Chapter 11

THE HISTORY OF THE DEVELOPMENT AND THE PSYCHO-PEDAGOGICAL CHARACTERISTICS OF PROBLEM-BASED LEARNING METHODS

Vasyleha P. A., Obukhova L. M.
DOI https://doi.org/10.30525/978-9934-26-443-6-11

INTRODUCTION

The evolution and application of problem-based learning methods represent a pivotal advancement in educational pedagogy. This approach, deeply rooted in the exploration of cognitive processes and psychological principles, has transformed traditional teaching paradigms. Through our dialogue, we have delved into the historical trajectory and the psycho-pedagogical characteristics of problem-based learning, shedding light on its significance and effectiveness in fostering critical thinking, knowledge transfer, and intrinsic motivation among learners.

Moreover, contemporary trends underscore the increasing recognition of problem-based learning as a cornerstone of 21st-century education. In an era characterized by rapid technological advancements and complex global challenges, educators are increasingly turning to problem-based learning to cultivate the skills and competencies necessary for success in the modern world. From interdisciplinary collaboration to real-world problem-solving, problem-based learning aligns with the demands of today's society, preparing learners to navigate ambiguity, adapt to change, and thrive in diverse contexts.

In the study of problem-based learning and the adaptation of its methods to current educational demands, many steps have been taken. The psychological essence of the effectiveness of problem-based learning methods has been revealed, a significant number of tools for implementing problem-based learning methods have been developed, and a theoretical concept of applying problem-based learning has been constructed. This fact lies in the specific structure and psycho-pedagogical essence of problem-based learning. Developmental education in general, and problem-based learning in particular, has great formative potential for developing individual

skills and abilities, realizing natural talents, and addressing the interests of the individual.

1. History of the development of problem-based learning

Studying problem-based learning methods requires addressing issues related to its inception, development, and current state. Problem-based learning, essentially, is a type of developmental education. Therefore, analysis should be conducted within the context of developmental education. The problem of developmental education has a long history, and its essence lies in resolving the relationship between learning and development. The concept of «developmental education» is attributed to the Swiss educator Johann Pestalozzi. Ushinsky K. referred to this idea as the «great discovery of Pestalozzi», as highlighted in his fundamental work «The Aims of Education and Other Essays».

The ideas of developmental education found their reflection in the works of many researchers, but they were not presented as a single concept and appeared as separate facts and principles. Thus, the essence of the interrelation between the learning process and development was not fully disclosed. Various views and approaches to solving this problem were formed, but it remained open until the 20th century. Decisive importance in forming the concept of developmental education was played by the experimental research of Elkonin D. and Davydov V., which began in 1959 at School No. 19 in Moscow. The goal of their developed system is the comprehensive development of the personality of a young student. Achieving this goal is ensured by the dominance of theoretical thinking, which contributes to the mastery of such intellectual skills as analysis, synthesis, reflection, modeling, and planning.[1]

The system of developmental education is based on the following principles:

1. The principle of organizing the educational process in accordance with the psychological characteristics of the age development of students. Accordingly, it is necessary to differentiate the various stages of students' education in school. The stages are distinguished based on the analysis of the psychological age characteristics of students, primarily taking into account the leading activity of age periods and the level of development of higher cognitive functions. For each stage of education, its own content and teaching methods for students are identified. Starting from primary school, the student should clearly distinguish the novelty of the educational material he receives

[1] Павленко В.В. Технологія розвивального навчання Д.Б. Ельконіна, В.В. Давидова. *Історичні аспекти, сучасний стан і перспективи розвитку системи дошкільної і початкової шкільної освіти :* збірник науково-методичних праць. Житомир: Вид-во ЖДУ ім. І.Франка, 2014. С. 11-14.

and differentiate it from preschool education material. During the transition to higher grades, this tendency should be maintained. The constant change of educational content and teaching methods should reflect the psychological trends in the child's development in different age periods. [2]

2. The principle of activity. Based on the views that the development of a student's personality is determined by activity, Davydov V. notes that effective knowledge acquisition occurs through active engagement. This is achieved through students performing specific actions. Implementing this principle provides a sensory basis for knowledge while simultaneously acquiring reliable scientific knowledge based on theoretical generalizations. This principle occupies a special place in the study of natural science disciplines, and its manifestations include the introduction of practical and laboratory work into the educational process, conducting student research, and carrying out educational projects.

3. The principle of objectivity. This principle elucidates what students should work with in the process of mastering educational material. The discovery of the content of the acquired concept initially occurs through the transformation of various objects, which then takes the form of a model. After forming the initial content of the concept, it is presented in material form and becomes accessible for further transformations aimed at revealing its essence. This principle is based on forming a learning attitude through modeling and comparative analysis. Comparison is based on identifying common and distinctive features and properties of the objects being compared, which helps to specify the content of the studied systems.[3]

The discussed principles of developmental education are aimed at developing theoretical thinking in students. The theoretical mode of mastering educational material is characterized by the following stages:

1. The first stage involves identifying fundamental properties, internal and external relationships, and regularities, and then extracting concepts based on this content.

2. The second stage involves reflecting the content of the concept in a model. The model should be as clear and substantive as possible. The first two stages represent the act of the student's initial acquaintance with the content of the concept.The third stage involves students receiving

[2] Василега П.А. Використання методів проблемного навчання в процесі реалізації навчального змісту профільної біологічної освіти. *Теоретичні та прикладні аспекти досліджень з біології, географії та хімії:* матеріали І Всеукраїнської конференції студентів та молодих учених, м. Суми, 25 квітня 2017 р. Суми: ФОП Цьома С.П., 2017. С. 126-129.

[3] Павленко В.В. Технологія розвивального навчання Д.Б. Ельконіна, В.В. Давидова. *Історичні аспекти, сучасний стан і перспективи розвитку системи дошкільної і початкової шкільної освіти :* збірник науково-методичних праць. Житомир: Вид-во ЖДУ ім. І.Франка, 2014. С. 11-14.

information about specific cases of implementing the concept, leading to a comprehensive understanding of the concept as a whole. [4]

These stages outline the process of theoretical thinking development in students, allowing them to grasp concepts deeply and apply them effectively in various contexts. This system contributes to the formation of internal positive motivations for learning activities and studying educational content. Problem-solving methods play a crucial role in this system. Learning in this case facilitates the processes of internalizing social-historical experience through solving educational tasks.[5]

Educational tasks can take various forms and contain a highly variable content. In the general scheme, the process of solving educational tasks consists of the following steps:

1. Analysis of the task conditions aimed at identifying the main properties of the object under investigation.
2. Formation of a model of the object under investigation. A model is a system that reflects the main features, processes, and phenomena characteristic of the object under investigation. Models can be presented in various forms: symbolic, graphical, mathematical, object-oriented, computer-based.
3. Obtaining information about the object under investigation based on studying the model.
4. Formulating tasks that need to be solved to acquire new knowledge about the object.
5. Monitoring the execution of tasks to identify unreliable data.
6. Evaluation of the acquired knowledge about the object under investigation.[6]

All these actions form a system aimed at solving the task. From the perspective of the psychological principles of the process of mastering educational material, there is a certain dependency. The more analytic-synthetic operations a student performs, the higher the level of material assimilation.

In the mid-20th century, Soviet educators Danilov M. and Yesipov V. formulated rules for activating the learning process, which essentially reflect the principles of organizing problem-based learning. Firstly, students should be led to generalize without providing ready-made knowledge. Concepts should be formed through understanding their individual components and then expressed in complete constructive form. Secondly, students need to be

[4] Кокун О.М. Психофізіологія. Навчальний посібник. Київ: Центр навчальної літератури, 2006. 184 с.

[5] Шевченко П.І. Профільне навчання в середній загальноосвітній школі. *Педагогічний альманах.* Збірник наукових праць. Київ-Херсон, 2006. С. 124-131.

[6] Бандурка О.М. Основи психології і педагогіки. Харків: Вид-во Нац. ун-ту внутр. справ, 2003. 334 с.

familiarized with the necessary minimum of research methods and develop competencies for their use in educational activities. Thirdly, fostering students' independent thinking and developing their ability to formulate arguments in support of their views are essential.[7]

Thus, in the early 1960s, the idea gained widespread acceptance that the learning process should be based on students' research activities. Soviet psychologists Rubinstein S. and Kudryavtsev T. significantly influenced the development of these tendencies. The thesis that intellectual development is reflected not only in the volume and quality of knowledge but more so in the structure of cognitive processes played an important role. The role of problem situations in thinking and learning processes was emphasized. Significant contributions to the development of the theory were made by Makhmutova M., Matyushkin O., Lerner I. and others.[8]

In the 1970s, the concept of problem-based learning by English psychologist E. de Bono gained significant popularity. His developed system of six levels of thinking and a special structure for developing each of them through problem tasks were noteworthy. Zankov's L. technology of educational activity is designed for the comprehensive development of students' personalities. Based on the concept's provisions, general development is considered as the development of students' abilities. To determine the level of individual development, a detailed analysis is required using indicators such as attentiveness, development of abstract thinking, and practical skills. In his attempt to formulate an educational system that would ensure the highest effectiveness of learning, Zankov L. formulated the basic didactic principles of educational activity, which are essentially different from the principles of traditional didactics.

In the 1990s, Davidov V. supplemented the theoretical foundations of the Zankov system, combining them with the needs of humanizing education. The traditional concept of teaching follows the vector from the concrete, individual to the general, from the case to the system. Such a system cannot contribute to the development of the ability to identify general trends since it is based on individual arguments. Therefore, Davidov V. proposed a new approach to teaching aimed from the abstract to the concrete, from the systemic to the individual. This is the essence of developmental teaching. The thinking developed through such teaching is called theoretical.[9]

---

[7] Павленко В.В. Технологія розвивального навчання Д.Б. Ельконіна, В.В. Давидова. *Історичні аспекти, сучасний стан і перспективи розвитку системи дошкільної і початкової шкільної освіти :* збірник науково-методичних праць. Житомир: Вид-во ЖДУ ім. І.Франка, 2014. С.11-14.

[8] Педагогічна психологія. за ред Л. Проколієнка. Київ: Либідь, 2001. 356 с.

[9] Павленко В.В. Технологія розвивального навчання Д.Б. Ельконіна, В.В. Давидова. *Історичні аспекти, сучасний стан і перспективи розвитку системи дошкільної і*

In pedagogical and methodological literature, various definitions of problem-based learning can be found:

Okun V. defines problem-based learning as «a set of actions such as organizing problem situations, formulating problems (students gradually get used to this themselves), providing students with necessary assistance in solving problems, checking these solutions, and finally, guiding the process of systematizing and consolidating acquired knowledge».[10]

Lerner I. sees the essence of problem-based learning in the fact that «under the guidance of the teacher, the student participates in solving cognitive and practical problems new to him within a certain system corresponding to the educational goals of the school».

Kudryavtsev T. sees the essence of problem-based learning in posing didactic problems to students, in solving and mastering generalized knowledge and principles of solving problem tasks.[11]

2. Psychological-pedagogical characteristics of problem-based learning methods

The effectiveness of the educational process depends on many factors. Among these factors, we can mention psychological, socio-economic, political, ideological, ecological, and so on. From the perspective of this study, it is most relevant to consider psychological factors, as their consideration is a necessary condition for the effective implementation of educational content in the process of educational activities. Psychological factors represent a certain hierarchical system, the structural elements of which manifest themselves in the educational process. These include general age-related features of cognitive processes development in a certain age period, individual personality traits of each student, and the psychological-pedagogical characteristics of teaching methods through which educational content is realized.

Psychological factors influencing the effectiveness of the educational process include:

1. Individual psychological characteristics: temperament, type of nervous system activity, character, personal values orientation, and so on.
2. Age-related psychological characteristics: leading activity, social development situation, level of consciousness and self-awareness, age crises.

початкової шкільної освіти : збірник науково-методичних праць. Житомир: Вид-во ЖДУ ім. І.Франка, 2014. С. 11-14.

[10] Василега П.А. Значення та особливості організації процесу проблематизації навчального змісту профільної біологічної освіти. *Virtus: Scientific Journal*. 2016, № 7 С. 79-83.

[11] Павленко В.В. Проблемне навчання: становлення, сутність, перспективи. Цілі та результати освітніх реформ. Київ: ун-т Б. Грінченка, 2013. С. 126-134.

3. Group-related: psychological climate, structure of interpersonal relations, level of organization of the collective.

4. Psychological characteristics of teaching methods. [12]

All the mentioned psychological factors have varying degrees of influence on the effectiveness of the educational process and manifest themselves in close interaction with each other. For example, the social status of a student in the classroom, especially its negative change, affects educational activities. The level of organization of the collective influences the overall success of the class, and so on. Since the research is dedicated to the methodology of implementing educational content through problem-based learning methods, the question of their psychological-pedagogical characteristics becomes relevant.

First of all, it is worth highlighting criteria based on which the analysis should be conducted. For convenience, let's divide them into general (correspondence to general pedagogical and psychological requirements for implementing educational content) and specific (characteristics of psychological processes manifested in the process of task performance).

One of the general psychological criteria is compliance with the psychological-pedagogical principles of effectiveness in implementing educational content. Based on the views of Lev Vygotsky (1896-1934), the formation of new knowledge and skills in students is ensured by collaboration with adults. He introduces the concept of the zone of proximal development (ZPD), which includes the actual development level, the nearest development level, and the potential development level. The actual development level represents what the child can do independently and is characterized by predominantly reproductive activities. The nearest development level serves as the basis for realizing the child's potential, and it is characterized by activity at a creative productive level. It is in the zone of proximal development that teaching should take place. From this perspective, we can say that problem-based learning, in all its forms, realizes its content in the zone of proximal development by establishing causal relationships between existing knowledge and knowledge being formed. [13]

Leontiev O., by specifying several of Vygotsky's propositions, has demonstrated that individuals, through internalization, appropriate the socio-historical experience of humanity in their own activity, reproducing historically formed human abilities. One of the attributes of problem-based

[12] Василега П.А. Психолого-педагогічні аспекти реалізації проблемного навчання. *Актуальні питання, проблеми та перспективи розвитку гуманітарного знання у сучасному інформаційному просторі: національний та інтернаціональний аспекти:* зб. наукових праць. Рубіжне: вид-во СНУ ім. В. Даля, 2015. С. 150-153.

[13] Василега П.А. Значення та особливості організації процесу проблематизації навчального змісту профільної біологічної освіти. *Virtus: Scientific Journal*. 2016. № 7. С. 79-83.

learning is the rediscovery by students of certain regularities, which contributes to the formation of competence and effective memorization of educational material, the perception of which is based on practical and theoretical foundations.

An important question is the impact of problem-based learning methods on students' motivation for learning. In the general psychological context, motivation is a set of differentiated psychological factors that determine the behavior and activities of an individual.

Motives for educational activities are all factors that determine manifestations of educational activity. According to Bozhovich L., motives can include objects from the external world, ideas, concepts, feelings, and experiences – in other words, everything that reflects a need.[14]

There are several approaches to the classification of motives. Motives can be:

External – punishment and reward, threat and demand, material objects, group pressure, expectations of future benefits. They are external to the goal of learning. Knowledge and skills in this case serve as a means to achieve other goals. «4» Internal motives include curiosity about one's own knowledge, sustained interest, a desire to elevate cultural or professional levels, and a need for active new information. In other words, all motives that arouse interest in learning as a goal.[15]

The completion of problem-based tasks requires significant volitional activity from students, which, in turn, is based on the formation of internal motivation for learning. In most cases, the execution of problem tasks is individualized, and without the presence of internal motivation for learning, their completion becomes nearly impossible. The main determinant of motivation formation is high creative activity and independence. Students clearly understand the results of their activities, identify their own mistakes, and work on them. Additionally, motives can be positive or negative. According to Ilyin E., the main factors influencing the formation of positive stable educational motives are:

1. The content of educational material. Educational content should have an interesting dynamic nature; a flow of new information ensures the volitional activity of the student.
2. Organization of educational activities, which includes three main stages (motivational, operational-cognitive, reflexive-evaluative).

[14] Бандурка О.М. Основи психології і педагогіки: Підручник. Харків: Вид-во Нац. ун-ту внутр. справ, 2003. 334 с.

[15] Ліфарєва Н.В. Психологія особистості: навчальний посібник. Київ: Центр навчальної літератури, 2003. 237 с.

3. Collective forms of educational activities. Group work contributes to the formation of friendly relationships among students, fosters the active development of organizational skills, and facilitates team-building.

4. The style of the teacher's pedagogical activities. An extremely important skill of the teacher in this case is the ability to create a positive psychological climate during classes. The teacher's personality reflects the knowledge and competencies that the students will subsequently acquire.[16]

Problem-based learning methods in the educational process perform several functions directly related to the development of cognitive processes and mental operations:

1.They ensure the assimilation by students of a special system of knowledge (depending on the educational content), algorithms, and methods of cognitive and practical activities. The formation of a knowledge system in this case is based on the performance of educational tasks at a productive level, which qualitatively differs from the reproductive level. Since educational activity requires the use of mental operations of analysis and synthesis, this contributes to the formation of a clear cause-and-effect relationship between the phenomena being studied. Knowledge acquired in this way has a dynamic nature and represents a labile, well-organized system that easily adapts to fluctuations. In other words, acquired knowledge can be easily adjusted, supplemented, and refined depending on the context of tasks. This mechanism counteracts the formation of stereotypes and ensures adaptability to the perception of new educational material.

2. Problem-based learning methods facilitate the development of cognitive activity and creative abilities in students. Cognitive activity in this context represents active interaction between the researcher (student) and the object of study, which is reflected in the form of a model accessible for mental operations. The investigation of certain elements of the model is possible through various approaches and mental operations, depending on the task context. This contributes to the formation and improvement of students' creative abilities by expanding the range of alternative approaches to problem-solving. The quantity of approaches to problem-solving directly affects the quality of knowledge, leading to a transition from quantitative changes to qualitative ones. This is reflected in the quality of assimilating educational material and the ability to apply it in practical activities.[17]

3. Fostering skills for creatively assimilating knowledge. Since solving problem tasks requires students to overcome the barrier between their

[16] Василега П.А. Психолого-педагогічні аспекти реалізації проблемного навчання. *Актуальні питання, проблеми та перспективи розвитку гуманітарного знання у сучасному інформаційному просторі: національний та інтернаціональний аспекти:* зб. наукових праць. Рубіжне: вид-во СНУ ім. В. Даля, 2015. С. 150-153.

[17] Фурман А.В. Модульне-розвивальне навчання: принципи, умови, забезпечення: Монографія. Київ: Правда Ярославичів, 1997. 340с.

existing level of knowledge and the level required for task resolution, students develop their own creative system for solving them. The formation of such a system is based on a creative search for ways to accomplish tasks. Creative independence is formed based on individual abilities and talents. Interestingly, quite often, several students find the correct answer using completely different approaches and analyzing different factors.

4. Fostering skills for creatively applying knowledge and skills in solving educational tasks. The practical application of knowledge is a fundamental manifestation of the level of knowledge. The process of forming a system of knowledge and skills transforms into active creative activity as opposed to reproductive activity where knowledge is superficial. Forming a creative approach to task-solving usually occurs through trial and error. Mistakes also carry significant educational value.

5. Formation and accumulation of experience in creative activity. The personal experience of the student is of great importance as it is deeply ingrained in memory and contributes to the formation of internal positive motives for educational activity. Interest and imagination serve as the basis for forming high-quality practically oriented knowledge.[18]

Based on the methodological principles of task formation, several types of problem situations can be distinguished:

The first type – a problem situation arises when students are unfamiliar with the methods and ways of solving the problem posed. During the initial familiarization of students with such tasks, the teacher should explain the essence of the problem by thoroughly analyzing its conditions and essence. It is necessary to develop skills and abilities to create an approach to solving the task. The solution to such tasks is based on the active creative activity of students, using a wide range of various approaches to the given problem. The main task is to develop the ability to form a solution path based on known facts. Skills for creative analysis and establishing cause-and-effect relationships between phenomena are most actively developed, highlighting the main vector of educational activity in solving the task.

The second type – a problem situation arises when it is necessary to use previously acquired knowledge in new or modified conditions. The essence of such tasks lies in expanding the potential of applying knowledge, partially based on knowledge repetition. At the same time, clarification and correction of known facts occur. In the process of performing such tasks, the level of mastering previously acquired knowledge is clearly reflected, as well as the ability to interpret them in a new light, abstracting from stereotypes. Tasks of this type emphasize the universal nature of educational information, its dynamism. The model of performing previously completed tasks acquires a

[18] Синергетика і освіта: монографія. за ред. В. Г. Кременя. Київ : Інститут обдарованої дитини, 2014. 348 с.

dynamic character, changing its structure and analyzing consequences, thus allowing students to improve their knowledge and skills. Modeling is extremely important, as the answer is formed in the alternative interaction of elements of the existing system. Comparison is one of the main determinants of task performance.[19]

The third type – a problem situation arises when there is a contradiction between the theoretically possible way of solving the problem and the practical impossibility of the chosen method. This type of tasks is quite complex and requires significant theoretical preparation of students. The contradiction between knowledge and the practical impossibility of their use forms a close relationship between theory and practice. Knowledge that has been formed indirectly through interiorization must undergo a process of exteriorization and manifest itself in the form of skills. An active process of forming skills takes place (especially actively if the task is in the context of practical or laboratory work), taking into account the necessary conditions. Such situations are best applied in the process of adjusting and refining knowledge. Task performance is ensured by significant creative and volitional activity and contributes to the development of reflection.

The fourth type – a problem situation arises when there is a contradiction between the practically achieved result and the lack of knowledge among students for theoretical justification. Such situations are similar to problem situations of the third type, but they have mutually opposite structures. They are aimed at generating new ideas and hypotheses based on practical activity. The basis for performing such tasks is observation and identification of factors reflected in the model. Formation of the model occurs through observation and theoretical research, based on the active cognitive-search activity of students. As a result of performing such tasks, the development and improvement of practical activity and cognitive processes occur.[20]

The process of solving problem-oriented tasks represents a step-by-step system, where each stage has certain priority vectors for the development of students' intellectual abilities:

1. Emergence of the problem situation: At this stage, there is initial acquaintance with the conditions of the situation, but it is rather superficial for analysis.
2. Problem situation: The structure of the problem becomes comprehensible and analyzable for the student, as it is presented in a fully formed manner.

[19] Василега П.А. Значення та особливості організації процесу проблематизації навчального змісту профільної біологічної освіти. *Virtus: Scientific Journal*. 2016. № 7. С. 79-83.

[20] Цуркан Т.Г. Шлях до успіху особистості – через проблемне навчання. *Педагогічні науки: теорія, історія, інноваційні технології.* 2015. № 10 (54). С. 313-318.

3. Understanding the essence of the task and forming the basis of the problem: This stage involves forming the structure of the problem and the barrier between existing knowledge and what is necessary. The student identifies a general vector of activity aimed at solving the problem, which serves as the starting point for further activity.

4. Searching for solutions based on experience and intuition, forming hypotheses, and justifying them based on existing facts: The hypothesis serves as a narrower channel of activity than the general vector, helping to establish possible solutions. The correct formation of a working hypothesis requires it to correspond to known facts and not contradict established rules, regularities, and laws.

5. Proving the hypothesis: This is done by forming a system of tasks, the solution of which either confirms or refutes the hypothesis. If confirmed, it becomes the basis for developing a solution methodology; if refuted, it may be adjusted or discarded.

6. Verification of the solution's reliability: This stage is crucial, as only after it can the reliability of the hypothesis be asserted. After verification and obtaining multiple facts indicating the reliability of the solution, the task is considered completed.[21]

Each of the stages mentioned has its own characteristics, and it is incorrect to consider skipping or disregarding any of them. It is worth noting that dominant cognitive operations and cognitive processes manifest differently at each stage. The stage of situational awareness holds particular significance. Psychological and pedagogical analysis indicates that a student's sense of surprise is extremely important for solving the entire task. If a student feels a slight emotional shock, it contributes to the formation of interest and internal positive motives for solving the problem. On the other hand, understanding the essence of the problem is crucial, as students often focus on secondary aspects. Only correctly formulated questions can lead to correct answers. At this stage, the teacher acts as a consultant, guiding students' activities in the right direction. This guidance can be indirect through simple questions aimed at revealing students' correct understanding of the situation. Effective application of various techniques for conceptualization, establishing hierarchies of concepts, etc., is also important.[22]

During the hypothesis formation stage, analyzing already known facts (facts stated in the task condition and from students' previous experience) is crucial for the active development of analytical and data systematization skills. If necessary, the teacher can help form a preliminary system of

[21] Швардак М.В. Проблемне навчання в умовах сучасної школи. *Фізико-математична освіта : науковий журнал*. 2017, Випуск1(11). С. 124-127.

[22] Чепіль М.М., Дудник М.М. Педагогічні технології : навч. посіб. Київ: Академвидав, 2012. 224 с.

interrelation of factors, their significance, and priority. It is important to allow students to make mistakes and go through the process again, starting from earlier stages. Through trial and error, a clearer and more accurate hypothesis is formed each time. Superficial analysis of the situation is usually the cause of mistakes. Repetition of the process contributes to the development of attention, imagination, and memory.

Proving the hypothesis is the most productive stage of solving the task. This stage reflects the correctness and accuracy of performing the previous stages. It is extremely dynamic and requires the activation of all underlying processes and cognitive operations. Overcoming the barrier between existing knowledge and what is necessary occurs. Upon successfully proving the reliability of the hypothesis, the task is almost solved; if the hypothesis is refuted, it is modified or corrected. After conducting the reliability check of the hypothesis in the final stage, the task is solved. As experience in task performance is formed, the number of mistakes made by student's decreases, as does the time taken to complete the task.[23]

The effectiveness of using problem-based learning methods is based on the following psychological principles:

1. Alignment with learning objectives: Problem tasks should clearly correspond to the goals of knowledge formation. The informational context of tasks should match the educational content. Knowledge acquisition in this case occurs indirectly through the execution of problem tasks. Tasks, in turn, form a hierarchical structure, starting from simple ones and ending with complex ones.
2. Accessibility for students: The essence of the task and the mechanism of its solution should correspond to the potential level of students' abilities; otherwise, its execution is impossible.
3. Motivation of students' learning activity: The motivational sphere of personality is an important mechanism for directing activity. Therefore, forming positive motivations for learning is an integral attribute of productive learning.
4. Challenge without reliance on existing knowledge: Tasks should be such that students cannot solve them relying solely on their existing knowledge. At the same time, the barrier between existing and necessary knowledge for task completion should not be significant, as this prevents its execution.[24]

As a result of performing problem tasks, students develop the following skills:

[23] Павлюк Л.В. Проблемне навчання як засіб формування дослідницьких вмінь. Педагогічні науки: реалії та перспективи. 2012. № 31. С. 167-174.

[24] Павлюк Л.В. Проблемне навчання як засіб формування дослідницьких вмінь. Педагогічні науки: реалії та перспективи. 2012. № 31. С. 167-174.

Skills of mental operations and actions: Abilities to analyze, synthesize, generalize, systematize, compare, and differentiate significantly improve. The application of these operations and actions extends beyond the subject-specific knowledge, manifesting in various activities.

Transfer of knowledge skills: Knowledge acquired from one subject easily transfers to the learning process of another. Interdisciplinary connections are established, forming a unified integrated system of knowledge, which is reflected in the worldview of the student.

Summarizing, problem-based learning adheres to fundamental psychological and pedagogical principles of effective content implementation in education. It helps cultivate strong motivations for learning in children, meeting their inherent needs for exploration, information, and self-realization. Problem-based learning particularly effectively creates a success-oriented environment during problem-solving activities.[25]

An important psychological aspect, and in a sense its limitation, of applying problem-based learning lies in the age period of the students in which it can be utilized. Problem-based learning requires abstract thinking and verbal-logical memory. The first signs of abstract thinking in students appear in primary school ages, but fully utilizing all the possibilities of problem-based learning may not be feasible. Children in the early and partially later primary grades predominantly employ practical-active and image-language analyses. Therefore, from the perspective of developmental psychology, problem-based learning is best implemented starting from adolescence. Although children in this age range are psychologically ready to solve various forms of problem tasks, their primary activities still revolve around peer communication. Additionally, physiological changes in a child's attention span during this period also divert attention from learning. Hence, it's crucial not to overload the curriculum with problem-based learning activities during this time to avoid relative academic lagging. Problem-based learning forms should be utilized, but at lower levels of complexity during adolescence. Problem-based learning finds its greatest potential for implementation in the upper grades, which correspond to late adolescence and early youth.[26]

The primary activities may still involve peer communication and learning, as in the earlier school years. During these ages, all forms of problem-based learning implementation can be employed, as students develop a problem-

[25] Василега П.А. Вплив біологічної освіти на формування світогляду особистості в контексті особистісної реалізації. *Європейський університет: імідж, мобільність та соціальні перспективи:* матеріали Міжнародної науково-практичної конференції для студентів та молодих учених. Суми: ФОП Цьома С.П., 2016. С. 6-8.

[26] Швардак М.В. Проблемне навчання в умовах сучасної школи. *Фізико-математична освіта : науковий журнал*. 2017, Випуск1(11). С. 124-127.

oriented view of subjects, transitioning from quantitative reproductive activities to qualitative creative ones. Thus, problem-based learning realizes both the natural abilities of the child and the societal needs for active, purposeful individuals. It's worth noting that students must be theoretically prepared to tackle all forms of problem-based learning implementation to overcome the level of difficulty of tasks.

CONCLUSIONS

Summing up, we can note that problem-based learning emerges as a transformative educational strategy that goes beyond traditional teaching paradigms. By immersing students in authentic, real-world problems, it cultivates a deep sense of inquiry and curiosity, prompting them to actively seek solutions and collaboratively construct their understanding. This approach not only equips students with subject-specific knowledge and skills but also develops essential transferable skills such as critical thinking, communication, and collaboration.

Moreover, problem-based learning underscores the importance of context and relevance in education. By presenting tasks that resonate with students' interests and experiences, it enhances engagement and motivation, leading to deeper learning outcomes. This student-centered approach acknowledges the diversity of backgrounds and learning styles, promoting inclusivity and equality in education.

In conclusion, problem-based learning serves as a catalyst for intellectual growth and personal development, helping students become lifelong problem solvers and active participants in society. Its integration into educational content signifies a transition to dynamic, experiential learning models that prepare students for the challenges of the modern world and equip them with the skills necessary for success in various personal and professional contexts.

SUMMARY

Problem-based learning has deep roots and a history spanning several decades. Its development is closely linked to the contributions of numerous educators and psychologists such as Pestalozzi, Ushinsky, Elkonin, Davidov, Zankov, and others.

The concept of problem-based learning is constantly expanding and reinterpreted in line with modern trends in societal and educational development. This is reflected in the wide application of problem-oriented teaching methods in contemporary pedagogical practices.

Problem-based learning promotes the development of students' theoretical thinking, activates their activities, and fosters internal positive motivations for learning.

The variety of definitions of problem-based learning indicates a wide range of possible interpretations and approaches to its application, making this method flexible and adaptable to diverse educational contexts.

Bibliography

1. Павленко В.В. Технологія розвивального навчання Д.Б. Ельконіна, В.В. Давидова. Історичні аспекти, сучасний стан і перспективи розвитку системи дошкільної і початкової шкільної освіти: збірник науково-методичних праць. Житомир: Вид-во ЖДУ ім. І. Франка, 2014. С. 11-14.
2. Василега П.А. Використання методів проблемного навчання в процесі реалізації навчального змісту профільної біологічної освіти. Теоретичні та прикладні аспекти досліджень з біології, географії та хімії: матеріали І Всеукраїнської конференції студентів та молодих учених, м. Суми, 25 квітня 2017 р. Суми: ФОП Цьома С.П., 2017. С. 126-129.
3. Кокун О.М. Психофізіологія. Навчальний посібник. Київ: Центр навчальної літератури, 2006. 184 с.
4. Шевченко П.І. Профільне навчання в середній загальноосвітній школі. Педагогічний альманах. Збірник наукових праць. Київ-Херсон, 2006. С. 124-131.
5. Бандурка О.М. Основи психології і педагогіки. Харків: Вид-во Нац. ун-ту внутр. справ, 2003. 334 с.
6. Педагогічна психологія. за ред Л. Проколієнка. Київ: Либідь, 2001. 356 с.
7. Василега П.А. Значення та особливості організації процесу проблематизації навчального змісту профільної біологічної освіти. Virtus: Scientific Journal. 2016, № 7 С. 79-83.
8. Павленко В.В. Проблемне навчання: становлення, сутність, перспективи. Цілі та результати освітніх реформ. Київ: ун-т Б. Грінченка, 2013. С. 126-134.
9. Василега П.А. Психолого-педагогічні аспекти реалізації проблемного навчання. Актуальні питання, проблеми та перспективи розвитку гуманітарного знання у сучасному інформаційному просторі: національний та інтернаціональний аспекти: зб. наукових праць. Рубіжне: вид-во СНУ ім. В. Даля, 2015. С. 150-153.
10. Бандурка О.М. Основи психології і педагогіки: Підручник. Харків: Вид-во Нац. ун-ту внутр. справ, 2003. 334 с.
11. Ліфарєва Н.В. Психологія особистості: навчальний посібник. Київ: Центр навчальної літератури, 2003. 237 с.
12. Фурман А.В. Модульне-розвивальне навчання: принципи, умови, забезпечення: Монографія. Київ: Правда Ярославичів, 1997. 340 с.

13. Синергетика і освіта: монографія. за ред. В. Г. Кременя. Київ : Інститут обдарованої дитини, 2014. 348 с.

14. Цуркан Т.Г. Шлях до успіху особистості – через проблемне навчання. Педагогічні науки: теорія, історія, інноваційні технології. 2015. № 10 (54). С. 313-318.

15. Швардак М.В. Проблемне навчання в умовах сучасної школи. Фізико-математична освіта : науковий журнал. 2017. № 1(11). С. 124-127.

16. Чепіль М.М., Дудник М.М. Педагогічні технології : навч. посіб. Київ: Академвидав, 2012. 224 с.

17. Павлюк Л.В. Проблемне навчання як засіб формування дослідницьких вмінь. Педагогічні науки: реалії та перспективи. 2012. № 31. С. 167-174.

18. Василега П.А. Вплив біологічної освіти на формування світогляду особистості в контексті особистісної реалізації. Європейський університет: імідж, мобільність та соціальні перспективи: матеріали Міжнародної науково-практичної конференції для студентів та молодих учених. Суми: ФОП Цьома С.П., 2016. С. 6-8.

Information about the authors:
Vasyleha Pavlo Andriiovych,
Doctor of Philosophy,
Teacher of chemistry and biology
School No. 309 of Darnytskyi District in the city of Kyiv.
21-B, Petro Hryhorenko ave., Kyiv, 02000, Ukraine

Obukhova Lyudmyla Mykolaivna,
Teacher of chemistry highest category
School No. 309 of Darnytskyi District in the city of Kyiv.
21-B, Petro Hryhorenko ave., Kyiv, 02000, Ukraine