HEURISTIC QUESTIONS AS A MEANS OF DEVELOPING STUDENTS' COGNITIVE INTERESTS

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Abstract. *The article is devoted to the topical issue of developing students' cognitive interests by means of heuristic questions. Emphasis is placed on the heuristic method, its essence, and its main principles. The connection between the heuristic method and inquiry-based learning is explored. The authors discuss how the implementation of the heuristic method can enhance students' cognitive interests, deepen their understanding, and foster critical thinking in the process of acquiring scientific knowledge. The impact of cognitive interest development on learning outcomes and its application to increase students' motivation in school learning is substantiated. The concept of "cognitive interest" is clarified, and the stages, phases, and levels of cognitive interest development are outlined. Indicators of cognitive interest formation are established, and the potential of heuristic questions in developing students' cogni-*

tive interests is explored. Methodological approaches to formulating heuristic questions are summarized. Attention is drawn to the pedagogical model of "philosophical dialogue", which involves posing heuristic questions and searching for answers. Examples of heuristic questions that can be used in various scientific disciplines are presented. The general theoretical and methodological features of conducting a heuristic conversation and formulating heuristic questions are determined.

Keywords: *cognitive interest, heuristic method, heuristic questions, Inquiry-Based Learning, philosophical dialogue, questioning techniques.*

> *"Let's teach a child to think, let's open up the source of thought – the surrounding world. We will give him the greatest human joy – the joy of knowledge"*
>
> *V. Sukhomlynskyi*

INTRODUCTION, PROBLEM STATEMENT

Crisis situations, and especially war, have severe consequences for education, including the destruction of the education institutions network, reduction in the number of teachers, learning losses of students, forms a completely new educational environment (Topuzov et al., 2024). The new reality raises the issue of developing students' special qualities and skills including critical thinking and independence. An important component of this process is engaging each individual in active inquiry and questioning, which are key elements of Inquiry-Based Learning (IBL) (Kovalova, 2020). Particularly valuable in this context is the use of heuristic questions that encourage students to analyse, compare, classify, and synthesize information, contribute to a deeper understanding of scientific concepts and theories, stimulate their curiosity and cognitive interest, desire to learn more about the surrounding world, turning ordinary learning into a process of active discovery. The use of this method in school practice can significantly change the perception of learning, making the study of subjects more effective.

Based on the results of the study, we can state that the explanatory-illustrative and reproductive learning methods still prevail in Ukraine which are focused on the acquisition of predetermined knowledge and create an urgent need to use more progressive educational practices. The introduction of the heuristic method of teaching into the educational process opens the way to creating a more interactive, stimulating and effective learning environment, which is crucial for the development of the modern educational area in Ukraine, especially in the context of European integration.

The *article is aimed* at exploring the theoretical and methodological features of using heuristic questions and their importance for the development of students' cognitive interests. The *objectives* of the article are:

1. Explore the essence of the heuristic method and its relationship with IBL.
2. To reveal the role of heuristic questions in development cognitive interests of students.
3. Identify types and give examples of heuristic questions and strategies, methods and techniques for their use in the educational process.

LITERATURE REVIEW

The article is based on the following original publications.

First, analytical materials on the problems in science education of students and also on the implementation of the heuristic approach, its integration with inquiry IBL (Armstrong, 1899; Kremen, 2018; Djanpeisova & Khalilova, 2019; Kovalova, 2020; Liubarets & Lyubyma, 2022; Topuzov et al., 2024; Holiqova, 2024).

Secondly, the authors' research on the peculiarities of the development of children's cognitive interest, in particular levels and stages (Kravets et al., 2008; Naboka, 2011; Bibik, 2011; Terletska, 2013; Kulchytska, 2014; Bodnar & Makarenko, 2014; Akkerman & Bakker, 2019; Schraw & Dennison, 2021; Hui & Mahmud, 2023) and the relationship between theoretical

approaches to the development of cognitive interest and the conceptual framework of IBL research learning (Novitra et al., 2024).

Thirdly, methodological materials on the use of heuristic or philosophical questions in educational practice (Polya, 1981; King, 1994; Kryvonos, 2013; Mytnyk, 2013; Chemonina, 2013; Robinson & Hutchinson, 2014; Rotanova, 2015; Tsilmak, 2017; Lazarieva, 2018; Helskog, 2019; Demchenko & Turchyna, 2019; Greelane, 2019; Djanpeisova & Khalilova, 2019; Plokhuta et al., 2021; Havryliuk, 2021; Liubarets & Lyubyma, 2022; Akhmedov et al., 2024).

The use of literature sources is indicated in the presentation of main results.

MAIN RESULTS

In modern pedagogical theory, various teaching methods have been developed, including: reproductive, heuristic, problem-oriented, etc. These methods demonstrate different strategies for engaging students in the educational process, with a particular focus on how students interact with knowledge and how this interaction affects the process and the result. Training methods range from direct memorization to active discovery and adaptation to individual needs. Each of these can be integrated into science education, providing an efficient learning process.

Let's focus on the heuristic method of teaching, the founder of which in educational and scientific practices is considered to be Armstrong (1899). This method is widely used in various fields, including various branches of science, economics, business and computer science. According to Liubarets & Lyubyma (2022), it involves an effective combination of each participant's creative self-realization with collective activity and is based on a number of psychological and pedagogical principles, including: freedom and activity, task relevance, intuitive and logical thinking, and purposeful experience.

It is worth noting that the heuristic method integrates quite naturally into IBL, giving the child the opportunity to realize an important mission – to discover the inner and outer world, including scientific laws that meet his or her abilities and needs (Djanpeisova & Khalilova, 2019). Besides, it activates students' intrinsic motivation to learn and apply knowledge, helping them to understand the material more deeply, develop critical thinking and problem-solving skills, and improve communication and collaboration skills (Holiqova, 2024).

An important feature of the heuristic method is to develop students' cognitive interests, which is associated with various aspects of motivation and cognitive development. This process is reflected in several theoretical approaches: Maslow's pyramid of needs, Vroom's expectancy theory, Desi & Ryan's self-determination theory, Festinger's theory of cognitive dissonance, Piaget's constructivist theory, Atkinson's theory of achievement motivation, etc. Analyzing the position of scientists (Novitra et al., 2024), we note that the conceptual framework of IBL research learning is also based on these theories.

For many years, the problem of stimulating students' cognitive interest has been the focus of the classics of pedagogical thought (Kravets et al., 2008). The issues of interest are being actively developed in modern domestic (Bibik, 2011; Terletska, 2013; Kulchytska, 2014) and foreign (Akkerman & Bakker, 2019; Schraw & Dennison, 2021; Hui & Mahmud, 2023) research. An analysis of the works of these scholars allows us to state that the concepts of interest in general and cognitive interest in particular are close, but not identical. Thus, "*interest*" is defined as a selective orientation of attention, activity of the mind and emotions, stimulation of various feelings, active emotional and cognitive attitude to the world and a specific attitude to an object due to its significance and emotional appeal. In turn, "*cognitive interest*" is interpreted as an integral part of the personality that is associated with cognitive activity and forms personal relationships, including a selective attitude to scientific fields, participation in them, and communication with other researchers. It contributes to the formation of worldview, world understanding and worldview, influencing their activity and orientation.

Referring to the position of scientists (Bodnar & Makarenko, 2014), it can be asserted that cognitive interest has four stages.

Curiosity is the second stage of cognitive intelligence and is a more stable trait. It emerges quickly and fades just as fast, offering only temporary orientation in new situations. While it does not reflect a true desire for knowledge, it can be the first step toward developing cognitive interest.

Inquisitiveness is the second stage of personal development and is seen as a more stable trait. It involves a deeper desire to understand the essence of phenomena and events that inspire wonder and joy from learning. Inquisitiveness manifests not only during learning but also in other areas of activity, where a person actively explores the world around them and seeks new knowledge.

Actually cognitive interest is usually accompanied by active cognitive activity, selective attitude to educational subjects and valuable motivation, where cognitive motives dominate. This stage allows the individual to better understand the essential connections and patterns surrounding him and contributes to deeper cognition.

Theoretical interest is associated with the desire to explore complex theoretical questions and issues in specific sciences. It also reflects the wish to use theoretical knowledge as a tool for understanding the world. This stage is characterized by an active influence on the surrounding reality, which is closely related to the personal worldview and beliefs about the possibilities of science.

In Naboka's (2011) work, the following levels of cognitive interest development are outlined: *reproductive-factual* — students reproduce previously acquired knowledge without deep understanding or analysis; *descriptive-exploratory* — students are able to describe information, search for new connections between facts, conduct simple generalizations and analysis; *creative* – students generate new ideas and solutions, approach tasks creatively, and create original products. The researcher identifies indicators of the formation of cognitive interest: orientation towards the object of cognition, its stability, localization, and awareness; emotional manifestations such as intellectual joy and sharing impressions; volitional manifestations, in particular concentration of attention and the desire to complete educational tasks; focus on free choice of activity.

In addition, it is worth noting that the formation of cognitive interest depends on the levels of cognitive activity and is manifested in students' questions, their desire to participate in activities on their own initiative, the active use of acquired knowledge and skills, as well as the desire to share information with others. The main stages of cognitive interest development include: "creating conditions for the emergence of the need for knowledge; forming a positive attitude towards the academic subject; organizing activities that promote the development of genuine cognitive interest" (Bodnar & Makarenko, 2014).

For the development of cognitive interest in the context of the heuristic approach, the heuristic method of learning is important, which was introduced long ago by the ancient Greek philosopher Socrates — "maieutics" by analogy with the work of a midwife / "Socratic irony" / "Socratic dialogue". At the beginning, it involved the rejection of written works and focused on direct communication, which became a kind of laboratory for the joint search for truth and the assimilation of new knowledge. Questions were used as a tool through which truth was born in the consciousness of the interlocutor, helping them to reveal their intellectual abilities. In general, the essence of Socratic philosophy is embedded in the words: "I know that I know nothing" (Greelane, 2019). He was convinced that ignorance is a prerequisite for knowledge, stimulates the search and compels thinking.

Later, Socrates' method was improved by others scientists. Further developing the ideas of Socrates, the outstanding American mathematician and educator of the 20th century, Polya

(1981), in his fundamental work "Mathematical Discovery", quite aptly stated that the best way to learn something is to discover it yourself, because what you were forced to discover on your own leaves a pathway in your mind that you can use again when the need arises.

Scientists claim (Plokhuta et al., 2021) that if a person learns, but does not ask questions (independently formulated), she does not experience a state of incompleteness, which is the basis for any cognitive activity. Only when questions are formulated does the individual take responsibility for the state of cognitive "hunger" it causes. *A regularity is observed*: the more uncertainty contained in the questions, the greater their heuristic potential.

We note the position of Kryvonos (2013), which emphasizes that an important condition for the use of the heuristic method is the proper preparation of the teacher, his pedagogical skills and his perfect mastery of teaching methods. According to Mytnyk (2013), his activities can be carried out in two directions. *The first direction* involves the teacher independently drawing students' attention to the dialectical movement of thought towards truth through the use of heuristic questions, gradually involving pupils in scientific inquiry. *The second* is that the teacher enables students to independently search for ways to solve the problem, but, if necessary, directs their thinking by asking heuristic questions, and teaches students to independently formulate such questions for each analytical action and each structuring in scientific work.

In such an atmosphere, due to strong motivation or a strong need to create something extremely important, children have unlimited freedom and a powerful energy of creative inspiration (Lazarieva, 2018). This contributes to the formation of a free personality that voluntarily self-realizes, self-grows and self-improves in an environment that corresponds to its natural abilities.

The main stages of a heuristic conversation identified in the methodological literature are: "actualization of basic knowledge; creation of problem-searching situations; encouraging students to express hypotheses about solving the problem; requiring them to justify their point of view; directing students' cognitive activities, correcting responses; generalization and systematization of knowledge".

In practical activities aimed at developing students' cognitive interests, teachers should use various techniques for posing heuristic questions. One of the accessible and at the same time effective techniques for helping pupils identify the key root cause of a problem and its solution method is the interactive questioning technique "Five Whys" (who? | what? | when? | where? | why?), referred to as 5W (Havryliuk, 2021; Plokhuta et al., 2021).

Another well-known method is the technique of posing seven heuristic questions, based on the teachings of the ancient Roman theorist M. Quintilian. This set includes the questions: Who? (subject), What? (object), Why? (purpose), Where? (place), With what? (means), How? (method, way), When? (time). This system of questions can guide students to anticipate the construction of not only a lesson but also a topic. Researchers emphasize the following rules when using these questions: they should stimulate reflection rather than suggest a solution to the problem; they should contain minimal information.

Lyubarets & Lyubima (2022) describe their question-posing strategy, emphasizing that "it is necessary to ask about the reasons (Why? How? Who?); to delve into the answer (Why not? What will change if...); to look for alternative theories (Is there another possibility? Where else has something similar been used? What does intuition suggest?)".

American psychologist and educator King (1994) developed a series of questions classified by levels of cognitive activity, which contribute to the development of various aspects of heuristic thinking (see Table 1).

Similar to the previous one, it is worth mentioning the typology of heuristic questions "Bloom's Daisy" based on Bloom's taxonomy (see Table 2).

Table 1. Heuristic questions based on King's typology

Level of c.a.	*Questions*
Remembering	What do we already know about <...>? What are the principles of <...>? How does <...> relate to what we have learned before?
Understanding	Summarize <...> or explain <...>, What will happen if <...>?, What does <...> mean?
Applying	What is a new example of <...>?, How can <...> be used for <...>?, What is a counterargument for <...>?
Analyzing	Why is <...> important? What is the difference between <...> and <...>? What are the implications of <...>? Explain why / Explain how? What is the analog of <...>? What are the similarities between <...> and <...>?
Evaluating	How does <...> affect <...>?, Why does <...> happen?, What is the best thing about <...> and why?, Do you agree or disagree with the statement <...>?, What evidence supports your answer?, What are the strengths and weaknesses?, What is the nature of <...>?
Creating	What is the solution to the problem of <...>? What do you think causes <...>? Why? How can we look at <...> differently?

Table 2. Heuristic questions based on Bloom's typology

Question type	*Features of question type*	*Examples*
Simple (literal)	require naming facts, recalling or reproducing certain information	What?, Where?, When?
Clarifying	aimed at obtaining unknown information	What is the nature of ...?, What is the difference between ... and ...?, So you are saying that ...?, As far as we understand it, ...?, I may be wrong, but it seems ...?, Did we understand correctly that ...?
Interpretive	help establish cause-and-effect relationships	Why ...?
Creative	contain elements of conditionality, assumption, or prediction	What would change in the world if...? or other questions with the particle "b"
Evaluative	aimed at clarifying the criteria for evaluating different events, phenomena, or facts according to established standards	Why is something considered right/good and something else wrong / bad?, How does ... differ from ...?, What is your opinion on ...?, How do you feel about ...?, Do ... help?, Is ... useful?
Practical	establish the relationship between theory and practice	Where in everyday life can you observe ...?, How would you act in the place of ...?, What would you recommend for ...?, What should be done to ...?

We share the position that these types of questions can be used at all stages of the lesson: from learning new material to generalizing knowledge (Chemonina, 2013).

Researchers from the National Center for Learning Problems, Robinson & Hutchinson, in their work, present an elaborate strategy of questions that pupils should ask themselves at two stages: four questions during the presentation of the problem (transforming the word "problem" into an equation) and four after solving the problem (Robinson & Hutchinson, 2014) (see Table 3).

Table 3. Heuristic questions according to the typology of Robinson & Hutchinson

Stages	*Questions*
I	Did I read and understand each sentence? Are there words whose meanings I need to inquire about? Have I gained a complete picture or understanding of this problem? Have I recorded my understanding on paper? (purpose; unknown; known; type of problem; equation)
II	Did I write an explanation? Did I elaborate on the terms? Did I list the steps of my solution on paper? (collected as conditions; identified the unknown; found the unknown; checked my answer against the goal; highlighted my answer) What should I pay attention to in a new problem to understand if it is of the same type?

European scholars in their study proposed a methodology involving the use of heuristic questions in a "yes" or "no" format. Children are shown a specific event (for example, an orange that sinks in water after peeling, or a non-Newtonian fluid that hardens upon impact), and their task is to determine the cause of this phenomenon by asking as few such questions as possible.

Another group of European scientists (Djanpeisova & Khalilova, 2019) propose using heuristic questions with preschoolers and junior schoolchildren in the context of the adaptation (empathy) method — "co-experience", "immersing" the child in the state of the studied object, "humanizing" the object through sensory and cognitive engagement, and understanding it from the inside.

Also of interest are the so-called lists of control questions by Bush, Eylort, Osborne, & D. Polya. Based on research (Akhmedov et al., 2024), these questions have logical and philosophical-dialectical aspects such as belonging, existence, necessity, possibility, and uniqueness, and are divided into direct and indirect questions. Direct questions are generally aimed at problem-solving and include questions about the properties, characteristics of the object, general traits of these characteristics, and relationships between objects, while indirect questions complement these aspects by considering individual properties of the object in the context of other objects and relationships between them, as well as identifying which objects are involved in these relationships. They are actively used in the design departments of large multinational aviation, automotive, and engineering companies to generate new ideas and search for innovative design and technological solutions. Indeed, G. Bush's question list is considered a questionnaire for the hypothetical experiment of an inventor.

Additionally, researchers of the heuristic method should familiarize themselves with Polya's questionnaire, which outlines recommendations for solving tasks (Polya, 1981).

In the advanced domestic pedagogical experience of mathematics teachers, we find a heuristic methodology for stimulating pupils' research activity in the process of solving mathematical tasks.

Posing heuristic or philosophical questions to students forms the basis of the pedagogical model "Philosophical dialogue", which is being tested in the context of the development of the research topic "Methodological Foundations for Implementing Educational Models of Scientific Orientation in General Secondary and Extracurricular Education Institutions" by the Giftedness Development Design Department of Institute of Gifted Child of the NAES of Ukraine. A detailed description of different types of philosophical exercises is presented in the works of foreign (Helskog, 2019) and Ukrainian scholars (Demchenko & Turchyna, 2019). The use of different types of philosophical exercises in the educational process will contribute to the education of a critically thinking and creative personality, development of the ability to identify the specifics and obstacles that may arise in the process of using controversial issues and strategies to overcome them; development of analytical and critical

thinking skills, ability to deduce; ability to formulate philosophical questions for discussion / analysis / evaluation of events, phenomena, problems in various fields (science, culture, public life); development of the ability to hypothesize, express and defend one's own opinion, select arguments, formulate conclusions, and make generalizations.

CONCLUSIONS

In the context of modern challenges and educational tasks in Ukraine, the use of heuristic methods is gaining relevance, which correlates with the key elements of IBL, is gaining relevance, as through the active involvement of students in the context of studying academic subjects in the independent formulation of questions, development of scenarios for solving problems and critical analysis of data, scientific skills such as hypothesis formulation, experimentation and reflection are developed. Critical thinkers and self-realized individuals will be able to increase the strength and potential of the state and society in the future, improving the quality of life for all people and creating a prosperous, just and spiritually rich social order.

One of the key aspects of implementing the heuristic approach is the development of students' cognitive interests, which play an important role in stimulating an individual to deeply understand scientific knowledge, not just to get acquainted with it superficially. Cognitive interest activates all mental processes, encouraging the individual to constantly search for and transform reality through activity. Moreover, cognitive interest affects not only cognitive activity, but also any other activity, since the cognitive inception is present in every sphere. Cognitive interest is a complex scientific phenomenon whose essence, stages (*curiosity, inquisitiveness, actually cognitive and theoretical interest*), and levels (*reproductive-factual, descriptive-exploratory, creative*) are detailed in psychological literature. It should be noted, however, that the boundaries between these stages are conditional. In practice, these stages of cognitive interest can intertwine and interact with each other. Curiosity can develop into inquisitiveness, and various stages of cognitive interest may coexist within the same individual. In the educational process, cognitive interest is manifested in the students' attitude towards learning and specific subjects.

Generalizing the techniques of posing heuristic questions allowed us to formulate *general requirements / recommendations* for their use in order to stimulate students' cognitive interests and research activity:

- heuristic conversation should be correlated with the subject-subject and activity-based nature of the educational process, according to which students, along with teachers, should be active participants in cognition;
- it is important to keep in mind that heuristic questions should not only be asked by the teacher, but gradually students themselves should learn to formulate them;
- it is important to teach students to express their opinions, promote independent discovery of new knowledge, stimulate interest in learning about the world around them; they should learn to establish logical connections between existing and new knowledge, form conclusions and generalizations;
- it is worth analyzing the curriculum, identifying topics and choosing the educational material in the process of studying which heuristic questions will be most effective;
- it is necessary to determine the place of heuristic conversation in the structure of the educational process, to find out at what stage of cognition it will have the greatest stimulating and developmental potential, to ensure that pupils establish cause and effect relationships, compare and contrast, analyze and synthesize, prove and generalize;
- it is necessary to adhere to the principle of consistency and systematicity, take into account the specifics of the organization of the learning process, gradually introduce heuristic

questions in the context of the lesson, teach to independently analyze and compare concepts and facts;

• it is better to avoid heuristic conversation when the material is too voluminous and the time for the lesson is limited, or while studying complex topics of the program;

• it should be remembered that heuristic questions should be adapted to the age, individual characteristics of students and their general training;

• the teacher should be careful and tactful, not suppressing students' activity, but encouraging them to express their own opinions and arguments based on their personal experience;

• it is important not only that students' answers are correct, logically consistent, but also reveal the essence of the question and contain factual material; it is valuable to have students' interest in the discussion, desire to express their opinions, ability to argue and defend them.

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