mechanically or acquired as an intellectual habit (Vygotsky, 1971, p. 291). Constructing concepts is a complex and real act of thinking, taking a child to a higher level in the development of structure and content of thinking. What is necessary then is the appropriate organization of the learning process, which becomes an activity that fosters children's mental actions, leading to the discovery and understanding of the structure of reality, followed by acting based on this understanding (Vygotsky, 1989). According to Vygotsky, "realisation enters through the gate of scientific concepts" (Vygotsky, 1971, p. 326). The level of development of scientific concepts creates the zone of proximal possibilities for colloquial terms and is a form of propaedeutic to their development (Vygotsky, 1971). To achieve this developmental task, asymmetrical social interaction is necessary, involving the engaged participation of an adult who is a mediator in thinking and reasoning (Ivić, 2000). All higher mental functions have a shared basis and in Vygotsky's opinion, they become "higher" thanks to being realized and mastered (Vygotsky, 1989). In this process of realization, theoretical thinking plays a significant role. This shared basis is a product of being of school age. Vygotsky's experimental works (1971, 1989) on the discovery of specific traits in the developmental path of scientific concepts in children, comparing them with the development of spontaneous concepts and the explanation of the fundamental rules governing their development, undoubtedly belong to pioneering works, yet the issue of the development of theoretical thinking in children of early school age has still not been sufficiently addressed.[4]

4 Apart from Davydov and Elkonin's Russian school of thought, there are other interesting theoretical and empirical works by researchers addressing the issue of the development of theoretical thinking, such as Y. Karpov, 2003, 2014; J. Lompscher, 1999, and H. Giest and J. Lompscher, 2003.

What is theoretical thinking?

Theoretical thinking has features characteristic of higher order reasoning. It is a complex cognitive activity aimed at concept formation. It enables comprehension of the essence of phenomena, establishment of relations between the structure and its particular elements. This thinking has a mediated character[5] and accompanies construction of theoretical knowledge, which later reveals itself in the way one conducts mental actions. It is directed not only at the subject of cognition, but also at understanding one's own thinking processes, and the discovery of means and ways of understanding. Thanks to such a path of cognition, children gradually develop conceptual content and render thought itself more complex (Davydov, 1996; Zak, 1989; Filipiak, 2018b). Reconstructing the specific cognitive path of a child engaged in solving problematic tasks (undertaking scientific activity), we discover the way in which children think about the content (nature) of an object cognized. The attention of both the researcher and the teacher is directed at actions accompanying theoretical thinking and the creation of theoretical knowledge. Theoretical knowledge and actions accompanying theoretical thinking need to be distinguished from empirical knowledge and actions accompanying empirical thinking (Davydov, 1996; Filipiak, 2015a, 2015b). Empirical knowledge can be compared to theoretical knowledge measured against different criteria: (1) the aim; (2) the path of knowledge construction; (3) the fundamental bases; (4) the concretization of knowledge; and (5) the transfer of knowledge (Davydov, 1996; Filipiak, 2015a, 2015b). The aim of empirical knowledge is to recognize shared essential objects and build on such a basis a generalization of the objects being cognized into a separate class, whilst the aim of theoretical knowledge is the formation of concepts of the object cognized and the recognition of a general relation in them. When constructing empirical knowledge, the child observes objects, which "tell" the child what their properties are. In its actions, the child draws on comparisons of objects and their images. On the other hand, when constructing theoretical knowledge, the child analyzes relationships and dependencies within a system, modifies objects and reaches beyond the framework of sensual images. The means for solidifying empirical knowledge are words (terms). Theoretical knowledge expresses itself in the ways a child carries out mental work. Empirical knowledge can be gained by

5 A child can experience mediation by another person (a human mediator) or mediation through tools, signs, or word meanings.

a child independently, with the appropriate motivation to act. Gaining this knowledge is located in the zone of current development. Theoretical knowledge, in turn, is constructed in the zone of proximal development, and its creation is possible only via constructive cooperation with an adult by solving special tasks under specific conditions (Davydov, 1996; Filipiak, 2015a). The implementation of the teaching strategy of ascending from the abstract to the concrete seems vital at this point.

Table 1 Comparative analysis of actions accompanying practical and theoretical thinking

Comparison criterion/ Type of thinking	**PRACTICAL THINKING**	**THEORETICAL THINKING**
Foundation: Dominant mental operations and actions	**ANALYSIS AND SYNTHESIS** of observations and imagination, differentiation of objects and phenomena, their elements and patterns, similarities and differences, and relationships between them.	**ABSTRACTION AND GENERALIZATION** – recognition and specification of essential properties of objects and phenomena, and the relationships between them. Putting them into categories on different levels of generalization. CONCRETIZATION – employing terms in actions on specifics.
Type of reasoning	**Practical reasoning** on material, content of observations and imagination – from their structure and the analogy between them.	**Theoretical reasoning** on conceptual material and propositions, from the formal relationships between them; deductively: inferring and proving; inductively: verification and explanation.
Activity	**Creating and processing visual schemata (models)** adding to their content new observations and using them in actions.	**Learning and constructing conceptual schemata (models)** forming general concepts and propositions, scientific theories, and technical rules. Organizing verbal expression. Cognizing the language of science.

Source: The author, based upon Davydov (1996).

By developing theoretical thinking, we build the arrangement of learning, internalize the learning process itself, and we assist the child not only in developing the method of scientific discovery but also in achieving independence in learning and acting, and in attaining tools for learning, inferring, logical thinking and regulating their own actions (Zuckerman & Wenger, 2015; Wood, 2006; Filipiak, 2012).

Joint activity of child and teacher in the zone of development

Developing theoretical thinking and higher mental functions (arbitrary attention, logical memory, verbal and conceptual thinking) is possible with the guidance and engaged cooperation of an adult. The adult creates the conditions and undertakes specific social interactions, which play a formative role and have a constructive function in the child's development (Ivić, 2000). Vygotsky formulated the cultural and historical principle of development, which has significant consequences on designing developmental education:

> Every function in the child's cultural development appears twice: first, on the social level and, later on, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. (Vygotsky, 1978, p. 57)

Higher mental functions manifest themselves and are formed in the process of development as a result of constructive social interactions between child and teacher. Hence, the teacher's activity is directed at initiated cooperation and readiness to "sensitive" reactive teaching. The teacher is "sensitive" both to the child's achievements (zone of current development), as well as to its potential possibilities (zone of proximal development). It is the teacher who sets up tasks, clarifies their content, modifies the conditions, enables the child to mentally manipulate the task's conditions, supports the child in recognizing data and, consequently, stimulates conceptual marking of relationships and helps to discover rules. S/he creates a framework, builds scaffolding for the child's thinking and acting by posing appropriate questions which provide intellectual support and encourage thinking. S/he gives "proper" formative instructions and provides constructive feedback.

Assisting the pupil in theoretical reasoning, the teacher poses concretizing questions, for example, *what will happen if …?* (predicting), *what needs to be done to …?* (proving), *why …?* (justifying). Organizing space and creating the conditions for the process of cognition directed at the development of theoretical thinking, s/he monitors the child's task achievement on "the mental plane", in "the mind" and on the internal plane, which, according to Vygotsky, describes the cognitive stage when mental tools have been internalized and are used independently. The teacher also helps to create

a mental model that modifies mental observations of traits and relations by decreasing, emphasizing, excluding, associating, and simplifying. S/he directs analyses, enables the study of cognized objects, and shows sensitive readiness to react (respond) "here and now" to what the child is doing. The teacher has a high level of sensitivity to the child's interests, skills, and abilities, which develops in dynamic interaction between the teacher and the child. Building the situation of learning, s/he performs different types of actions: supporting, aiding, and provoking (and even challenging) (Filipiak, 2015a). S/he changes the scope of assistance that the child is provided with and the range of awareness and control (Filipiak, 2012, pp. 32–33).

The building of scaffolding enables the child to gain experience during problem solving, with the involved guidance of the teacher, who "controls" and directs the child's activity and organizes effective strategies that support reasoning and search (discovery), which is a key feature of scaffolding. The result of the teacher's and the pupil's actions is the arrival at a joint solution to problems and the "division" of the actions performed. Functioning in the situation of interaction, the teacher and the pupil swap roles. Instructing the pupil, the teacher does not only "reflect in a mirror" the pupil's actions, but also helps them to recognize the exercise algorithm and grasp the sense of the activity undertaken. It can be said that the child, acting with an adult in the zone of proximal development, "borrows" the teacher's more mature awareness in a way, so as to handle by this means the content which cannot yet be independently absorbed in the child's mind (Stemplewska-Żakowicz, 1996). The process of mutual learning is a process of dynamic transfer from supported acting to independent acting, from the control over a task by others to self-control over one's own actions.

The possibility of developing theoretical thinking in children in early education, independence in thinking, acting, and learning – experimental studies

Vygotsky's theory stating that teaching not only can, but ought to lead the child's development was transferred in Russia into the theory of "developmental teaching" (*теория развивающего обучения*) and the concept known as the Elkonin-Davydov system. This concept assumes that in teaching focused on the development of the individual's mind, it is necessary to

develop theoretical thinking, the pupil's reflectivity, mastery of the method and tools of scientific discovery. The object of the pupil's activity should not be objects, but ways of introducing changes in them, which enables the discovery of the essential properties of these objects (Davydov, 1996; Elkonin, 1989).

In Elkonin's opinion, the traditional approach to elementary education, based on such principles as illustration and concreteness, limits the possibilities of pupils' development. The path of teaching leading from the specific to the general, from the concrete to the abstract, from a fact to a system, from a phenomenon to its essence, primarily develops the empirical thinking of children of early school age. The Elkonin-Davydov system prefers a different, opposing way of constructing children's knowledge: from the general to the specific, from the abstract to the concrete, from learning a system to recognizing elements in it. Thereby, it creates conditions for the development of theoretical thinking, scientific activity, and the pupils' genuine cognitive activity (Elkonin, 1989; Davydov, 1996). The educational activity of children is focused on their solving a system of tasks in which they transform the problem, discover relationships, and carry out "research". In organizing developmental situations enhancing children's thinking, teachers are led by the principle of going from the abstract to the concrete; they initiate and support children's activities directed at the search for knowledge and the pursuit of comprehension, making use of modelling (Elkonin, 1989; Zuckerman & Wenger, 2015). Studies conducted on the psychological properties and the properties of theoretical thinking have been carried out over the years by Davydov and his followers (A. Z. Zak, E. I. Isaev, A. M. Miedwiediew, Y. A. Ponomarev, V. V. Rubtsov, N. I. Polivanova, Y. V. Gromyko, A. A. Margolis, V. V. Rubtsov, I. M. Ulanovskaya, G. A. Zukerman et al.) through the theory of developmental teaching. These studies included experimental studies on the possibilities of development of this type of thinking concerning different aspects of construction (planning, analysis, reflection), taking into account the aforementioned principles.

These experimental studies (making use of Vygotsky's original methodology) have shown that children of early school age are able to master knowledge and develop skills characteristic of a much higher level than those generally considered to match their possibilities. Yet, it is necessary to introduce new educational content (with theoretical terms constituting the basis of a given scientific discipline) and new ways of teaching, which

should help children discover properties and relationships not directly visible, but hidden in the task content. The system of developmental teaching helps children not only to comprehend the educational content more profoundly, but also to master it more quickly (Elkonin, 1989; Zak, 1989; Zuckerman, 2003).

In a ten-year longitudinal experiment, Zuckerman and Wenger carried out a micro-analysis of the development of independence in learning, in which they described the manifestations of initiated activity in learners, as well as the properties of their reflexive thinking and learning. In the researchers' opinion, the ability to reflect is not only a gift, but is also an ability of gifted children. By creating the appropriate conditions and introducing the system of activities, the reflexivity and independence of all pupils can be developed (Zuckerman & Wenger, 2015).

Since 2015, studies focused on the possibility of developing theoretical thinking in children of early school age have also been conducted in the Department of Didactics and Culture of Education Studies at Kazimierz Wielki University (UKW) in Bydgoszcz under the leadership of the author. The studies were initiated by the organization of a design experiment (Filipiak, 2015a) in which the process of solving specially constructed developmental tasks given to children in the natural environment of classes in the early years of school was monitored. The studies were carried out in three primary schools, in five first-to-third grade classes. Some 96 children were included in the studies. There were nine researchers participating in the project (including three external experts), five women teachers/interventionists (previously prepared via training workshops for setting up tasks and building the developmental situation of learning), 22 pupils of early school age (prepared for the observation of a child in task-solving situations by means of the SOZ scale[6]). The members working within each team in the experimental class included one teacher/interventionist and one expert researcher from UKW, and 4–5 school children. Ten sessions of developmental teaching were conducted, which encompassed 42 developmental tasks in four thematic packages (linguistic, mathematical, scientific, and artistic).

6 For the purposes of the project, ACK developmental teaching according to Vygotsky, a special tool was constructed – the Observation Scales of a Child in a Task Situation ("SOD-SZ") by A. I. Brzezińska, which made it possible to register the observations of early school-age children in task situations requiring cooperation with a partner in planning and performing the task.

The tasks proposed to the pupils in accordance with the premises of Elkonin (1989) and Davydov (1996) were scientific tasks hidden in problematic situations, and they were meant to develop children's scientific activity. They required abstract thinking and the performance of complex operations such as: comparison, analysis, synthesis, abstraction, and generalization. The result of the children's activity was the discovery of their way of acting, the formulation of a conclusion, and a research note. The sessions of developmental teaching were registered in video and audio recordings, observation sheets, photographic material, and children's output (study notes). The observations of the process of children's activity were registered on SOD-SZ sheets and analyzed during discussion meetings (laboratory conversations) in the form of "hot" feedback and deferred feedback from the pupils, teachers, researchers, and experts (Filipiak, 2015a, 2018b). The analysis concerned the following problems: (1) What type of activity did the children undertake in order to solve the task? (2) What strategies of acting and thinking did they employ for this purpose (what way of reasoning did they follow)? (3) What meaning did they assign to their "discoveries"? (4) What arguments and study notes did they formulate? (5) In what way did they make use of the teachers' formative instructions? (6) In what way did they involve "mediators/intermediaries" in the situation of "studying" the problem?

The experimental studies showed that there is significant intellectual potential in early school-age children and thus confirmed Davydov's hypothesis that children of this age have substantial, unused intellectual reserves. The children (6–10 years of age) proved able to carry out reflection (in the area of linguistic, mathematical, scientific, and artistic tasks), and solve tasks directed at the analysis of theoretical concepts. In the experiment, it was possible to capture the way that children construct (in their minds) concepts that enabled them to develop rational thinking. The researchers in the experiment were also able to identify and name the stages in the process of solving a developmental task: (1) initial data analysis; (2) agreement of positions; (3) planning activities; (4) drawing up a strategy of action with the use of "exploratory speech"; (5) decision-making; (6) formulating hypotheses; (7) verification of ideas and hypotheses through discussion, argumentation, and asking questions; (8) trying out strategies; and (9) checking and verifying.

The solving of a developmental task was accompanied by the teacher's formative instruction, which had developmental and non-directional

character. The researchers also managed to identify the phases of the child carrying out self-assessment: (1) explaining the activities undertaken; (2) assessing one's own acting and thinking; (3) analyzing predictions of the effects of one's own actions combined with generalization and transfer with regard to other subjects; (4) identifying and analyzing difficulties combined with comparison by way of instigating independent and critical thinking; (5) identifying and analyzing the strengths and weaknesses in one's own thinking and actions undertaken; and (6) generalizing in order to improve actions to be undertaken in the future. Each of the phases was accompanied by the sensitive alertness/attention of the teacher, who, through his/her instruction in the form of, for example, questions or active listening, giving direct non-evaluative feedback, supported the development of the children's self-regulation. The studies also revealed the possibilities and opportunities to develop higher mental functions in children with special learning difficulties. Attention was drawn to the problem of creating appropriate support, called "tailored support", and to the tension between the excess and deficit of "scaffolding construction" for these children's reasoning, which was observed in the experiment (Filipiak, 2015a, 2015b).

Conclusion

The development of theoretical thinking in children in early school education is not only possible but necessary and it is consistent with the child's development, which is confirmed by research conducted by Davydov (1996), Elkonin (1989), and Bertsfai and Polivanova (1988). It is the key to building the basis for further effective, autonomous education, based on the method of scientific discovery. To enable this, the modification of school into a culture of mutual learning (cf. Bruner's concept, 1996) is indispensable, which is only possible when teachers' beliefs about the nature (theory) of the children's minds change. Opening the school culture to a new quality, transgressing formerly established pragmatic patterns of actions, and changing the teachers' way of thinking and acting requires the creation of a critical space to allow for change in the learning community of teachers and the preparation of the ground for openness to "an unpredictable novelty".

The conflict of "resistance vs. readiness" in partaking in changes, as well as barriers and limitations in teachers' thinking, were encountered in the experiment conducted by the Department of Didactics and Culture of

Education Studies. In order to start the design experiment, the research team needed to do some work on the convictions and understanding of the teachers (and the pupils taking part in the experiment) of how children learn and think. The construction of understanding of these problems constituted the basis for creating conditions to conduct a conversation facilitating the comprehension of practice, the analysis and reflection on the sessions of developmental teaching carried out in the classroom, creating conditions for a developmental cognitive change. The meetings preceding the experimental activities to develop theoretical thinking were meant to generate sensitivity towards understanding how children structure their own learning, memorizing, guessing, and thinking. The Laboratory of Educational Change was created and functioned as a critical space for understanding what happens in the classroom (Filipiak, 2020).

The activities in the Laboratory continue. Teachers are invited to participate in sessions during which different cases, problems, and situations are analyzed. We are jointly devising a new mode of thinking, initiated thanks to a common understanding of meanings, and leading to shared meanings. The participants in the dialogue are becoming observers of their own thinking. Vygotsky's theory has a heuristic potential, which may become a potent tool in changing the way of thinking about education and in creating instruments and strategies causing that change.

Author biography

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