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INTERDISCIPLINARY LINKS AS A DIDACTIC CONDITION FOR IMPROVING THE QUALITY OF THE EDUCATIONAL PROCESS

Abstract

In geographical education, interdisciplinary links allow to identify the main elements of educational content, to develop system-forming ideas, concepts, general scientific methods of learning activities, opportunities for students to comprehensively assimilate knowledge from different scientific disciplines. Interdisciplinary links influence the composition and structure of each academic discipline. Therefore, it is very important to emphasize the interdisciplinary connections taken into account in the content of geography and, conversely, in other fields of science besides geography. The aim of this study was to conduct a systematic review of interdisciplinary related science fields that integrate geographic educational technologies. The study used methods of analysis, differentiation, systematisation to identify the interdisciplinary links between geography and sciences such as history; biology; ecology; mathematics; cartography; physics and chemistry. As a result of the study, it was found that these branches of science - form a holistic scientific worldview in the student, strengthen interdisciplinary links. Thus, interdisciplinary links in geographical education are a modern principle of learning, influencing the choice and structure of teaching material in a number of disciplines, and an integrated organisational form that activates teaching methods.

Keywords: geography; education; interdisciplinary links; systematic review; analysis.

Basic provisions. This study aimed to find out how cross-curricular links affect the improvement of the quality of the learning process. This is because identifying interdisciplinary linkages is considered the most important factor in building a complete and quality education system. Interdisciplinary communication improves critical thinking, objective and subjective thinking in value acquisition by involving collaboration between researchers from different disciplines to solve complex problems.

Therefore, this study presents a systematic review of the interdisciplinary fields of science that integrate natural geography education technologies. This has enabled the relationship of geography to natural history and other sciences to be explored and a number of generalisations to be made. The study details the interdisciplinary relationship of geography with history, biology, ecology, mathematics, cartography, physics and chemistry. The methods of analysis, differentiation, systematisation were used to determine the interdisciplinary relations of geography. Because there are very few scientific studies that reveal the interdisciplinary links between geography and other sciences. Therefore, these methods were chosen to conduct the study.

Thus, curricula designed on the basis of interdisciplinary linkage have proved to be very flexible in the pragmatic use of subjects. Proper integration of topics from different fields motivates a person to participate in the educational process and thus ensures quality training. The interdisciplinary approach does not contradict the disciplinary approach, but rather complements it. It also helps to bridge the gap between geography and the natural sciences and improve understanding and co-operation.

Introduction. In the period of globalisation, geography and natural sciences have become an interdisciplinary field that integrates educational technologies (Taylor, 2009). Since geography is the most appropriate discipline for interdisciplinary learning as it serves as a bridge between humanities and natural

sciences (Sağdiç et al., 2014). In this sense, there are very few subjects in today's updated educational programme that are not related to geography. In fact, the subject of geography is a science connected to all scientific fields. Interdisciplinary communication through close interaction with each other facilitates the learning of any science, the acquisition of knowledge and its effective use by students (Mansurjonovic et al., 2023; Gao et al., 2023). Therefore, when studying science, teachers should pay attention to such issues.

Interdisciplinary connections are integral to a quality education system because when students understand a problem, they learn more about a scientific discipline (Didonato, 2013). Therefore, interdisciplinary learning allows students to improve their thinking and reading skills, have higher cognitive abilities, and make connections between different contexts (Yang et al., 2014). Interdisciplinary communication is necessary to create a balance between objective and subjective thinking, critical thinking, and interdisciplinary learning is a natural process of structuring and implementation(Sarsebayeva et al., 2023; Ibrahim, 2020). At this stage, teachers come to the fore, for example, when considering the topic of migration in a geography lesson, it is necessary to relate it to migration events in literature, migration of tribes studied in history, migration activities of living beings past biology. Accordingly, it is necessary to invite students to plan their study time effectively within the curricula of these disciplines.

Among the branches of science that study nature, geography, physics, astronomy, biology, chemistry, and ecology are called natural sciences. The main place among them is occupied by physics, because the meaning of this term means "nature" (Margot et al., 2019). At the same time, the relationship between geography and other branches of science that study nature is very broad and encompasses various aspects. Therefore, several disciplines have emerged to study various phenomena occurring in the environment. However, as new knowledge accumulated, the objects of study became more complex and biology was separated from geography and then from geology (Shogan et al., 2020). Currently, thanks to the work of scholars such as D'agostino & Santus (2022), Walshe (2016), Lyall et al. (2013), who have investigated the various components of the geographical envelope, the link between geography and other sciences continues to strengthen. Thus, given the structure and research characteristics of geographical science, the main purpose of this research paper was to explore the interdisciplinary links between geography and other sciences. The research will reveal a wide range of interdisciplinary links between geography and physics, chemistry, history, mathematics, cartography, biology and ecology. Prediction of the study: teaching a geography lesson using an interdisciplinary approach enhances cognitive development, abstract thinking, creativity and problem-solving skills through the integration of different disciplines.

Materials and Methods. The notion of interdisciplinary connections not only implies solving a concept or problem using several disciplinary methods, but also separately considers the interconnection of disciplines (Wang et al., 2020; Alieva, 2020). While an interdisciplinary approach is effective in deepening subject knowledge, they look for mutually relevant connections with an emphasis on higher level thinking (Mancas, 2011). In addition, interdisciplinary communication of educational knowledge implements the dialectical method, performing primarily methodological functions. The most basic dialectical task of interdisciplinary communication is to create a link between the educational and developmental nature of the learning process. Challenges such as globalisation, environmental and social changes, and the transition to the information society can be addressed very effectively through an interdisciplinary approach (Orazymbet, 2014). This is because planning the teaching and learning process based on an interdisciplinary approach plays an important role in consolidating the in-depth knowledge gained in the study of individual disciplines and maintaining the educational process. However, some teachers believe that the integration of subjects may become overload for students.

In this context, the desire to study a wide range of problems involving a complex combination of phenomena and processes is the impetus for research that brings together traditional disciplines. Indeed, geographers play an active role in many interdisciplinary projects. Geography draws on such majors as spatial analysis, human-environment interaction, and geographical and regional analyses, which fosters links with many other disciplines. It studies the dynamics of space, place and interactions, especially within and between spaces and places, as well as geographical perspectives and ideas, peripheries (Terranova, 2022). It is through interdisciplinary collaboration that faculty members, noting the many positive aspects of working with colleagues from other fields, confirmed their desire for interdisciplinary work in the future. Patience and open-mindedness is one of the most important factors contributing to the success of interdisciplinary collaboration (Bloodworth et al., 2011). Therefore, geographers should continue to demonstrate interdisciplinary leadership by accepting different perspectives, seeking knowledge and methods that other fields can share, supporting institutional arrangements that foster interdisciplinary work.

Therefore, the aim of this study was to explore the interdisciplinary links between geography and other sciences. This is because the use of interdisciplinary links in geography lessons normalises students' holistic view of the environment and increases student's cognition. Also, such interdisciplinary links in geography lessons build freedom of thought and expression, which allows the teacher to take an interest in their subject.

Interdisciplinary studies are seen as an amalgamation that preserves the autonomy of different disciplines and does not lead to changes in existing theoretical structures. Interdisciplinarity of school subjects has one major feature, as do the processes of integrated teaching of many sciences. Mutually coordinated teaching of subjects by content - not only improves the quality of students' knowledge, but also promotes the practical application of acquired knowledge, expands the scientific worldview, opening the way to the formation of a unified world thought. Moreover, since geography is a universal school subject, integration and connection with any subject can be found at the will of the teacher. Therefore, in this study the links between geography and other sciences (history, biology, ecology, mathematics, cartography, physics and chemistry) were examined in detail. The methods of analysis, differentiation, and systematisation were widely used to maximise the disclosure of geography's interdisciplinary links. The research was based on the results of the international study and aimed at analysing their features. In the course of the analysis, the peculiarities were evaluated and special attention was paid to each field of science. In addition, a comparative analysis was carried out to identify the specificities of the study. This analysis made it possible to identify the relationship of the fields of science with geography.

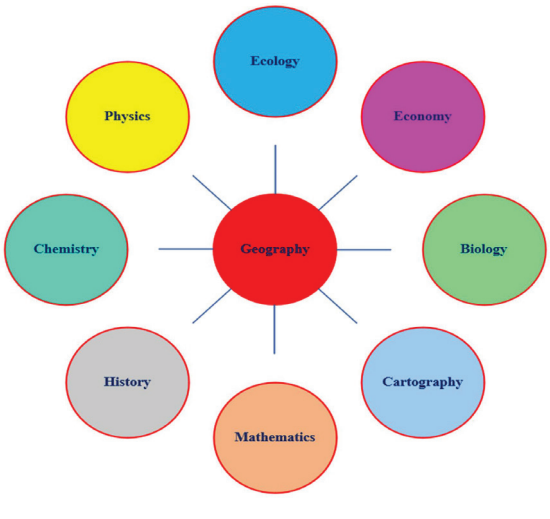

Figure 1: Interdisciplinary links between geography and other sciences

Results. As a result of this study, the interdisciplinary connection between geography and other sciences has been fully described (Figure 1). The role of such sciences as history, physics, chemistry, biology, economics and ecology in the interdisciplinary connection with geography is particularly high.

1. Interdisciplinary links between geography and history

Since history is geography in time and geography is the history of the universe, young geographers need to know this. This is why, despite the idea of scholars to merge the two disciplines, some universities have "History and Geography" curricula. In this regard, as a result of a review of research in this context, methods of using interdisciplinary connections between geography and history were identified (Table 1).

Table 1. Methods of interdisciplinary communication of geography and history disciplines

Mansurjonovich et al. (2023) D'agostino & Santus (2022)	Updating previously acquired knowledge and skills. Explanation of new material based on material known before history courses
Walshe (2016), Ibrahim (2020)	The use of argumentation tasks in other courses and disciplines that require recalling the main content of the previously studied material
Lyall et al. (2013)	Creating problem situations on an interdisciplinary basis, setting problem tasks that require education and generalization
Gao et al. (2023)	Conducting integrated classes
Yang et al. (2014)	Conducting interdisciplinary conferences or events

Close relationships between geography teachers and history teachers are mainly based on the relationship between time and place, and it is the teachers who create these relationships (Kaimuldinova et al., 2020). In this regard, Sarsebayeva (2023) found that geography teachers' relationships with teachers of other subjects were insufficient in 82.7% of cases, sufficient in 17.3%, and absent in the remaining 2% (Figure 2).

Historical science is a science that explains the events created by mankind in the past by defining time and place within the principle of cause and effect (Abdulvagabova et al., 2020). Therefore, the change of natural and human phenomena in relation to time and space determines the dynamics of geographical science and also requires co-operation between geographical and historical sciences.

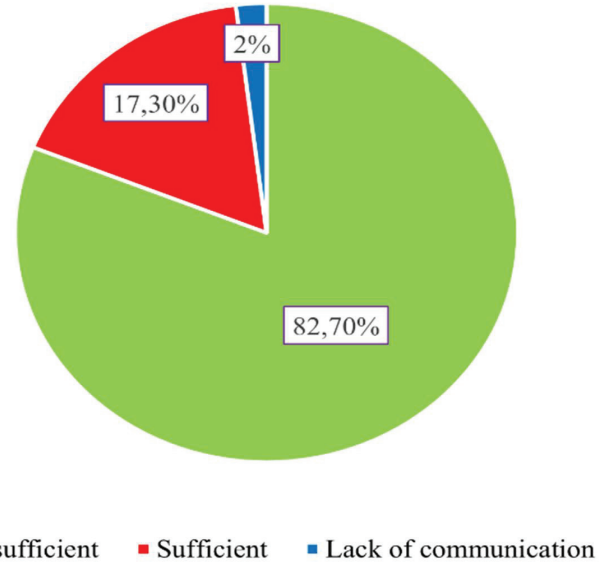

Figure 2: The share of interdisciplinary communication communication of subject teachers

2. Interdisciplinary links between geography and biology

Biology is essentially the science of life (Wood et al., 2020). Biology answers many questions, such as: what living beings are there on Earth and how many of them?; how is a living organism organised?; how do organisms reproduce and develop?, their relationships with each other and with inanimate nature.

Regarding the relationship between geography and biology, biology studies living organisms and geography studies non-living components such as rocks, rivers, lakes, climate, etc. Due to the close relationship between living and non-living objects in nature, the fusion of biology and geography has led to the formation of a new discipline, biogeography. The two sciences are linked by the problem of the rational use of nature, and geographers and biologists must combine all their efforts to find the right answer to this question. This is because biological topics occupy an important place in the curriculum of modern geography.

3. Interdisciplinary links between geography and ecology

It is safe to say that geography and environmental education are very closely related and that it is geography that is the basis for the emergence of ecology as a science. This is due to the fact that the dependence of nature on geographical conditions becomes a problem of environmental studies. Also, the solution of modern environmental problems, unlike other sciences, requires not only accurate knowledge of geographical processes and phenomena, but also a comprehensive understanding of the natural and social environment. Therefore, to study the relationship between geography and ecology, it is necessary to compare objects from a scientific point of view. Since the connection of ecology with physical geography is 80-90%, it led to the formation of a new science - geoecology (Natter, 2003). In the human environment, one of the main tasks of geoecology is rational nature management, assessment of prospects for sustainable development of individual regions and territories.

4. Interdisciplinary links between geography and mathematics

As for the interdisciplinary relationship between mathematics and geography, the link between the two subjects is so tight that the teaching of topographical and geographical maps in primary schools is impossible without mathematics. Therefore, the connection between mathematics and geography is expressed in the form of geographical tasks (Fig. 3). In addition, correlation, balance, statistics and computer modelling based on mathematical methods are often used in geography.

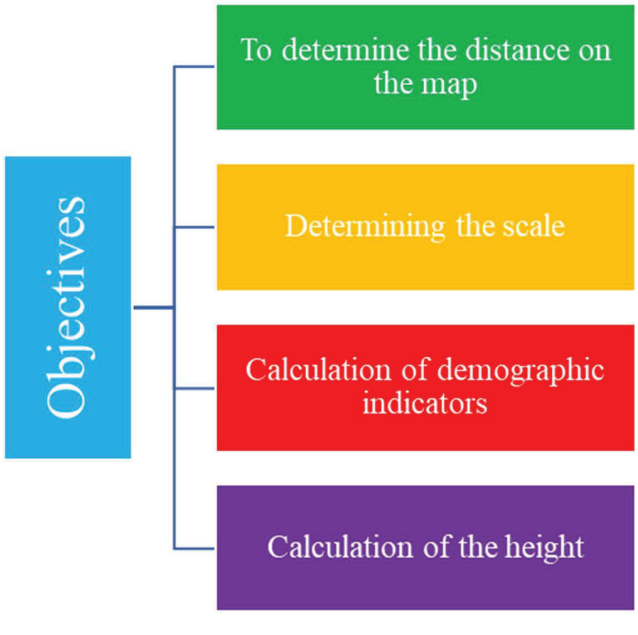

Figure 3: Mathematics objectives in relation to geography

5. Interdisciplinary links between geography and cartography

Cartography is the science of geographic mapping, its creation and use. Cartography is a science that studies the combination and relationship of natural features using a map (Slocum et al., 2022). Cartographic concepts include globes, terrain maps, celestial bodies and starry sky maps, spatial models represented by cartographic symbols (Table 2).

Table 2. The main areas of communication of cartography with geography

Kainz (2020)	The subject and methodology of cartography, the doctrine of the map, the theory of cartographic projections, theories of generalization and imaging methods
Edney et al. (2020)	History of the science and production of cartography
Fairbairn et al. (2021)	Recognition of cartographic data (differentiation of cartographic data and related problems of scientific and information theory)
Talmar et al. (2020)	Theory and technology of designing maps and preparing them
Yang et al. (2014)	Theory and methodology of using cards

Thus, the relationship between cartography and geographical sciences is not contradictory, because maps are the language of geography, and science cannot be imagined without cartography. Geographical maps are widely used as an important source of information in many disciplines, including history and economic studies.

6. Interdisciplinary links between geography and economics

The discipline of Economic geography emerged as a result of the interaction between geography and economic sciences. Economic geography emerged in the 18th century and became an area of interest in the problems of the location of productive forces and urbanisation (Broz et al., 2021) (Figure 4).

Economic geography is a branch of human geography that studies economic activity and the factors that influence it. It can also be considered as a department or method in economics (Hidalgo, 2011). There are four divisions of economic geography. Economic geography is the relationship between international trade, real estate, industrial location, transport, agglomeration economy, development, ethnic economy, environment and economy.

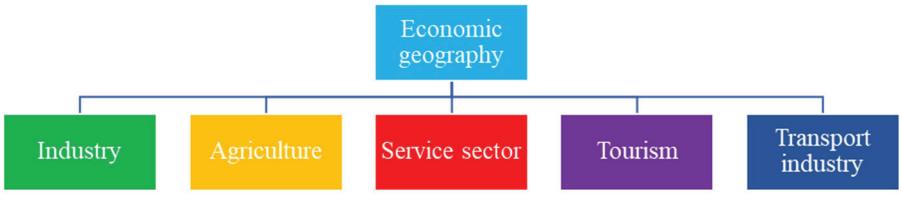

Figure 4: Branches of economic geography

7. Interdisciplinary links between geography and physics

Physics is a science that studies various phenomena of nature (Chorley, 2019). For example, the motion of objects, the changes that occur when objects are heated or cooled, electricity, sound, light, why lightning flashes or thunder rumbles, how echoes occur, what a rainbow is, and so on. But physics explains not only what is found in nature, which is the basis for engineering. Without knowledge of physics, it is very difficult to explain concepts such as aeroplane, car, crane, refrigerator, computer or the formation of wind, atmospheric pressure. That is why some secondary schools have classes related to physics and geography. The link between these two sciences helps to improve schoolchildren's knowledge and increases their cognitive interest in related sciences.

8. Interdisciplinary links between geography and chemistry

Chemistry is the science of substances and their transformations (Laubach et al., 2019). Much of this is known today, and each substance

has its own properties, and with the exception of a few substances, all substances can manifest themselves under certain conditions. There is no great magic in these transformations, and through chemistry people learned to obtain the substances they needed at home from laboratories and chemical plants. Chemistry is a natural science closely related to the geography of soils in geography (Agrawal et al., 2022).

Based on these connections, new scientific fields have emerged, related to hydrosphere chemistry, geochemistry, landscape geochemistry and atmospheric chemistry. To teach them, the geographer must have a good knowledge of chemistry, otherwise he will not be able to explain the topic properly. Students will absorb this material best in an integrated laboratory or chemistry classroom based course.

Discussion. The study results highlight the significance of interdisciplinary connections between geography and other sciences. Particularly close relationships are observed with history, biology, ecology, mathematics, cartography, economics, physics, and chemistry. These connections not only enrich the content of geographical education but also contribute to the formation of a holistic worldview among students.

It is noteworthy that 82.7% of geography teachers report insufficient interdisciplinary interaction with colleagues. This indicates a need to strengthen collaboration between teachers of different disciplines to enhance the quality of education.

Special attention should be given to the connection between geography and ecology, as this area is crucial for addressing contemporary environmental issues and fostering ecological awareness among students. The integration of mathematical methods into geography, including the use of correlation analysis, statistics, and computer modeling, opens up new opportunities for research and teaching.

The interrelation of geography with economics, expressed in economic geography, emphasizes the importance of studying spatial aspects of economic activities.

Overall, the interdisciplinary approach in teaching geography promotes the development of critical thinking, analytical skills, and a deeper understanding of complex relationships in the surrounding world. This aligns with modern educational trends aimed at forming a holistic worldview and preparing students to address complex problems in the future.

Conclusion. Thus, learning based on an interdisciplinary approach increases cognitive development, creativity, and problem-solving skills. Curricula created through interdisciplinary linkage will be very flexible in the pragmatic use of subjects. Proper integration of topics from different fields can motivate an individual to participate in the educational process and thus provide quality training. In addition, the integration and unification of curricula of different subjects to realise the overall aims of the school can be done in different ways. This allows for the active use of interdisciplinary links for the formation of universal learning actions, especially metaedisciplinary ones. The use of interdisciplinary links allows to solve several tasks at once:

- promotes the development of a scientific style of thinking;
- allows studying the material as a whole within the framework of different disciplines;
- stimulates mental activity;
- promotes understanding of the practicality of knowledge;
- enhances the use of techniques for analysing information;
- expands visualisation and the possibilities of using technical means;
- encourages students to search, study and research activities;
- improves the emotional mood of the class in accordance with sanitary and hygienic requirements.

In addition, the methods and forms of using interdisciplinary links in geography lessons, the type of lesson in which they are applied, are chosen by the teacher. Effectiveness directly depends on the willingness to master the technology, the competence of the teacher. The teacher must have extensive knowledge of various subjects and be able to apply them methodologically competently.

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