



Theory and teaching methods

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Formation of causal relationships in schoolchildren while studying geological processes

Oleh Vodianyi

Candidate of Historical Sciences,

Associate Professor of the Department of Ecology, Geography, and Teaching
Methods

of Hryhoriy Skovoroda University in Pereiaslav

Orcid ID: 0000-0003-3585-8296

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Annotation. The article reveals the problem of forming cause-and-effect relationships in schoolchildren in the process of studying geological processes in geography. It substantiates the importance of developing cause-and-effect thinking as an important component of students' cognitive activity, which ensures a deep understanding of natural phenomena, the patterns of development of the Earth's crust, and the interrelationships between the components of the geographical envelope. The psychological and pedagogical foundations of the formation of cause-and-effect relationships at school age and their role in the development of logical, systematic, and critical thinking are analyzed. The didactic possibilities of topics related to endogenous and exogenous geological processes are identified for developing students' ability to establish the causes of phenomena, predict their consequences, and assess their impact on the natural environment and human activity.



Particular attention is paid to teaching methods and techniques that promote the cognitive activity of schoolchildren, in particular the use of problem questions, educational situations, analysis of geographical maps and diagrams, modeling of geological processes, as well as working with cause-and-effect chains and logical diagrams. It is shown that the systematic application of such methods increases the level of awareness of the educational material and contributes to the formation of a holistic view of the dynamics of geological processes.

It is concluded that the purposeful formation of cause-and-effect relationships during the study of geological processes increases the effectiveness of geography teaching, contributes to the development of students' natural scientific thinking, and forms the basis for an environmentally responsible attitude towards the environment.

Keywords: *geography, theory and methodology of geography teaching, geological processes, cause-and-effect relationships, geographical education, cognitive activity, critical thinking, methods of teaching geography, school geography course.*

Формування причинно-наслідкових зв'язків у школярів під час вивчення геологічних процесів

Водяний Олег Миколайович,

кандидат історичних наук,

доцент кафедри екології, географії і методики навчання

Університету Григорія Сковороди в Переяславі

Orcid ID: 0000-0003-3585-8296

Анотація. У статті розкрито проблему формування причинно-наслідкових зв'язків у школярів у процесі вивчення геологічних процесів у курсі



географії. Обґрунтовано значення розвитку причинно-наслідкового мислення як важливої складової пізнавальної діяльності учнів, що забезпечує глибоке розуміння природних явищ, закономірностей розвитку земної кори та взаємозв'язків між компонентами географічної оболонки. Проаналізовано психолого-педагогічні засади формування причинно-наслідкових зв'язків у шкільному віці та їх роль у становленні логічного, системного й критичного мислення. Визначено дидактичні можливості змісту тем, пов'язаних з ендогенними та екзогенними геологічними процесами, для розвитку в учнів уміння встановлювати причини виникнення явищ, прогнозувати їх наслідки та оцінювати вплив на природне середовище й діяльність людини.

Особливу увагу приділено методам і прийомам навчання, що сприяють активізації пізнавальної діяльності школярів, зокрема використанню проблемних запитань, навчальних ситуацій, аналізу географічних карт і схем, моделювання геологічних процесів, а також роботі з причинно-наслідковими ланцюгами та логічними схемами. Показано, що систематичне застосування таких методів підвищує рівень усвідомленості навчального матеріалу та сприяє формуванню цілісного уявлення про динаміку геологічних процесів.

Зроблено висновок, що цілеспрямоване формування причинно-наслідкових зв'язків під час вивчення геологічних процесів підвищує ефективність навчання географії, сприяє розвитку природничо-наукового мислення учнів та формує основу для екологічно відповідального ставлення до довкілля.

Ключові слова: географія, теорія і методика навчання географії, геологічні процеси, причинно-наслідкові зв'язки, географічна освіта, пізнавальна діяльність, критичне мислення, методи навчання географії, шкільний курс географії.

Relevance of the study. Modern geographical education is focused not only on the acquisition of factual knowledge by students, but also on the formation of key



competencies, among which the development of logical, critical, and cause-and-effect thinking occupies a special place. The ability to establish connections between natural phenomena, explain the reasons for their occurrence, and predict possible consequences is a necessary condition for a comprehensive understanding of the Earth's geographical shell and the processes taking place within it.

The study of geological processes in the school geography course creates favorable didactic conditions for the formation of cause-and-effect relationships, since such processes are characterized by a clear sequence of factors, the interdependence of phenomena, and the visible results of their manifestation. The analysis of endogenous and exogenous processes allows students to understand the dynamic nature of the Earth's crust, the interconnection between the Earth's internal and external forces, and the impact of geological phenomena on natural complexes and human economic activity.

At the same time, the results of pedagogical practice show that a significant part of schoolchildren learn the material in a fragmented way, without a proper understanding of cause-and-effect relationships, which reduces the effectiveness of learning and complicates the formation of a holistic scientific picture of the world. This necessitates the introduction of teaching methods and techniques that would ensure active cognitive activity of students and contribute to the conscious establishment of logical connections between geographical phenomena.

In this regard, it is important to find and justify effective pedagogical approaches to the formation of cause-and-effect relationships in schoolchildren when studying geological processes, which determines the content and focus of this study.

Analysis of recent publications. In recent years, both domestic and foreign pedagogical studies have shown growing attention to the problem of developing students' geographical, critical, and inquiry-based thinking, which is directly related to the formation of skills for establishing cause-and-effect relationships in the process of learning geography.



The methodological foundations for the use of inquiry-based technology in the school geography course are thoroughly analyzed in the work of N. V. Biriukova and V. P. Romaniuk (2025). The authors argue that engaging students in research activities promotes the development of analytical thinking, the ability to formulate hypotheses, analyze causes, and predict the consequences of geographical phenomena. Particular emphasis is placed on combining problem-based tasks with independent information search, which creates conditions for a conscious establishment of cause-and-effect relationships.

The development of critical thinking as a necessary component of geographical education is explored in the study by D. K. Zhdanov, N. M. Maslova, and V. M. Myrza-Sidenko (2024). The authors substantiate the effectiveness of problem-based learning methods for forming students' ability to explain geographical processes, analyze their causes, and assess possible consequences. At the same time, cause-and-effect relationships are considered mainly as an element of critical thinking, without being specifically identified as an independent didactic outcome.

In the context of forming research competencies, the work of V. S. Yatsenko is significant, as it demonstrates that geography has strong potential for developing students' scientific thinking through the analysis of natural processes and phenomena. The author emphasizes that research activity in geography is impossible without establishing cause-and-effect relationships; however, the issue of purposeful formation of such skills is addressed only indirectly.

Issues of the content of geographical education in conditions of integration are highlighted in the works of T. H. Nazarenko (2022) and T. H. Nazarenko and O. A. Poltavchenko (2022). The authors emphasize the importance of forming students' holistic understanding of natural processes and phenomena, which presupposes comprehension of their causes, conditions of origin, and consequences. At the same time, the focus is placed mainly on content integration, whereas the methodological mechanisms for forming cause-and-effect relationships require further clarification.



Of particular interest is the study by O. V. Nepsha (2024), devoted to the use of critical thinking development technology in the school geography course. The author proves that systematic work with problem questions, situation analysis, and reflection contributes to the formation of students' ability to explain geographical phenomena. However, cause-and-effect relationships are considered as a component of general cognitive development, without detailing their formation based on specific geographical topics.

In the article by V. Nosachenko (2024), the possibilities of digital technologies in the training of future geography teachers are examined. The author notes that digital tools open new opportunities for visualizing complex processes and developing analytical thinking; however, the issue of developing students' cause-and-effect thinking in the school geography course is addressed indirectly, through the professional training of teachers.

Foreign studies complement the domestic scientific discourse. Thus, T. Bendl (2024) considers geographical thinking as a key goal of geographical education, emphasizing the role of explaining spatial and processual relationships. P. Charzyński (2025) focuses on the need to shift from digital consumption of information to real analysis of geographical processes, which contributes to a deeper understanding of causes and consequences. J. Heuzeroth (2021) substantiates the effectiveness of metacognitive strategies for forming complex cause-and-effect structures in geographical learning; however, his approach is of a general methodological nature and requires adaptation to the specific content of the school course.

Thus, the analysis of contemporary scientific publications indicates a significant interest in the development of students' geographical, critical, and inquiry-based thinking; at the same time, the problem of purposeful formation of cause-and-effect relationships in the process of studying geological processes remains insufficiently developed.



Identification of previously unresolved aspects of the general problem.

Despite the availability of a considerable number of studies devoted to the development of students' critical, geographical, and inquiry-based thinking, analysis of scientific sources shows that the formation of cause-and-effect relationships is mostly considered as a derivative or accompanying component of these processes rather than as an independent object of methodological analysis.

In most works, there is no holistic approach to using the content of topics related to geological processes as a systematic means of forming cause-and-effect thinking. The didactic potential of endogenous and exogenous processes for developing students' abilities to establish causal relationships, trace sequences of events, predict consequences, and assess their impact on the natural environment and human activity is insufficiently outlined.

In addition, contemporary studies lack clear methodological substantiation of the step-by-step formation of cause-and-effect relationships in the school geography course—from simple linear dependencies to complex multifactorial interrelations that are characteristic of geological processes.

These aspects determine the need for a special study aimed at identifying pedagogical conditions, methods, and techniques for forming cause-and-effect relationships in students during the study of geological processes in the geography course.

Presentation of the main material. The formation of cause-and-effect relationships is one of the key tasks of geography education, as it is these relationships that provide a conscious understanding of natural processes and patterns of development of the geographical environment. Mastering this skill allows students not only to reproduce educational information, but also to analyze phenomena, explain the mechanisms of their occurrence, and make logically sound conclusions. This approach facilitates the transition from reproductive assimilation of knowledge to its meaningful application in educational and life situations.



At school age, the development of the ability to establish causes and effects occurs gradually – from simple linear dependencies to complex multifactorial relationships. In the early stages of learning, students focus on the immediate causes of phenomena, while in the upper grades, their ability to consider a set of factors and their interaction increases. That is why systematic work with cause-and-effect relationships is an important condition for the development of logical and critical thinking in schoolchildren.

As V. Popov notes: “Identifying and understanding the causes of processes, the consequences of these causes that lead to changes in geographical objects, and determining patterns form the basis of students' geographical thinking” [12, p. 23]. Therefore, understanding the causes of processes, their consequences, and patterns is a key component of students' geographical thinking, which coincides with the idea of a gradual transition from simple linear to complex multifactorial relationships.

A study by L. Prokhorova et al. asserts that the process of forming geological and geomorphological skills is carried out through the gradual inclusion of practical and independent work in the educational process in accordance with the course program and through the office processing of field research during geological excursions and trips so that students can see the results of their work and Thanks to this, students not only gain theoretical knowledge, but also see the real consequences of their activities, which strengthens their understanding of cause-and-effect relationships in nature.

Geological processes, which have clearly defined dynamics and spatial-temporal manifestations, create a favorable basis for the development of this type of thinking in students. The study of endogenous and exogenous processes makes it possible to trace the sequence of events, determine the causes of changes in the Earth's surface, and analyze their consequences, which in turn contributes to the formation of a holistic view of the development of the Earth's crust and the interaction of internal and external forces of the Earth.



The ability to combine theoretical knowledge with visual examples of geological processes in the real environment is of particular pedagogical value. The analysis of maps, diagrams, photographs, and examples from the surrounding world helps students to better understand cause-and-effect relationships and consolidate the learning material [5; 14; 15]. Such activities stimulate cognitive interest and contribute to a deeper understanding of natural phenomena.

Therefore, the purposeful formation of cause-and-effect relationships in the process of studying geological processes is an important factor in improving the effectiveness of geography education. It contributes to the development of students' analytical thinking, the formation of a scientific picture of the world, and creates the basis for a conscious and responsible attitude towards the natural environment.

The content of topics related to endogenous geological processes, in particular volcanism, earthquakes, and mountain formation, provides ample opportunity for students to form ideas about the underlying causes of changes in the Earth's crust. Studying these phenomena allows students to understand that the external manifestations of geological activity are the result of complex internal processes occurring in the Earth's interior. This contributes to an understanding of the cause-and-effect relationships between the structure of the planet and the formation of the modern relief.

When considering the topic of lithospheric plate movement, students analyze the mechanisms of their interaction—divergence, collision, and subduction. For example, explaining the formation of the Himalayas based on the collision of the Indian and Eurasian plates allows students to clearly trace the chain of events: “plate movement – compression – folding – mountain formation.” This approach helps students understand the regular nature of mountain-building processes and the spatial distribution of the world's largest mountain systems.

The study of volcanism contributes to the formation of ideas about the connection between magmatic processes and manifestations of volcanic activity on the



Earth's surface. Analysis of the causes of volcanoes in plate divergence zones or subduction zones, as well as examples of eruptions of Vesuvius, Etna, or Krakatoa, allow students to trace the relationship between the structure of the Earth's crust and the nature of volcanic activity [15]. Examining the consequences of eruptions – changes in relief, the formation of new islands, the impact on climate and human life – deepens understanding of the complexity of geological processes.

Equally important is the analysis of the causes of earthquakes, which allows students to establish a connection between the accumulation of stress in the Earth's crust and its sudden release. Looking at examples of strong earthquakes in Japan, Turkey, or Chile helps students understand the spatial distribution of seismically active areas along the boundaries of lithospheric plates. This helps students develop the ability to explain the causes of seismic hazards and assess the possible consequences of such natural phenomena.

Working with maps of tectonic structure, diagrams, and profiles of the Earth's crust contributes to the effective formation of cause-and-effect relationships [5]. Comparing maps of the distribution of volcanoes and earthquakes with a map of lithospheric plates allows students to independently draw conclusions about the patterns of their distribution. The use of video materials and computer models of dynamic processes helps to visualize complex phenomena and better understand the sequence of events.

Thus, the content of topics on endogenous geological processes, supplemented with real-world examples and a variety of teaching aids, creates conditions for a deep understanding of cause-and-effect relationships, which contributes to the development of scientific thinking in schoolchildren and forms a holistic view of the dynamic nature of the Earth's development.

Exogenous geological processes, such as weathering, erosion, surface and underground water activity, wind, and glaciers, are equally important in forming cause-and-effect relationships. Studying them allows students to understand the role of



external factors in changing the Earth's surface and to understand that the modern relief is the result of long-term interaction of natural processes. Such topics contribute to the formation of ideas about the gradual but constant nature of geological changes. The study of weathering processes allows us to trace the dependence of rock destruction on climatic conditions. For example, comparing physical weathering in arid regions with sharp daily temperature fluctuations and chemical weathering in humid tropical zones helps students establish a connection between temperature, precipitation, and the rate of rock destruction. This helps them understand why some landforms remain unchanged for a long time, while others undergo intense changes.

Studying erosion processes caused by water helps students understand the reasons for the formation of ravines, gullies, and river valleys. Analysis of examples from Ukraine, in particular the development of water erosion on the slopes of the Podillia Upland or the Dnipro Upland, allows us to trace the dependence of erosion intensity on precipitation, slope steepness, soil type, and vegetation cover. Students learn to explain how deforestation or plowing of slopes intensifies erosion processes and leads to land degradation.

The activity of wind and glaciers is also an important example of the formation of cause-and-effect relationships. Looking at the formation of dunes in desert and coastal areas or moraines and glacial valleys in mountainous areas allows students to establish the dependence of landforms on the strength and duration of external agents. Analysis of modern and ancient glaciations helps to understand the role of climate change in landscape formation.

An important part of studying exogenous processes is understanding their impact on human economic activity. Students learn to predict the possible consequences of floods, landslides, deflation, or coastal erosion, as well as to assess the risks to settlements, agriculture, and infrastructure. Thus, the analysis of exogenous geological processes contributes to the formation of not only cause-and-effect thinking, but also



environmental awareness and a responsible attitude towards the use of natural resources.

The effectiveness of establishing cause-and-effect relationships largely depends on the use of active teaching methods, in particular the use of problem-based questions, analysis of real geographical situations, construction of cause-and-effect chains, and logical diagrams. Modeling geological processes, performing practical tasks using maps and profiles, as well as group work contribute to the development of analytical skills and the formation of skills for reasoning one's own conclusions.

An important role in the formation of cause-and-effect relationships is played by the systematic and consistent work with them at different stages of the geography lesson – from motivation and actualization of basic knowledge to generalization and reflection. This approach ensures the integrity of the learning process and contributes to the gradual complication of cognitive tasks. Students not only learn individual facts, but also learn to see the logic of the development of natural phenomena and processes.

At the motivation stage, it is advisable to use problem questions and real-life situations that encourage students to think about the causes of the observed phenomena. For example, questions such as “Why are most volcanoes concentrated along the boundaries of lithospheric plates?” or “Why do river valleys have different shapes?” arouse cognitive interest and create the prerequisites for searching for cause-and-effect relationships in further study of the topic.

When studying new material, work with cause-and-effect relationships is carried out through the analysis of diagrams, maps, tables, and logical chains. Students learn to answer questions such as “What is the cause?” and “What is the effect?” by establishing the sequence of events and the interdependence of factors. The use of comparative analysis is particularly effective, as it allows students to identify common and distinctive features in the development of geological processes in different natural conditions.



At the stage of consolidating knowledge, it is advisable to use practical tasks aimed at independently establishing cause-and-effect relationships. These can be tasks for predicting the consequences of changes in natural conditions, drawing up cause-and-effect diagrams, or analyzing specific geographical situations. Such activities contribute to the development of analytical skills and form the ability to explain one's own conclusions in a reasoned manner.

The stage of generalization and reflection allows students to comprehend the knowledge they have acquired and evaluate their own learning progress. Constant reference to questions such as “why?”, “what are the consequences?”, “under what conditions?” develops students' scientific thinking skills, their ability to generalize information and draw logical conclusions. As a result, systematic and consistent work with cause-and-effect relationships contributes to a deeper understanding of the material and increases the effectiveness of geography education in general.

Conclusions. Thus, the purposeful use of geological topics in combination with a well-thought-out system of methodological techniques creates favorable conditions for the effective formation of cause-and-effect relationships in schoolchildren. Analysis of endogenous and exogenous geological processes, work with cartographic materials, diagrams, models, and real-life examples contribute to an understanding of the regular nature of changes in the Earth's surface and the interdependence of natural phenomena. This allows students to move from a fragmented perception of information to a holistic understanding of geographical processes.

Systematic work with cause-and-effect relationships at different stages of the lesson stimulates students' cognitive activity and develops logical and critical thinking skills. Constant involvement in the analysis of the causes, conditions, and consequences of geological phenomena develops the ability to explain natural processes in a reasoned manner, make generalizations, and predict possible changes in the natural environment. As a result, awareness of the assimilation of educational material and the effectiveness of geography teaching in general are increased.



At the same time, the formation of cause-and-effect relationships in the process of studying geology has important educational significance. Awareness of the interdependence of natural processes and human activity contributes to the development of environmental awareness, a responsible attitude towards the use of natural resources, and an understanding of the consequences of anthropogenic impact on the environment. Students acquire the ability to assess natural risks and realize the need to adhere to the principles of sustainable development.

Therefore, the geological component of the school geography course is an effective means of forming a holistic scientific picture of the world, developing natural scientific thinking, and preparing students for conscious interaction with the environment. The implementation of a systematic approach to the formation of cause-and-effect relationships not only improves the quality of geography education, but also creates the basis for the development of environmentally responsible and socially mature individuals.

References

1. Bendl T. Geographical thinking in geography education. *International Research in Geographical and Environmental Education*. 2024. URL: <https://www.tandfonline.com/doi/full/10.1080/10382046.2024.2354097> (accessed: 21.12.2025).
2. Charzyński P. Geography from screens to streets – Navigating digital natives into real-world geographical thinking. *European Journal of Mathematics and Science Education*. 2025. URL: <https://www.ejmste.com/download/geography-from-screens-to-streets-navigating-digital-natives-into-real-world-15986.pdf> (accessed: 20.12.2025).
3. Heuzeroth J. Metacognitive Strategies for Developing Complex Geographical Causal Structures by Students in the Geography Classroom. *Journal of*



- Education and Learning (MDPI, 2254-9625). 2021. URL: <https://www.mdpi.com/2254-9625/11/2/29> (accessed: 20.12.2025).
4. Бірюкова Н.В., Романюк В.П. Методичні особливості використання дослідницької технології навчання в процесі вивчення географії. *Наукові записки Вінницького державного педагогічного університету імені Михайла Коцюбинського. Серія: Теорія та методика навчання природничих наук.* № 9. 2025 С. 19-28
 5. Дидактика географії : монографія (електронна версія) / В.М. Самойленко, О.М. Топузов, Л.П. Вішнікіна, І.О. Діброва. Київ : Ніка-Центр, 2013. 570 с.
 6. Жданов Д.К., Маслова Н.М., Мирза-Сіденко В.М. Розвиток критичного мислення учнів у процесі навчання географії методами проблемного навчання. *Наукові записки. Серія: Проблеми природничо-математичної, технологічної та професійної освіти.* 2024. С. 62-70
 7. Модельна навчальна програма «Географія. 6-9 класи» для закладів загальної середньої освіти (авт. Кобернік С.Г., Коваленко Р.Р., Гільберг Т.Г., Даценко Л.М.). URL: <https://mon.gov.ua/static-objects/mon/sites/1/zagalna%20serednya/Navchalni.prohramy/2021/14.07/Mo-del.navch.prohr.5-9.klas.NUSH-poetap.z.2022/Prirod.osv.galuz/Neohrafiya/Neohrafiya.6-9%20kl.Kobernik.ta.in.06.05.22.pdf>
 8. Назаренко Т.Г. Створення шкільного підручника географії на засадах інтегрованого навчання. *Проблеми сучасного підручника.* Вип. 28. 2022.С. 80-89.
 9. Назаренко Т.Г., Полтавченко О.А. Дослідження функції географічної складової інтегрованих курсів. *Український педагогічний журнал,* Вип. 3. 2022. С. 90-99



10. Непша О. В. Використання технології розвитку критичного мислення в навчанні шкільного курсу географії. *Наука і техніка сьогодні*. 2024. № 5(33). С. 764-778. DOI:10.52058/2786-6025-2024-5(33)-764-778.
11. Носаченко В. Використання цифрових технологій у підготовці майбутніх учителів географії для формування їхніх професійних компетентностей *ScienceRise: Pedagogical Education*. 2024. №3(60). С. 34-39. DOI:10.15587/2519-4984.2024.310373.
12. Попов В. Формування причинно-наслідкових зв'язків в процесі вивчення географії. *Інформаційний, науково-методичний журнал «Освіта Сумщини»*, № 2 (58), 2023. С. 23-27.
13. Прохорова Л. А., Непша О. В., Завялова Т. В. Формування геолого-геоморфологічних навичок та вмінь учнів на уроках географії в освітніх установах. *Педагогіка формування творчої особистості у вищій і загальноосвітній школах*. 2019 р., № 62, Т. 1. С. 123-127.
14. Слюта А. М. Методика навчання географії. *Навчально-методичний посібник для студентів ЗВО спеціальності 014 Середня освіта (Географія)*. Чернігів: Десна Поліграф, 2021. 248 с.
15. Фідря Н. М. Навчання учнів процедур «порівняння» та «пояснення» як ключовий елемент переходу до суб'єкт-об'єктної моделі побудови навчально-виховного процесу. *Географія та економіка в сучасній школі*. 2013. № 11. С. 24-33.
16. Яценко В. С. Формування дослідницьких компетентностей учнів з географії як наукова проблема. Wydawnictwo: MANS w Łomży, m. Łomża, Polska - m. Kijów, Ukraina, С. 141-149.