Teaching methods based on constructivism in environmental education

Klaida Doychinova

Department of Biology, Faculty of Natural Sciences, Konstantin Preslavsky University of Shumen,
115 Universitetska Str., 9700 Shumen, Bulgaria

Abstract: The traditional educational paradigm is increasingly giving way to active learning and the various possibilities for its application, which methodological basis is constructivism. They are all part of integrative learning, expressed in the creation of sustainable interdisciplinary connections. Constructivism is associated with key competencies for lifelong learning, necessary for ensuring a sustainable and adaptable to changes educational environment. This in turn requires a change in the teaching model and the application of technologies and approaches adjusted to these changes in the learning process. Part of these methods, that are successfully applied in problem-based, ecological education is project-based, and cooperative learning.

Keywords: constructivism, ecological education, problem-oriented learning, project-based learning, cooperative learning

Introduction
Rapidly growing educational system requires implementation of new teaching technologies and the use of innovative methods in ecological education, through which an active and independent position of the students is formed. Part of these technologies, which have emerged as innovative in recent years, include the project method, problem-based and cooperative learning. Today, one of the main goals of modern education is to cultivate a truly free individual, to form students’ ability to think independently, to absorb and apply
knowledge, to carefully consider the decisions made, and to clearly plan their actions and effectively cooperate in work groups of different composition and profile (Akinchina, 2015).

**Constructivism as a Philosophy**

Constructivism is a philosophical doctrine in education based on the idea that individuals actively construct their own understanding or knowledge through the interaction of what they already know and believe, and the ideas, events, and activities they engage with. In her book ‘Constructivism in Education’, Leslie Steph emphasizes that constructivism is the field focused specifically on the acquisition and structuring of knowledge, where it seeks to discover new perspectives (Steff, 1995). The philosophy of the constructivist approach treats knowledge not as acquired but constructed in the individual's mind and therefore cannot simply be transmitted from one person to another. New knowledge is built upon previous knowledge and the individual's experiences as a result of targeted activities in a specific situation (Tafrova-Grigorova et al., 2012). Constructivism as a theory of knowledge is based on the ideas of Piaget regarding the active nature of learning (‘knowledge is actively acquired by the learner, rather than passively obtained from the outside), Dewey's ideas emphasizing on the foundational significance of the learner's reflective activity, Viko's notion of the ability to articulate knowledge as a measure of understanding (‘Only the one who can explain something, is that one who can claim to know it’), and the Vygotsky’s recognition of the role of language in thinking. It considers language as a crucial tool in the process of cognitive development, as advanced models of thinking are transmitted through words (Swan, 2005). Constructivism in education can be defined as ‘learning through participation’ because the learner's cognitive activity plays a key role. The learner is not a passive recipient of information but an active participant in the learning process. By connecting existing knowledge and experience with new information, a learner constructs their own understanding based on active targeted activities, collaboration, and solving real-life problems. According to constructivism, we need knowledge in order to learn: it is impossible for any new knowledge to be assimilated without some structure being developed from previous knowledge. Therefore, the more we know, the more we can learn. New information entering the mind from the outside is not implanted ‘inside’ as it is: the learner seeks an appropriate model to transform it into new knowledge. Social relationships and interactions are also a source of knowledge. The learning environment presents the natural complexity of the real world, taking into account the influence of various factors: culture, technology, the learning process. The tasks are real and have contextual significance. The key aspects of social interaction are giving and receiving information, asking questions, providing answers, challenging and offering timely support, assisting, and providing feedback. The role of learners in education is related to their personality, motivation for learning, interests, opportunities for personal choice, social connections, and interpersonal relationships (Klisarov, 2019).
Constructivists unify around four central characteristics that are believed to impact the entire learning: 1) learners construct their own learning; 2) the dependence of new learning on students' existing understanding; 3) the critical role of social interaction; and 4) the need for authentic learning tasks for meaningful education (Applefield & Moallem, 2019).

To achieve the goals of environmental education, the constructivist design of learning proves to be suitable. It differs from the traditional learning model in two essential features. The first feature is the need for an exceptionally high level of interactivity. This requires planning to be done from a learner-centered approach, while learning is approached from a systemic perspective.

Teaching methods based on cooperation, interaction, problem-solving, as well as autonomy, activity, and creativity are of particularly high value. The second characteristic is related to the nature of knowledge. Students do not simply reproduce someone else’s knowledge, instead, they arrive at it through their own ways. This stimulates their critical thinking and cultivates motivated and independent learners (Vakleva et al., 2006). The constructivist design of learning significantly impacts pedagogical discourse. While the instructor typically does not name the cognitive-epistemic procedures, instead presenting ‘learning tasks’, the constructivist teacher utilizes cognitive terminology (‘classify’, ‘analyze’, etc.) when structuring the assignment. In the ‘Traditional method’ of teaching, the teacher asks memory-related questions and does not insist on an exact answer from the student – often it is sufficient if the response provides a clue regarding what the student wants to say. On the contrary, the constructivist asks questions related to thinking and analysis and insists on clear verbal externalization of the speech intention, as it is the only reliable indicator of understanding. If in traditionally organized learning, the teacher is predominantly the one who is asking, then constructivist learning theory focuses on the student's acquisition of the ability to ask meaningful questions.

The main role of the teacher is expressed in promoting the process of learning and thinking, structuring and providing information about problems and ideas that would motivate students towards learning, and assisting learners in understanding new knowledge by connecting it with the knowledge they have already acquired. The activities implemented in practice are aimed at encouraging students to ask questions. They conduct their own experiments, make their own similarities, and arrive at conclusions. They consider others' opinions while also critically reflecting on it. Individual knowledge is a result of constructing meanings and interpretations gained from the student's experience, questioning and analyzing tasks, and finding their own solution to problems. Despite different interpretations, it is generally accepted that the constructivist model of learning is characterized by the construction of one's own knowledge, which depends on existing knowledge and experience (Klisarov, 2019).
Ecological education in pedagogical theory and practice.

Ecological education is a ‘continuous process of learning, education and personal development aimed at forming a system of scientific and practical knowledge and skills, evaluative orientations, behavior and activities, appropriate character requirements that ensure the ecological responsibility of the individual for the state and improvement of the socio-natural environment’ (Zverev, 1980).

According to Vakleva (2008), in educational aspect, several emphases in the goals of environmental education stand out:

➢ To conceptualize environmental education as an aspect of the educational process and as a foundation for building a new lifestyle to ensure the survival of humanity. Acquiring ecological knowledge to preserve the integrity of nature, enhance the productive, healthy, and aesthetic qualities of the environment, and promote its sustainable development. To develop skills for individual and collective environmental activities, evaluative orientations, and a readiness to protect nature;

➢ Analyzing and understanding the outcomes of environmental education in relation to individual personality and their individual ecological culture, ecological consciousness, and behavior towards the natural environment. Demonstrating skills for effective interaction: being proactive, expressing freedom, providing support, organizational skills, etc.;

➢ Forming a conscious attitude among learners towards nature, their immediate surroundings, and the entire planet, and demonstrating ecological awareness and ecologically literate behavior in everyday life;

➢ Operationalisation of the goals and targeting them to universal human values.

Ecological education is called upon to fulfill an important socio-ecological function today, related to a new aspect of social life - the formation of ecological literacy, the cultivation of ecological consciousness, ecological ethics, and a responsible attitude towards nature as a universal value (Brylev, 2005).

Ecological literacy. J. Barrett is one of the first to define ecological literacy as ‘understanding the links between natural and social systems” (Barrett et al., 1997). Ecological literacy encompasses three levels (Coyle, 2005) - general ecological awareness, ecologically informed behavior, and ecological competence.

Ecological consciousness. The concept of ecological consciousness refers to the perception of the surrounding world and the attitude towards it. It is the result of implementing systematic ecological education and acquiring higher-level ecological knowledge, which involves a deep understanding of the unity of ‘society - individual – nature’ and the assessing the importance of environmental protection, which is vital for the normal life and existence of humanity (Dimitrova, 2013). Ecological consciousness encompasses several components: ecological knowledge, ecological self-awareness, goal-setting activities aimed at optimizing interaction with nature, and a system of intellectual, moral, economic, aesthetic, and value-based attitudes towards nature and the environment, manifested in the practical activity of man and society (Vakleva, 2008).
Ecological culture - Ecological culture should be understood as a combination of material and spiritual values created by humanity in the process of historical development. It is a result of mixing of objective and subjective characteristics based on a value-based attitude towards an ecologically clean environment. At the same time, ecological culture is characterized by fundamental features such as:

- Environmental education, environmental awareness, the desire to preserve and improve the geographical environment and its components as a basis for the existence of society;
- The ability to apply environmental knowledge in practice and in everyday life.

The ability to identify real environmental problems and find their optimal solutions, etc. (Andreeva, 2009).

Ecological Ethics - Ecological ethics is oriented towards a society being in harmony with nature, upon which its survival depends, and is guided by the principle of fair treatment of all living beings that play a role in preserving ecological sustainability. By its nature, ecological ethics is pluralistic and represents a wide range of socio-ecological values and beliefs. Its main goal is to provoke rapid change in collective practices and individual behavior (Dereniowska, 2019).

Ecological literacy, ecological culture, ecological consciousness, and ecological ethics regulate ecological behavior. It is expressed in actions and deeds that preserve nature, personal and public health (Vakleva, 2008).

To achieve the goals of environmental education, different forms of active learning play a significant role - problem-oriented learning, project-based learning, cooperative learning. They change the pragmatic orientation of learning and the active position of the trainees; the reproductive style is overcome; behavior evolves through group communication, aimed at assuming different roles and learning from the experience of participants; they present a new vision for the role of the teacher in education; the teacher transitions from being a primary source of information to a moderator of the process; they change the structure of communication in the lesson; students become active participants in the learning process and can change its course through their own experience and impressions; conclusions and summaries are consistently formulated by the students themselves through active communication at different levels; it relies on the natural inclination of students to communicate with each other.

**Problem-oriented learning**

Problem-oriented learning is based on the concept of ‘problem’, focusing on seeking and finding a solution from a given situation. It activates students' cognitive activity by putting them in situations to search for and discover information, facts, phenomena, concepts, presenting them as conclusions.
Problem-oriented learning implies acquiring new knowledge and skills as a function of existing knowledge associated with activities for obtaining new ones. The knowledge and skills are characterized by great breadth and durability, because they are acquired through the intellectual activity of the learners, high consciousness and motivation, which also develop their creative abilities. Therefore, this type of training has a special type of organization of educational knowledge, which assumes the creation, under the guidance of the teacher, of situations in which learners solve problems, mastering a number of knowledge and skills in the studied area independently. In this way, the students' cognitive activity is activated and their creative abilities are formed (Dimitrova, 2012).

In problem-oriented learning, the teacher does not provide ready-made knowledge but creates conditions for the discovery and application of the knowledge necessary for mastering new learning content. In this way, students become active participants in the learning process - they are not consumers of ready-made knowledge, but independently seek a solution to the posed problem, applying previous knowledge. Solving environmental problems requires creativity, criticality, creativity, analytical thinking. Arends (2012) outlines the following main characteristics of problem-oriented learning:

- **Stimulating question or problem** - problem-oriented learning focuses on socially significant problems for the students;
- **Interdisciplinary nature of the problem** - it requires the application of knowledge from different subject areas;
- **Conducting real research** - involves analyzing and defining the problem, developing hypotheses and making predictions, collecting and analyzing information, formulating conclusions and making generalizations;
- **Early results**;
- **Collaboration**.

In problem-oriented learning, heuristic methods are used - case study, brainstorming, discussion, with the basis of these methods being the analysis of specific situations as a ‘set of events occurring in a space in which the subject can react with some kind of action’ (Minchev, 1991).

**Example of a brainstorming session:** The case described is as follows: The 'Sand Lily' reserve belongs to the so-called 'maintained reserves' and is under the control of the RIOSV - city of Burgas. The Sand Lily itself is a rare Mediterranean species, a Tertiary relict, and is included in the Red Book of Bulgaria with the status 'endangered'. All activities are prohibited in the reserve. Most of the reserve is a kind of buffer zone between the beach and bungalow-like buildings. This makes it extremely convenient for use as a landfill. In places, paths and gates have been made, and the fence has been removed.
Suggest measures to preserve the habitat of the sand lily in the reserve that would be effective in the long term.

**Case example:** In connection with the expected learning outcome from 'Biology and Health Education' for 9th grade, that the student can 'forecast changes in the state of the biosphere as a result of human activity', the following case study could be set for resolution:

„This year, China will invest over 64 billion yuan ($10.13 billion) in a huge project to redirect southern rivers to the northern regions of the country. The total cost of the 'river reversal' project, approved in 2002, is over $77 billion. So far, $21.8 billion has been invested.

The project envisages the construction of a network of canals - Eastern, Central, and Western, through which part of the waters of the Yangtze, Huanghe, Huaihe, and Haihe rivers will be transferred north. The work is expected to continue for 50-60 years. Once the canals with a total length of 1300 km are dug, the Chinese North will receive nearly 50 billion cubic meters of water each year. In recent years, nearly 330 thousand people have been relocated from the areas in the central zone covered by the project. This year, thousands more will be relocated. A city in Hubei province is likely to be submerged under 170 meters of water.“

What changes will the project cause in the territories that will be dried up? What consequences could the project have on the plant and animal biodiversity in the affected areas?

**An example of a discussion:** In relation to the expected outcome from the Biology and Health Education course for 11th grade, where the student should justify the importance of genetic engineering for human progress from various aspects (socio-economic, scientific, ethical, etc.), a discussion can be organized on the topic: 'Pros and Cons of the Application of Genetic Engineering in Livestock and Agriculture.'

**Project-based learning**

Project-based learning (Toshev, 2009) is another variation of constructivist learning with a learning environment in which students perform complex comprehensive activity, requiring them to plan the tasks necessary to achieve the goal, to create a product to present to the audience, and to evaluate it. The application of the project method is one of the ways through which we can turn the school into a territory desired by the student. Students not only expand their knowledge on a specific topic, but also develop personal qualities of social significance. A prerequisite for this is teamwork, where the student learns to discover and present arguments, to defend a position, to be tolerant, and to listen to the opinion of the partner next to him. Project work requires initiative, precise planning of actions, and good organization.

Project-based learning is a form of situated learning (Greeno & Engeström, 2014) and is based on the constructivist assumption that students gain a deeper understanding of the material when they actively build
their knowledge by working with and using ideas in a real-world context. Project-oriented learning is closely linked to the constructivist model of learning and teaching, and also practically supports the implementation of concepts for self-regulated and transformative learning. The intention of the teacher when introducing project-based learning is to facilitate students' learning by involving them in an investigation that provokes their curiosity and critical thinking. This learning approach can help students develop the skills and strategies necessary for the 21st century, such as metacognitive, cognitive, and social. The metacognitive skills gained from project-based learning are planning investigations, reflecting on their research process, tracking their own progress, etc. Cognitive skills related to project-based learning are data collection, analysis and interpretation of data, synthesis, evaluation, and presentation. The social skills gained from project-based learning are collaboration, alternating, negotiating knowledge, sharing, etc. (Blumenfeld et al., 1991). Other skills acquired through project-based learning include: skills for active and critical learning, connecting learning with real-life situations, skills for critical and creative thinking, for facilitating problem solving and entrepreneurship, skills for collaboration and communication, and skills for critical reflection (Du Toit et al., 2016). Unlike problem-oriented learning, project-based learning is aimed at creating a specific end product. It ‘engages students in compound, complex activities. It is characterized by a high degree of motivation and allows everyone to discover themselves as subjects of knowledge’ (Mihova, 2002) PBL is a systematic teaching method that engages students in learning knowledge and skills through solving research problems, answering authentic questions and well-designed final products. PBL is also defined as an ‘instructional method’ that gives students complex tasks based on challenging questions or problems that involve problem solving, decision making, research skills, as well as self-reflection (Totseva, 2018). Project-based learning is seen as an interdisciplinary, student-oriented activity, the result of which is clearly defined. The essence of the project activity is not only expressed in the creation of an end product, but rather in the overall process of organizing and implementing the project itself and reaching the final product (Viraneva, 2016).

In PBL, students can actively participate in the learning process and the teacher can observe their activity throughout the educational process. Project-based learning leads to improvement of psychomotor skills, analytical thinking, teamwork skills, creativity and imagination, in accordance with the requirements for improving the learning process and increasing its quality. The implementation of the project goes through three stages (Doychinova, 2021):

- **Organizational-preparatory** - the following activities are carried out - forming the groups, setting the project theme, developing the technology for executing the project, defining a timeline for executing individual activities, an action plan, a list of necessary means, tools and materials;
➢ Technological - it is associated with the implementation of technological operations in the execution of individual subprojects and the quality of their execution. The leading activity is the practical application of the students;

➢ Summarizing - includes correcting and eliminating shortcomings, formatting the subprojects according to the requirements, presenting and defending the final result. The final products could be posters, presentations, boards, etc. The evaluation of the final products is based on predetermined criteria. The evaluation is done not only of the final product but also of the overall work of the team.

Project-based learning involves independent work by students, both in the development of individual projects and in group work. It is a challenge and a motivation, requiring students to think critically, cooperate, tolerate, and analyze, stimulating the formation of high-level thinking skills.

Example:

*Project Topic: The Journey of Waste, Grade 7.*

*Product: Presentation, poster, board, products from recyclable materials.*

*Orientation: The class is divided into groups of three and the groups choose to work on one of the following subtopics:*

➢ The journey of paper;
➢ The journey of metal;
➢ The journey of plastic;
➢ The journey of glass.

**Cooperative learning**

Cooperative learning is a constructivist model where students, divided into small groups, perform activities to achieve a common goal. The main goal of cooperative learning is for students to work together, thereby increasing not only their own learning results but also the results of others. Each group member is responsible for the final result. By analyzing cooperative, competitive, and individual learning situations, Johnson et al. (1989) conclude that cooperative learning is more productive, relationships are characterized by mutual respect, mutual aid, and concern, creating a favorable psychological climate. In situations of cooperative learning, there is a ‘positive interdependence between the achievements of the students' goals; students perceive that they can achieve their learning goals if and only if the other students in the learning group also achieve their goals (same source). In most cases, the class is divided into groups and works on a specific task. However, dividing the class into groups does not yet mean team/group work. For a group to start working as a team, there needs to be empathy among group members; individual and group responsibility; tolerance and direct interaction (Klisarov, 2019).
The most commonly used variations of cooperative learning is group research. Its theoretical foundation is J. Dewey's ideas of ‘progressive education’, where the educational content and teaching technologies are adapted to the interests and needs of the learners. The stages of group research are: determining a common theme - it could be formulated by the teacher; subtopics are chosen for the respective research teams; each team, after discussion, makes a decision on planning, organizing, and conducting the research process; searching and processing of information; preparing and presenting a report on the conducted research; evaluation and self-assessment of the presentations by the teams; evaluation of the presentations by the teacher.

It is important for each member of the team to have a specific role - e.g. leader, researcher, photographer, analyzer, speaker, etc. Thus, each member of the team feels responsible and significant for the final result of the given task. The participants do not compete with each other. Everyone has equal rights, and responsibilities, hence they receive a final grade - for the overall work of the team.

According to Joyce, the advantages of group research lie in the possibility of solving problems with high academic value; acquiring additional knowledge in the course of the research; improving skills for critical thinking, decision making, problem solving. He believes that this type of learning contributes to the development of tolerance, responsiveness and collegiality in the conducted discussions; formation of a sense of belonging and independence. Collective responsibility leads to a sense of fulfilled duty and better self-assessment (Joyce et al., 1992).

Collective responsibility leads to a sense of fulfilled duty and better self-esteem (Joyce et al., 1992). Group research requires time for planning and implementation and high professionalism from the teacher. There is a possibility that only some students will actively participate. This model is a successful learning strategy for all ages when studying academic problems or those directly related to the interests of students.

Example of a research project: The effect of lactic acid bacteria on corrosion.

Conclusion

The approaches presented as part of constructivism are directly related to the innovative processes that are increasingly applied in various subjects, including environmental education. Through them, key competencies are formed and developed, and successful personal realization is achieved. In the field of environmental education, the learning environment, the model of behavior towards the environment, and attitudes towards nature and the surrounding world are changing. The techniques mentioned stimulate research, investigative, creative, and innovative activities related to product creation or solving an environmental problem. In relation to students as equal participants in
the educational process, they increase motivation for learning and students’ cognitive activity; they develop creative and critical thinking; they expand the opportunities for cooperation and tolerance, contribute to the formation of decision-making skills; they improve the students' communication and presentation skills. All of this leads to the development of flexible thinking and the realization of the human-nature-society interconnection.

Acknowledgement

This article is published with the financial support of Project No.RD-08-113/20.02.2023 of the Konstantin Preslavski University of Shumen.

References

5. Blumenfeld, PC; Soloway, E; Marx, RW; Krajcik, JS; Guzdial, M; Palincsar, A. Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist*, **1991**, 26(3-4), 369-398.


