

UDC 159.955-043.86:373.3.016:528.9-028.31(045)

DOI: 10.52534/msu-pp1.2025.32

Marianna Horvat*

PhD in Pedagogy, Associate Professor
Mukachevo State University
89600, 26 Uzhhorodska Str., Mukachevo, Ukraine
<https://orcid.org/0000-0003-2320-9731>

Mariia Kuzma-Kachur

PhD in Pedagogy, Associate Professor
Mukachevo State University
89600, 26 Uzhhorodska Str., Mukachevo, Ukraine
<https://orcid.org/0000-0002-8580-5830>

Development of spatial thinking in the process of cultivating cartographic literacy in primary education learners

Article's History:

Received: 23.10.2024

Revised: 25.02.2025

Accepted: 26.03.2025

Suggested Citation:

Horvat, M., & Kuzma-Kachur, M. (2025). Development of spatial thinking in the process of cultivating cartographic literacy in primary education learners. *Scientific Bulletin of Mukachevo State University. Series "Pedagogy and Psychology"*, 11(1), 32-40. doi: 10.52534/msu-pp1.2025.32.

Abstract. The development of spatial thinking is a crucial aspect of cognitive growth in primary education learners, as it enables the ability to navigate both real and graphical spaces, analyse relationships between objects, and assess their dimensions, distances, and locations. In contemporary educational contexts, the issue of fostering cartographic literacy as a means of enhancing spatial thinking has become particularly relevant, as it equips pupils with the skills necessary to work effectively with geographical maps and other graphical materials. This study aimed to substantiate the significance of spatial thinking for the intellectual development of young learners and to identify effective methods for its advancement in the process of cultivating cartographic literacy. The research involved an analysis of regulatory documents, educational curricula, and methodological guidelines governing the primary school education process. Additionally, an assessment of spatial thinking proficiency levels among young learners was conducted, revealing a predominance of intermediate and sufficient levels of competence development. This confirmed the need to refine methodological approaches to its development. The article examined contemporary pedagogical approaches that foster the development of spatial thinking, including graphic modelling, interactive exercises, problem-based learning, and the use of information and communication technologies. It has been established that implementing these methods enhances pupils' cognitive engagement, cultivates analytical thinking skills, and improves their ability to work with cartographic materials. The study findings indicated that the spatial thinking proficiency of most young learners is at an intermediate or sufficient level, highlighting the need to refine methodological approaches to its advancement. The proposed methods can be integrated into educational practice in traditional, blended, and distance learning formats, facilitating the development of spatial analysis and critical thinking skills while enhancing the effectiveness of knowledge acquisition.

Keywords: visual thinking; cognitive development; map work; graphic modelling; educational process

*Corresponding author



INTRODUCTION

In contemporary education, there is a crucial need to prioritise the development of spatial thinking among primary education learners. This skill forms the foundation for children's understanding of the world around them and is a vital component of overall cognitive function. However, a significant portion of academic studies in this area remains largely theoretical, lacking empirical research into the impact of cartographic literacy on spatial thinking development. The importance of fostering spatial thinking is underscored by its role in enabling individuals to navigate both physical and abstract environments. Consequently, the relevance of this research is further justified by the prevalence of theoretical discourse that is not substantiated by empirical evidence demonstrating the effects of cartographic literacy on the development of spatial thinking in primary school pupils.

In contemporary society, there is an increasing emphasis on developing well-rounded individuals who can adapt effectively to rapid changes, make creative decisions, and solve nonstandard problems (Resolution of the Cabinet of Ministers of Ukraine No. 87, 2018). A key factor in this development is spatial thinking, a vital human ability that involves spatial analysis and orientation in real-world environments, contributing to successful social adaptation. Spatial thinking is viewed as a mental process involving the creation and manipulation of spatial representations when solving practical and theoretical tasks. Its development is essential for the comprehensive intellectual growth of learners, as it fosters specialised skills important for future professional pursuits. Thinking, as a phenomenon, is a subject of research across various academic disciplines, including Psychology, Philosophy, Heuristics, Aesthetics, Cybernetics, and Neuropsychology. This has led to the identification of its essence, forms, types, and characteristics. Thinking is understood as a complex psychological process that enables purposeful, mediated, and generalised cognition of the essential characteristics of objects and phenomena in reality, as well as the relationships between them. It operates through integrated complexes of concepts and representations, facilitating the acquisition of new knowledge, easing adaptation to changes, predicting events, and achieving set goals (Kustov & Aleekseeva, 2010).

The development of spatial thinking significantly influences the overall intellectual growth of schoolchildren. It serves as a means for the practical perception of objects and phenomena in reality, facilitates successful engagement with various graphical models, and plays a crucial role in the psychological preparation of learners for diverse professional activities. The development of a pupil's personality through cartography is primarily associated with the formation of spatial thinking. According to H.I. Ivanova (2022), the process of spatial thinking involves the constant recoding of images, i.e., the transition from spatial images of real objects to their conventional graphical representations, from three-dimensional to two-dimensional images, and vice versa. The researcher characterised spatial

thinking by these procedural features: the ability to generate visual hypotheses (both reproductive and original), categorical flexibility, and constructive activity. Furthermore, she identified "three levels of spatial thinking development: initial – the ability to change the position of a spatial object; intermediate – the ability to change the structure of a spatial object; and advanced – the ability to create a new spatial object based on a model".

The influence of cartographic literacy on the development of spatial thinking has been explored by S.M.V. Castellar & B.G.F. Jordao (2021), who, based on their research findings, convincingly justified its significance, particularly given the increasing accessibility of digital cartographic resources in both public and private institutions. In-depth investigations into the impact of cartographic literacy on spatial thinking have been conducted by T. Wang (2022). This research emphasised the importance of teaching cartographic literacy in primary and secondary schools, highlighting its unique role in developing spatial thinking, especially considering the accelerated use of digital technologies in online teaching and learning during the COVID-19 pandemic.

In the research of O.I. Pometun & N.M. Hupan (2024), it is emphasised that the need to understand geospatial data has been further heightened in Ukrainian society by the war. Knowledge of geographical maps and the ability to navigate space have become crucial for survival. This underscores the need to develop spatial thinking, which facilitates the acquisition of geospatial data skills. Consequently, the researchers proposed the introduction of the pedagogical term "geospatial thinking" into the educational process, defined as "a set of knowledge and skills in using spatial concepts, maps, and graphs to analyse events, phenomena, and processes of the past, as well as the ability of learners to use them for the analysis and solution of contemporary problems".

Didactic recommendations on the methodology for developing cartographic literacy at various stages of working with maps are described by E. Oliveira *et al.* (2021). The value of this research lies in its description of an algorithm for pupils to complete practical tasks in map creation, which can even be visualised with detailed analysis of the territories or events depicted. The process of familiarising oneself with cartographic concepts is conducted in a gamified format, which motivates greater engagement in cognitive activities. I. Raynes (2020) proposed contemporary approaches to developing visual thinking when working with maps. A generation raised in a visually saturated culture requires something new and unconventional. The formation of cartographic literacy could be achieved through the method of animating the geographical environment in combination with storytelling. This research aimed to establish the significance of spatial thinking in the intellectual development of primary education learners and to diagnose and foster its development through cartographic literacy. Following the research aim, the following objectives were set:

1. To examine the dynamics of spatial thinking development in primary education learners during the formation of cartographic literacy.

2. To conduct a diagnosis of spatial thinking development in primary education learners during the formation of cartographic literacy.

MATERIALS AND METHODS

The research methods employed in this article included both theoretical and practical approaches. The theoretical aspects involved the analysis of scientific literature (Varii, 2009), psychological and pedagogical studies (Kustov & Alekseeva, 2010), methodological resources (50+ virtual tours..., 2020), and the review of primary

school textbooks and learning materials in the natural sciences. This review aimed to identify suitable methods and techniques for developing spatial thinking through cartographic literacy in primary education learners. The practical aspects included observations of the cognitive learning activities of primary school pupils (Hilberg *et al.*, 2021). The study of spatial thinking development in primary education learners was conducted according to the requirements of the Order of the Ministry of Education and Science of Ukraine No. 813 (2021). To determine the established levels of spatial thinking development in primary education learners, the proposed characteristics were used, and interpreted concerning the subject of the research (Table 1).

Table 1. Framework for assessing spatial thinking development in pupils during the formation of cartographic literacy

Levels	Criteria and indicators
High (H)	The pupil completes learning tasks at a productive-creative level: independently <i>identifies</i> objects mentioned in the tasks in the environment or on a graphical representation; <i>characterises</i> them, establishes cause-and-effect relationships and classification features; <i>applies</i> acquired competency components to achieve results in tasks related to the development of spatial thinking; <i>finds</i> additional information, evaluates it and transforms it into graphical form (on a contour map, site plan, diagram, etc.); <i>predicts</i> possible outcomes, correlates the results of completed work with assumptions and evaluates them
Sufficient (S)	The pupil completes learning tasks at a productive level: independently <i>identifies</i> objects mentioned in the tasks in the environment or on a graphical representation; <i>characterises</i> them, establishes cause-and-effect relationships and groups them; <i>applies</i> acquired competency components to achieve results in tasks related to the development of spatial thinking; <i>finds</i> additional information and transforms it into graphical form (on a contour map, site plan, diagram, etc.); <i>explains</i> the method of performing actions, verifies the possibility of completing tasks and evaluates them
Average (A)	The pupil completes learning tasks at a reproductive level: requires clarification when <i>identifying</i> objects mentioned in the tasks in the environment or on a graphical representation; <i>names</i> their essential features, groups them; <i>reproduces</i> learning actions according to an algorithm/scheme to achieve results in tasks related to the development of spatial thinking; <i>finds</i> additional information and transforms it into graphical form (on a contour map, site plan, diagram, etc.) following a model or with teacher assistance; <i>comments</i> on learning actions using reference points
Initial (I)	The pupil completes learning tasks at the level of copying examples after repeated explanation: requires clarification when <i>identifying</i> objects mentioned in the tasks in the environment or on a graphical representation; <i>names</i> their essential features; <i>reproduces</i> learning actions according to an algorithm/scheme to achieve results; <i>finds</i> additional information and partially transforms it into graphical form (on a contour map, site plan, diagram, etc.) following a model or with teacher assistance; <i>comments</i> on individual learning actions using reference points

Source: developed by the authors

The diagnostic assessment of spatial thinking levels was conducted based on the results of a thematic diagnostic task, “Nature of Ukraine”, with 4th-grade pupils from the Mukachevo territorial community. A total of 120 pupils participated in the study during the first semester of the 2024/2025 academic year. The task design incorporated a tiered approach:

- first level tasks required performing actions based on a model: using a local plan, draw the symbol for a mixed forest, a spring, etc.; using a physical map of Ukraine, mark the city of Kyiv on an outline map, and so on;

- second level tasks were reproductive and involved completing tests (selective);

- third level tasks involved practical work related to orientation on illustrated images, drawing basic local plans using five symbolic signs, and marking geographical objects (land surface forms) on an outline map of Ukraine;

- fourth level tasks were creative and exploratory in nature, presenting problems: using a local plan, prove that the distance between settlements is shorter when travelling along a path, and so on.

The task construction also considered the “Characteristics of Learning Outcomes” for primary education pupils, as outlined in the Order of the Ministry of Education and Science of Ukraine No. 813 (2021), relevant to the subject of the study. As the study used the results of planned diagnostic tasks from the curriculum, presented in an aggregated form (while maintaining confidentiality), the atmosphere during their completion was traditional, without any added psychological pressure.

RESULTS AND DISCUSSION

Modern education is adopting new educational practices and concepts, becoming more flexible, open, and dynamic. The volume and quantity of information that learners must master is constantly increasing. Independent searching for methods of selecting, transforming, and reproducing educational information becomes crucial, to incorporate technologies based on the principle of visualisation into the learning process. These technologies provide the opportunity to unify all theoretical concepts, allowing for rapid and comprehensive material summarisation and the application

of theoretical information in practical activities. Spatial thinking is characterised by a continuous process of recoding images. This involves transitioning from spatial representations of real-world objects to their symbolic graphical representations, as well as from three-dimensional to two-dimensional images and vice versa. This mental flexibility is a fundamental requirement for effective work across a broad spectrum of fields, from cartography to engineering.

The dynamic and fluid nature of imagery in younger school children necessitates a reevaluation of traditional approaches to developing cartographic literacy. The use of pre-made maps without analysis and interactive engagement transforms them into static images, which have low effectiveness in developing spatial competencies. Images that are not subjected to active analysis and transformation remain merely aesthetic objects, lacking educational value. Consequently, the pedagogical process loses the opportunity to employ active methods of working with cartographic materials, which would ensure the development of analytical and creative abilities. For example, the implementation of tasks involving the construction of three-dimensional models, the analytical processing of cartographic materials, or their interpretation.

The development of spatial thinking occurs non-linearly and is determined by age, individual, and sociocultural factors. The most sensitive period for its formation is early childhood when children exhibit an increased ability to dynamically manipulate spatial images. At this age, cognitive structures are not yet stabilised, creating opportunities for the active development of spatial imagination and analytical thinking under appropriate pedagogical guidance. Spatial thinking also functions as a subconscious cognitive process, integrating information from various sensory modalities. Breakthroughs in science and technology often originate in the subconscious, where information is integrated and transformed. Only at the stage of conscious analysis are they subjected to logical verification, which is crucial for their validity. This process directly contributes to the development of spatial thinking, a versatile tool for acquiring knowledge and mastering various activities. Therefore, the formation of spatial thinking in early childhood is not only a pedagogical task but also a critical condition for cognitive development.

Spatial thinking reaches its highest level of development on a graphical basis, due to its ability to visualise abstract ideas. This is especially important in the modern educational process, where the graphical representation of knowledge is an effective tool for its acquisition. Simultaneously, each subject area defines specific requirements for spatial thinking, forming a system of knowledge and skills that are adapted to the needs of the particular discipline. Spatial thinking enables individuals to represent the surrounding world in spatial forms, which is an integral part of their cognitive activity. All types of human activity are associated with both direct contact with objects and the manipulation of their mental images. The ability to manipulate spatial images allows for the integration of knowledge

about objects into coherent models of reality. In the context of school education, the problem of developing visual thinking is extremely relevant. Often, the reasons for learner underachievement remain obscured due to insufficient consideration of their individual cognitive styles. In particular, a lack of development in spatial thinking can become a barrier to mastering educational material, especially in subjects that require analytical and visual processing of information, such as mathematics and natural sciences.

The most advanced forms of spatial thinking are formed based on graphical representation, which serves as a foundation for constructing complex visual structures. Visual images are dominant in this process, as they most naturally reflect the spatial properties of objects and their interrelationships. In the process of solving cognitive tasks related to spatial thinking, there is a constant transition from one visual image to another, which allows for the sequential analysis, interpretation, and reconstruction of spatial interactions. Fig. 1 provides examples of tasks on the topic "What is the surface of Ukraine?" (4th grade) (Hilberg *et al.*, 2021):

1. Examine the diagram. Which types of terrain are classified as mountains, and which as plains? What do the numbers mean? Formulate a definition of a hollow.
2. On which plains (flat or hilly) is the horizon line visible further?
3. Mark the main landforms of Ukraine on an outline map.

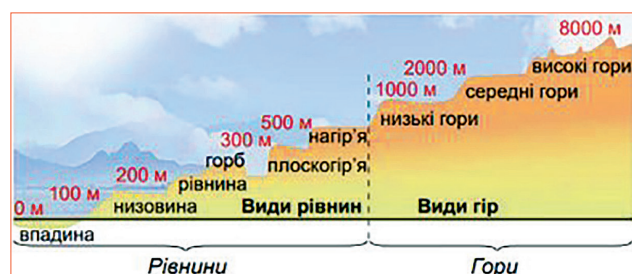


Figure 1. Types of terrain: plains and mountains

Note: Ukrainian textbook, the figure is presented in the original language

Source: T. Hilberg *et al.* (2021)

Modelling is an effective means of developing spatial thinking during the formation of cartographic literacy. When studying this topic, pupils will find it engaging to model landforms using materials such as modelling clay. The level of technological development has led to the saturation of the educational environment with digital devices. However, reduced funding for educational institutions due to the war limits the use of interactive whiteboards and smart tables for modelling, which would encourage pupils to create simple models or visualise geographical objects. Nevertheless, there are gadgets and interactive whiteboards that allow for the integration of digital technologies with interactive methods. Interactive methods, such as group work, the development of three-dimensional models, and

the analysis of cartographic data, play a crucial role in this process. The use of productive and problem-solving methods fosters the development of not only spatial thinking but also key competencies in learners. Furthermore, conducting demonstration activities using digital maps increases learner motivation and engagement in the learning process.

A distinctive feature of this process is the use of various types of graphical representations that complement each other, forming a systematic basis for thinking. Visual images not only reflect individual characteristics of objects but also interact with each other, creating coherent systems of representations. This systematicity allows for the transition from isolated object perception to an understanding of their complex interrelationships, which is key to developing flexible and analytical spatial thinking. This can include problem-based tasks such as: “Help third-graders select maps from the school atlas to answer the following questions:

- Where does spruce grow in Ukraine?
- Which countries border Ukraine?
- What is the highest mountain peak in Ukraine?
- Where is the Askania-Nova reserve located?
- Where is the region in which you live located?”

(Hilberg *et al.*, 2021).

Spatial thinking is based on the analysis of spatial properties and relationships of realistic objects or graphical representations. The foundation of spatial thinking is the manipulation of spatial images, which is formed in the process of perceiving or imagining spatial characteristics and relationships of objects. The term “imagination” is often considered synonymous with the concept of “spatial thinking”, as both these mental processes involve the active use of images and representations. Analysing the similarity between these concepts, it can be stated that there is a close connection between imagination and spatial thinking. Both processes are oriented towards the manipulation of images that reflect technical or spatial properties of objects, and they also jointly function in solving problems that require visualisation and transformation of spatial information.

The similarity between imagination and spatial thinking manifests in the shared mechanisms through which these processes form, process, and integrate spatial images. This has led to the frequent interchangeable use of the terms “imagination” and “spatial thinking” in literature, although there are certain differences related to their functional specificity. Spatial thinking primarily focuses on solving tasks that involve realistic manipulation of spatial properties, whereas imagination encompasses a broader range of cognitive operations related to the creative construction of images. Thinking is considered a method of cognition. From a psychological perspective, cognition appears as the process of creating representations (images) of the environment, its representations, and models. However, perception can also be cognition. Therefore, it should be emphasised that thinking is defined as “special cognition, “mediated and generalised”” (Varii, 2009). An example according to the subject of study: by examining the trunk of a tree, one can observe the placement of moss on it (representation 1).

In the case of mediated thinking, which goes beyond direct perception of the environment, a conclusion can be drawn about the location of the points of the horizon (representation 2). This process is schematically depicted in Fig. 2, using another example.

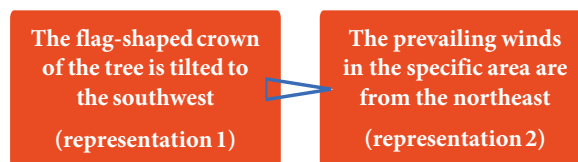


Figure 2. Representations

in thinking using cartographic concepts

Source: developed by the authors based on M.Y. Varii (2009)

When examining site plans and other geographical representations as models of the Earth’s surface, it is essential to highlight the importance of understanding the processes of their perception, as this regulates the cognitive process and influences decision-making when navigating space using a map. Spatial perception involves the conscious reflection of shape, size, distance between objects, and their relative positions. Perception is inseparable from the thinking and activities of learners and is one of the most important aspects of the holistic process of cognition. At the initial stage of developing spatial thinking through cartographic literacy, it is necessary to discuss spatial vocabulary with learners. The core concepts include words that can:

- describe shape in three-dimensional space: circle, ellipse, sphere, disc;
- define the size of objects: large, small, medium-sized;
- establish spatial characteristics: straight, wavy, concave;
- determine the location of objects: north, south, east, west.

It is essential to consistently encourage primary school learners to use spatial vocabulary during task completion, exercises, and other activities. When conducting tasks to develop spatial thinking, it is important to establish a direct connection between objects and the space around them. The methodological apparatus of the textbook includes illustrative cartographic material for modelling such tasks. These may include:

- for the topic “What is a site plan?” (4th grade): Which settlement is marked on the site plan? In which direction from the settlement is the orchard located? In which direction from the orchard should you move to reach the spring? If the Bila River flows from northwest to southeast, on which bank is the village of Lyvky situated? etc.;
- for the topic “What are globes and maps for?” (4th grade): Determine in which hemisphere, relative to the equator, Ukraine is located? Measure the length of the meridians and parallels on the globe with a measuring tape. Are the meridians and parallels of equal length? etc.

By understanding how maps are constructed, pupils can orient themselves, visualise locations, relative

positions, and sizes of objects and territories, and assess distances in their studies. However, using maps as a visual aid is not limited to the formation of spatial representations. Methods and techniques for developing cartographic literacy can vary and contribute to activating learning and cognitive activities: productive (applying learned material in practice), heuristic or partially searchbased (pupils discover individual elements of new tasks by solving cognitive problems), problem-based (pupils recognise a problem and find ways to solve it), and interactive (active interaction of all pupils, during which each pupil reflects on their activity and experiences their success). It is important to acknowledge the current realities of education, where the majority of institutions have transitioned to blended or distance learning. Nevertheless, internet resources (Pinterest, spatial intelligence) provide numerous ideas and suggestions for exercises to develop spatial thinking. Numerous proposals can be found for conducting virtual tours, with online access to these tours becoming more prevalent during the pandemic (50+ virtual tours..., 2020).

Through such activities, alongside spatial thinking, visual thinking is also developed. Learners can visualise images and details of objects or phenomena. For example, indicating the distance between objects, describing the nature of the steppe or tundra, modelling a food chain in a mixed forest, etc. New educational software and pedagogical tools designed to develop logical, critical, and spatial thinking in primary school learners are constantly appearing in the educational services market. Mini-games are particularly popular. Their application in the educational process requires primary school teachers to be knowledgeable in the theoretical and practical aspects of computer didactics (Horvat *et al.*, 2023). The diagnosis of spatial thinking development during the formation of cartographic literacy was conducted based on the analysis of a diagnostic task on the topic "Nature of Ukraine", where a tiered approach was considered in the task design. The results of the analysis are presented in Fig. 3.

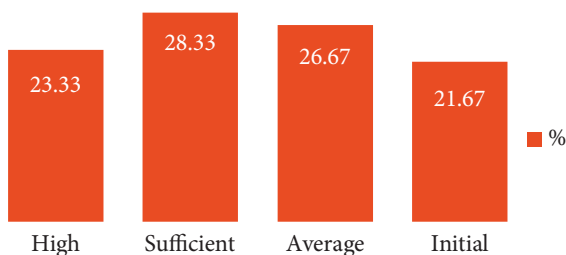


Figure 3. Quantitative indicators of diagnostic task results
Source: developed by the authors based on the results of the study

The experimental results demonstrated that the majority of primary school learners exhibit average (26.67%) and sufficient (28.33%) levels of spatial thinking development. This indicates that most pupils possess basic and intermediate skills in spatial orientation, with the ability to complete reproductive and partially productive tasks. Concurrently,

23.33% of pupils demonstrated a high level of development, characterised by the ability to analyse, apply a creative approach, and solve complex tasks. The smallest percentage of pupils (21.67%) are at the initial level, indicating a need for individual pedagogical support and repeated explanations. O. Novikova (2010) conducted thorough research on the development of spatial thinking in primary school learners, using a range of general methodologies ("Pattern Construction", "Meadow", Verkhuv tests, Silver tests, etc.). The research results showed that spatial thinking in pupils is not developed at a sufficient level: 23.59% – low; 56.1% – average; 20.31% – high. However, the list of diagnostic methods used does not include a cartographic component.

The National Doctrine for the Development of Education in Ukraine defines the need to modernise educational approaches that promote the development of key competencies, particularly spatial thinking. This thinking plays an important role in the formation of analytical and creative abilities, which are necessary for the harmonious development of the individual. Ukrainian researchers (Zharkova & Mechnyk, 2009; Novikova, 2017) emphasise the importance of using interactive technologies in the educational process, such as modelling, analysis of cartographic materials, and the construction of graphical models. These approaches help to develop learners' ability to independently solve practical and theoretical problems.

The obtained experimental results provide evidence of the relevance of this issue. Pupils with sufficient and average levels of development demonstrated the ability to work with graphical materials but required additional tasks to facilitate the transition to a higher level of development. At the same time, the proportion of pupils with a high level demonstrates that with appropriate pedagogical support, the development of spatial thinking is achievable even at the primary school level. All methodologies have their own characteristics, and their effective implementation depends on the level of teacher training. To address existing challenges and enhance learning effectiveness, it is necessary to:

1. Employ tasks involving graphical modelling and analysis of geographical maps.
2. Integrate information and communication technologies into the educational process.
3. Provide a differentiated approach to pupils with varying levels of spatial thinking development.
4. Maintain pupils' interest through interactive exercises and visualisation of learning materials.

Therefore, the research findings confirm the importance of improving pedagogical methodologies aimed at developing spatial thinking. The integration of innovative approaches will create conditions for the harmonious cognitive and personal development of learners, fostering skills necessary for the modern world. The problem of researching the development of spatial thinking and finding ways to improve it has been addressed by both past and present educators and psychologists. In particular, J. Piaget (2008) emphasises the role of images in mental activity. In his view, thinking originates in perceptual activity.

An important thesis for this research is that a map, like any other geographical representation, acts as an intermediary environment for humans, contributing to the development of the psyche. Mastering an image occurs in object-practical activity through the sphere of the ideal. Thus, the formation of cartographic literacy influences the development of an individual's spatial thinking.

In an analytical review of scholarly sources on the investigated problem, particular attention was focused on publications from recent years by both foreign and Ukrainian researchers. The fundamental principle was the relevance of the topic under consideration and the value of the research materials. T. Wang (2022) described the future of cartography and geoinformation systems, as well as the unique role of maps in the study of various disciplines for the development of spatial thinking. Among the challenges facing society, the author focuses on the fact that the level of spatial thinking and the ability to reason require more specific training in the context of their application. Therefore, particular attention should be paid to maps and the study of cartography. Understanding the components of cartography (scale, conventional symbols, orientation tools, etc.) is important in making decisions about spatial information. In this aspect, J. Kerski (2001) emphasises the importance of cartographic literacy for the development of spatial thinking and the deepening of geographical knowledge. The research results of G. Chu *et al.* (2018) highlighted that cartographic literacy is a valuable tool for developing pupils' spatial thinking and influencing their essential understanding of thematic maps.

The significance of spatial thinking, which is an integral component of cartographic literacy and a fundamental aspect of geographical education, was highlighted by D. Clarke (2003). In his opinion, geospatial technologies play a significant role in its development. Spatial information is considered particularly important for development, and he provides the example that up to 80% of decisions, particularly regarding construction, are based on space-related data, confirming the significance of an individual's spatial thinking. The psychological patterns of spatial thinking development were studied by O.A. Novikova (2017). The researcher emphasised that spatial thinking is a type of visual thinking and described five substructures of visual thinking: topological, projective, ordered, metric, and dominant compositional. Important in her research, considering the problem of the current study, is the assertion that "in its most developed forms, spatial thinking is formed predominantly on a graphical basis, and its features are studied in the context of general characteristics of visual thinking. Spatial thinking is formed in a system of knowledge that is to be acquired; each subject area, through its content, defines the requirements for the development of spatial thinking".

The elements of spatial thinking include: transitioning from surface to space and back and shifting from a fixed frame of reference to an arbitrary one. Graphical teaching aids for developing spatial thinking in primary school include site plans and geographical maps, through which

pupils directly perceive a visual representation of space. I. Zharkova & L. Mechnyk (2009) describe ways to improve the process of forming cartographic knowledge in primary school learners and their ability to work with geographical maps in their research. It is worth noting that practical educators, applying scientific research, offer their own developments regarding the development of spatial thinking in the study of the geographical component of education. For example, I. Obratsova (n.d.) (a teacher at Chernivtsi Gymnasium No. 5) proposed methods of visualising information in the process of studying topics in geography lessons: structural-logical schemes, Ishikawa diagrams ("Fishbone"), "Country Business Card" frame schemes, "Pyramid of Thoughts", and others. T. Nazarenko (2015) conducted a deep research analysis of the methodology for using cartographic literacy in the learning process, based on which it was proposed to use information and telecommunication technologies that would stimulate the development of cartography teaching methods in schools.

In the research of O. Pometun & N. Hupan (2024), it could be found a justification for the transformation of spatial thinking into geospatial thinking, which appears as a unity of three elements: spatial concepts (spatial cognition), representation tools (spatial thinking), and spatial reasoning (conclusions and hypotheses). E. Tretyakova (2018) closely links the categories "spatial thinking" and "spatial competence", emphasising that "the development of learners' spatial competence must go through two stages – the performance of exercises by pupils to acquire certain skills, and the performance of tasks aimed at forming a certain ability". Some aspects of the influence of cartographic material on the development of visual thinking in primary school learners are reflected in the study of I. Lapshina & S. Lupinovich (2022). The author presents the following algorithm for forming cartographic skills as a means of developing spatial thinking: object plan, object plan scale; site plan: conventional symbols of the site plan, site plan scale, cardinal directions on the site plan; map; map symbols, map scale. Despite a significant amount of research on this problem, not all aspects of primary school teachers' professional activities in developing spatial thinking during the formation of cartographic literacy have received complete and comprehensive coverage in the scientific literature and pedagogical practice.

CONCLUSIONS

The research results confirmed that the level of spatial thinking development in the majority of primary education learners is average or sufficient, indicating a need to improve methodological approaches to its development. Spatial thinking is an integral part of cognitive development, as it provides the ability to analyse relationships between objects, navigate space, and apply acquired knowledge in practical situations. The formation of spatial thinking is closely linked to cartographic literacy, which facilitates learning to work with geographical maps, analyse spatial data, and create graphical models. The conducted research showed

that the use of interactive exercises, graphical modelling, problem-based learning, and digital technologies promotes the development of pupils' analytical thinking and improves their skills in working with cartographic materials.

The results of the study also confirmed that the level of spatial thinking of students largely depends on the educational context in which they study. Both teaching methods and the use of various educational technologies can influence the development of spatial representations. Digital tools, such as interactive exercises and mapping software, play an important role in this process, helping not only to improve spatial orientation skills but also to develop analytical thinking in students. At the same time, the research

revealed that some pupils demonstrate a low level of spatial thinking, which requires an individual approach and adaptation to learning tasks. Further research could be aimed at developing personalised learning programs that take into account the individual characteristics of learners, as well as improving methods for assessing the level of spatial thinking development.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

None.

REFERENCES

- [1] 50+ virtual tours of museums around the world and Ukraine. (2020). Retrieved from <https://surl.li/zmurzo>.
- [2] Castellar, S.M.V., & Jordao, B.G.F. (2021). Spatial thinking in cartography teaching for schoolchildren. *International Journal of Cartography*, 7(3), 304-316. doi: 10.1080/23729333.2021.1969716.
- [3] Chu, G., Hwang, C., & Choi, J. (2018). Teaching spatial thinking with the national atlas of Korea in U.S. secondary level education. *Proceedings of the Ica*, 1, 1-5. doi: 10.5194/ica-proc-1-22-2018.
- [4] Clarke, D. (2003). *Are you functionally map literate?*. In *Proceedings of the 21st international cartographic conference* (pp. 713-719). Durban: Hosted by The International Cartographic Association (ICA).
- [5] Hilberg, T., Tarnavska, S., & Pavych, N. (2021). *I explore the world*. Kyiv: Geneza.
- [6] Horvat, M., Kuzma-Kachur, M., Bryzhak, N., Mochan, T., & Chuchalina, Y. (2023). *Information and communication technologies as a means of teaching natural science in primary schools: Professional teacher training*. *Youth Voice Journal*, 1, 30-39.
- [7] Ivanova, G.I. (2022). *Development of spatial thinking of students using 3D modeling*. In *The current state of development of world science: Characteristics and features: IV International multidisciplinary scientific and theoretical conference* (pp. 135-137). Lisbon: Portuguese Republic.
- [8] Kerski, J. (2001). A national assessment of GIS in American high schools. *International Research in Geographical and Environmental Education*, 10(1), 72-84. doi: 10.1080/10382040108667425.
- [9] Kustov, A.V., & Alekseeva, Y.A. (2010). *Thinking: Psychological, psychopathological and psychotherapeutic aspects*. Sumy: Publishing house of Sumy State University.
- [10] Lapshina, I., & Lupinovich, S. (2022). Stages of formation of information security skills in masters of specialty 013 Primary education. *Pedagogical Sciences*, 5(2), 64-69. doi: 10.33989/2524-2474.2022.80.278217.
- [11] Nazarenko, T.G. (2015). *Formation of cartographic literacy in primary school students in geography lessons*. *Ukrainian Pedagogical Journal*, 3, 126-136.
- [12] Novikova, O.A. (2010). *Conceptual model of studying spatial thinking in primary school students*. *Scientific Journal of the National Pedagogical University Named After M.P. Dragomanov. Series 19: Correctional Pedagogy and Special Psychology*, 16, 294-298.
- [13] Novikova, O.A. (2017). *Psychological patterns of spatial thinking development*. Retrieved from <https://ap.uu.edu.ua/upload/publicationpdf/bc57b435f8a5bcd5b60a8205db4c8e7d.pdf>.
- [14] Obratsova, I. (n.d). *Information visualization in geography lessons: Purpose, techniques, feasibility*. Retrieved from <https://vseosvita.ua/library/vydy-vizualizatsii-informatsii-z-heohrafii-756330.html>.
- [15] Oliveira, É., Ferreira, M., Oliveira, R., & Maciel, V. (2021). Usual and unusual maps: A playful introduction to the basic concepts of cartography in high school. *South Florida Journal of Development*, 2(1), 738-751. doi: 10.46932/sfdv2n1-053.
- [16] Order of the Ministry of Education and Science of Ukraine No. 813 "On Approval of Methodological Recommendations for Assessing the Learning Outcomes of Students in Grades 1-4 of General Secondary Education Institutions". (2021, July). Retrieved from https://drive.google.com/file/d/1DuEdJ31mq4-gyMoszi89TOWfu8q_-PRM/view.
- [17] Piaget, J. (2008). *Children's conceptions of space*. London, New York: Psychology Press.
- [18] Pometun, O., & Gupan, N. (2024). Issues of developing students' geospatial thinking in teaching history in the new Ukrainian school. *Ukrainian Pedagogical Journal*, 2, 131-139. doi: 10.32405/2411-1317-2024-2-131-139.
- [19] Raynes, I., & Heiser, N. (2020). Cartographic literacy through object-based learning: The value of primary sources in instruction. *Journal of Map & Geography Libraries*, 15, 1-23. doi: 10.1080/15420353.2020.1739188.
- [20] Resolution of the Cabinet of Ministers of Ukraine No. 87 "On Approval of the State Standard of Primary Education". (2018, February). Retrieved from <https://surl.li/svpsce>.

- [21] Tretyakova, O.V. (2018). [Cartographic skills as a component of spatial competence](#). *Theory and Methods of Teaching Social Disciplines: Scientific and Pedagogical Journal*, 1(6), 3-5.
- [22] Varii, M.Y. (2009). *General psychology*. Kyiv: Center for Educational Literature.
- [23] Wang, T. (2022). Future education of cartography and GIS: What is next?. *Journal of Geodesy and Geoinformation Science*, 5(3), 1-6. doi: 10.11947/j.JGGS.2022.0301.
- [24] Zharkova, I., & Mechnyk, L. (2009). [Ways to improve the process of forming cartographic knowledge and skills in working with geographic maps in younger schoolchildren](#). *Scientific Notes of Ternopil Volodymyr Hnatiuk National Pedagogical University. Series: Pedagogy*, 4, 95-100.

Маріанна Горват

Кандидат педагогічних наук, доцент
Мукачівський державний університет
89600, вул. Ужгородська, 26, м. Мукачево, Україна
<https://orcid.org/0000-0003-2320-9731>

Марія Кузьма-Качур

Кандидат педагогічних наук, доцент
Мукачівський державний університет
89600, вул. Ужгородська, 26, м. Мукачево, Україна
<https://orcid.org/0000-0002-8580-5830>

Розвиток просторового мислення в процесі формування у здобувачів початкової освіти картографічної грамотності

Анотація. Розвиток просторового мислення є важливим компонентом когнітивного розвитку здобувачів початкової освіти, оскільки воно забезпечує здатність орієнтуватися у реальному та графічному просторі, аналізувати взаємозв'язки між об'єктами, оцінювати їхні розміри, відстані та розташування. У сучасних освітніх реаліях особливої актуальності набуває проблема формування картографічної грамотності як засобу розвитку просторового мислення, що дозволяє учням ефективно працювати з географічними картами та іншими графічними матеріалами. Метою дослідження було обґрунтування значущості просторового мислення для інтелектуального становлення особистості молодших школярів та визначення ефективних методів його розвитку в процесі формування картографічної грамотності. У ході дослідження було проведено аналіз нормативно-правових документів, навчальних програм і методичних рекомендацій, що регламентують освітній процес у початковій школі. Також здійснено діагностику рівнів сформованості просторового мислення у молодших школярів, що дозволило встановити переважання середнього та достатнього рівнів розвитку цієї компетенції. Це підтвердило необхідність удосконалення методичних підходів до її формування. У статті розглянуто сучасні педагогічні підходи, які сприяють розвитку просторового мислення: графічне моделювання, інтерактивні вправи, проблемно-орієнтоване навчання та використання інформаційно-комунікаційних технологій. Виявлено, що впровадження цих методик дозволяє активізувати пізнавальну діяльність учнів, формувати навички аналітичного мислення та покращувати здатність працювати з картографічними матеріалами. Результати дослідження засвідчили, що рівень сформованості просторового мислення у більшості молодших школярів є середнім або достатнім, що вказує на необхідність удосконалення методичних підходів до його розвитку. Запропоновані методики можуть бути впроваджені в освітню практику у традиційній, змішаній та дистанційній формах навчання, що сприятиме формуванню в учнів навичок просторового аналізу, критичного мислення та підвищенню ефективності засвоєння навчального матеріалу

Ключові слова: наочно-образне мислення; когнітивний розвиток; робота з картою; графічне моделювання; освітній процес