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Opportunities for implementing interdisciplinary connections in the process of teaching mathematics

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Abstract. The article discusses the education of students in mathematics and their ability to apply their knowledge comprehensively through interdisciplinary links. The stages of the development of modern science are characterized by the interconnectedness of sciences, making inter- and intra-subject links in the learning process relevant. Inter- and intra-subject links are crucial for the systematisation, deepening of students' knowledge, and the formation of skills for independent cognitive activity. Therefore, an integrated approach to teaching and educating schoolchildren must prioritize these links. The text discusses the importance, methods, and peculiarities of applying knowledge and skills in the study of natural and mathematical disciplines. It also provides theoretical justification for the construction of a task system and formulates the features of interdisciplinary research.

The features of interdisciplinary research are formulated. The functions of didactics as a science are clarified. The importance of interdisciplinary research in the field of education is highlighted, along with the need to develop a specific methodological approach and to expand the research field of didactics to include related sciences and scientific directions.

Keywords: school course of mathematics, interdisciplinary relations, didactics, historical approach, mathematical calculations, new methods.

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Introduction

Interdisciplinary communication in education is one of the modern methods of education. It defines the connection between the subjects, as well as bringing the students' acquired knowledge into one system. The interaction of knowledge and methods in various research objects has not only practical significance, but also creates a favorable situation for the formation of a scientific forecast.

The interest in the issue of interdisciplinary connections is not accidental - the modern requirements of the labor market suggest significant changes in the content and methods of training. These changes arise from important processes in the modern development of science - their integration and differentiation [1].

Education has real content due to professional knowledge that provides information about real production processes. The combination of general and professional knowledge forms the didactic basis of interdisciplinary connections. Such connections, prepare students for learning any profession in the future. In order to bring general education and general technical subjects closer to the goals and objectives of the educational institution, they should be professionally oriented. Such training should contribute to the development of students' professional skills and abilities necessary for acquiring professional experience [2].

The relevance of the topic is determined by the fact that recently active research has been conducted in the field of integrated forms of training classes in secondary school classes. Also, the practical importance of the lesson is that integrated lessons expand the scope of the regular lesson, which means that every student has an opportunity to develop creative abilities. Integration allows students to learn independently, to increase their intellectual level, to develop interest in learning, to expand their thinking field and to develop their potential.

The purpose of the topic is to determine the possibility of implementing interdisciplinary connections in mathematics classes, taking into account the connection between school subjects and its role in modern education.

Research methods

Observation; analysis of theoretical sources on the research topic; summarizing the concept.

When conducting integrated classes, the problem is solved, as is the individualized approach to teaching students with different abilities. Integrated lessons appeal to students and increase their motivation for learning. These lessons help to form spelling awareness, develop speech and enrich children's vocabulary, as well as aesthetic taste and an understanding and appreciation of works of art, the beauty and richness of nature, and creative potential.

Thus, interdisciplinary connections form a necessary condition for organizing the educational process as a comprehensive way of teaching and strengthening its unity with education. Implementation of interdisciplinary connections in students' educational activities is a didactic condition for its revitalization, systematization of knowledge, independence of thinking and cognitive interest [3].

The communication between subjects should be systematically included in the entire educational process. It contributes to the deepening and consolidation of previously acquired knowledge of students, the development of their cognitive interests and thinking activity, and the ability to comprehensively apply their knowledge of various subjects in the process of theoretical and industrial training. This allows students to quickly adapt to any situation in the future. So, what is interdisciplinary communication? The concept of "interdisciplinary communication" has the following two definitions.

1. Interdisciplinarity is the main principle of didactics, which contributes to the coordination and systematization of educational material and is carried out through the system of normative functions and general methods of knowledge of nature.

2. Interdisciplinary communication is a principle of didactics that performs integrative and differentiated functions in the process of teaching a certain subject and acts as a means of integrating subject knowledge into a whole system, expanding its scope without losing the qualitative features of this subject.

Systematic use of interdisciplinary connections of technical and special subjects in general education develops students' ability to think logically, contributes to quick perception of current phenomena of the studied material and helps to develop the skills of using potential knowledge in applied subjects. Therefore, systematically mastering of the material, formation of students' knowledge and skills, in particular, implementation of interdisciplinary connections, which is an important condition for the strength and effectiveness of the acquired knowledge.

Interdisciplinary connections make it possible to determine the main elements of the content of education, that is, to develop ideas, concepts, general scientific methods of educational activities that form a specific system, to collect and comprehensively apply the knowledge of students from various subjects. By solving tasks, students develop cognitive and calculation skills:

– To understand the meaning of the report and the need to apply the knowledge obtained from other subjects to it;

– Selection and proper use of necessary knowledge obtained from other subjects;

– Transferring them to a new situation, comparing knowledge in mixed subjects;

– Synthesizing knowledge, determining the compatibility of concepts, units of measurement, calculation, their implementation;

– Obtaining results, summarizing concepts, consolidating concepts.

Systematic use of problems with interdisciplinary practical content in the form of problem questions ensures the formation of students' skills in establishing and mastering knowledge connections between different subjects. This will be one of the important functions of the development of mathematics education [4]. An interdisciplinary problem can be considered from different angles. Historical survey, examples of interdisciplinary studies in education, main areas of methodological development of interdisciplinary approaches, practical application of the method in pedagogy and education, criteria for evaluating the quality of one or more interdisciplinary studies I.M. Osmolovskaya, L.A. Krasnova and considered in E.I. Snopkova's articles [5, 6].

Methodology

One of the main educational functions of interdisciplinary communication is the formation of a general knowledge system about the real world that shows the interrelationship of various forms of matter movement. The formation of a whole scientific worldview necessarily requires taking into account interdisciplinary connections. In this case, the connection of mathematics to natural science and human cycle subjects is strengthened; knowledge transfer skills, their application and comprehensive, deeper thinking skills are improved.

Therefore, interdisciplinary communication is a modern principle of teaching aimed at using complex forms of teaching organization that affect the selection and structure of educational material of a number of subjects, strengthens the systematicity of students' knowledge, activates teaching methods, and ensures the unity of the educational process.

Interdisciplinary connections affect the composition and structure of academic subjects. Any lesson is a source of certain types of interdisciplinary connections. Therefore, it is possible to distinguish the connection with the elements of mathematics in other educational subjects, which are given during the teaching of mathematics or vice versa. It is impossible not to use the concepts of mathematics during the study of all subjects of the natural science cycle. Mathematics provides students with the necessary knowledge and skills in everyday life and human work, and is also important for studying related subjects.

The knowledge gained in mathematics is observed by students' use of general disciplinary calculation and measurement skills. The study of interrelated disciplines shows scientific knowledge, mathematical knowledge obtained by students influencing the formation of the idea of mathematical modeling as a generalizing method for understanding the world and skills used in practice [7].

Let's give brief examples from the results of our experience observed throughout the year in secondary school No. 202 in Almaty. It is possible to reveal the connections with physics while arranging the topics of the algebra level of grades 7-9 in order. When studying strong, uniformly progressive motion, information about a linear function is used. Similarly, when studying electric current, information about direct and inverse proportional dependence are used. At the same time, the concepts of proportion, vector, product, functions, graphs, etc. are deliberately used in the teaching of physics. Knowledge about percentages and the ability to solve equations are used in the course of chemistry. Also, it is clear that while teaching these connections, students are forming their mathematical skills, which are necessary for drawing conclusions from other subjects. However, there is also a feedback loop. The knowledge about scale and geographic coordinates obtained from the course of physical geography allows mathematics students to fill in the given general (abstract) mathematical concepts with concrete content.

Teaching interdisciplinary relations can be done in different ways. One of the most effective ways to achieve this goal is to teach students the use of mathematical methods and practical solutions to solve problems from other subjects [8].

Example 1. How much time is needed to rise to a height of 15 m when thrown with a speed of 20 m / c? Can it rise to 25 meters?

Solution. A body thrown vertically upwards with speed V moves according to the law.

Taking approximately g = 10 m / c^2, we get the formula S = vt – $5t^2$.

Substituting the given data, we get the quadratic equation: $5t^2$ – 20t + 15 = 0.

Solving this equation, we get the answer to = 1c, t = 3c.

To answer the second question, we put 25 m in place of S. The resulting quadratic equation $5t^2$ – 20t + 25 = 0 has no roots, so the time t for the body to reach a height of 25 m has no value.

In order to solve this problem in the physics class, students will be able to use the quadratic equations correctly, in the mathematics class they will be able to effectively use the formulas taught in the subject of physics, and the process described in the given task will be made possible. In particular, while solving the first part of the task, we need to answer two questions. Why? The answer is very simple, if the thrown body reaches a certain height, it is clear that it will fall back to the ground. It is necessary to describe the conditions at a height of 15 m above the surface twice: the first time when it was raised uphill, and the second time when it fell.

dy/dx=f(x)·g(y)It is necessary for the teacher of physics subject in mathematics classes to correctly understand the meaning of the equation when issuing the content equations. In order to solve problems with physical content, students should carefully read the conditions of the problem. It is very important for students to be able to write the content of the essay in a concise manner, using the methods of analyzing the essay. Ready-made models can be used to teach students to write a contract in a simple way. The given values in the text are written separately in the form of columns. A strong, excellent review as follows: The motorcyclist goes at a speed of 95 km/h, and the cyclist at a speed less than 76 km/h. How many km faster is the speed of the motorcyclist?

Let's try to write in the text of task:

Speed – ?

Motorcyclist – 95 km/h

Cyclist – 95 km/h-76 km/h

Writing the terms of the essay in a concise manner helps students to correctly understand the meaning of the given vital information in the text of the essay.

Extracting vital information from the text and writing them down in a rational way makes it possible to separate and identify certain values and unknown values. Writing the right line in a concise form separates the condition of the problem and the sought value, compares the given values with each other, and reduces the work of analysis, that is, the determination of the relationship between them. Students' ability to solve problems in this content allows to demonstrate the importance of mathematical material for studying other sciences.

Another way to open interdisciplinary relations is when the teacher gives ideas from other subjects, thus showing students other subjects that respond to the teaching material.

Example 2. Equations about equality do not always occur only in mathematics. In the physics class, students get acquainted with the concept of Archimedes' force. The condition for the buoyancy of a body on the surface of a liquid and its sinking is considered according to the following inequality:

1. FA > mg (body floats)

2. FA < mg (the body sinks), where FA is the Archimedean force, and mg is the force of gravity.

The above examples show the connection between the disciplines of mathematics and the cycling disciplines of natural science and mathematics, but this does not mean that mathematics

cannot be connected with other disciplines, for example, it does not mean that the social and humanitarian cycle of the discipline is impossible. Let us give examples of how to make connections between mathematics and history, literature and the Russian language.

One of the important goals of every kindergarten is to teach children to speak and write well. It is necessary to pay special attention to internalization of the goal in mathematics.

Pupils need to write mathematical terms correctly, repeat the rules and conclusions of the theorems, and speak fluently during oral work. Some teachers take this issue very seriously, they call on children to follow the correct spelling of mathematical terms, to pay attention to accuracy, and to clearly explain their exact solutions. Of course, this type of work is necessary in 5-6th grade, at that time students whose attention has not yet developed enough make a lot of mistakes.

In many mathematics classrooms, there are special sections called "correct writing and speech", the content of which includes mathematical terms with the correct emphasis and separating the parts of the word that can be misspelled.

The use of materials from a work of art in mathematics lessons, citing an excerpt from a quote from famous people about the need to study mathematics, makes it possible to interest students and show the connection between mathematics and literature as an important school discipline.

Example 3. Tolstoy depicted in the form of parts the character of the whole human child, in part – the moral needs of a person, in part - his self-esteem. The larger (higher) the cross section of the shot, the finer the shot and vice versa.

In mathematics classes, teachers often use didactic poems and fairy tales, connecting with them various functions: observation, teaching, world knowledge. For example, a happy character in a fairy tale, can influence the formation of a worldview that emphasizes the need to study a certain topic or general mathematics. Poems and fairy tales provide an opportunity to monitor students' knowledge of the subject. Poems and fairy tales, where the characters in the stanzas of the poem reveal new facts, also contribute to the study of new material.

Example 4. Riddle.

There are three of us in any triangle.
Crossing the center of gravity on the road,
We draw from the top of the triangle downwards.
What is our name, find it boy?
(Medians).

To solve the riddle, students must memorize the definition of the median in the course of geometry, while they must apply information that says that the center of gravity of a triangle is the point of contact of the median of the triangle, this rule is more often used in physics than in mathematics. Thus, it is possible to connect literature not only with mathematics, but also with physics.

Another way to interest students in learning materials and the opportunity to discover their creative potential is for students to perform mathematical works, fairy tales and poems in a specific topic or to perform drawings with them.

For example, tasks such as "Mathematics in a person's life", "Mathematics in the life of my parents" and so on, you can provide them with such home tasks that allow you to differentiate independent activities.

The connection of mathematics with history will not only allow for the emergence of interest in the subject and maintaining a connection with it, but will also allow achieving important goals, that is, it has an important role in shaping the worldview and general culture of students.

Occupations frequently occurring mathematical, historical and local historic nature of the consideration of funds. "In the teaching of the history of mathematics, the element of any single statement in relation to the history of any fact is straight mathematics."

Example 5. The development of agriculture in ancient Egypt is known from history. In order to divide the land into a rectangle, the land surveyor used the following method. The rope was divided into 12 equal places and knotted, and the ends were tied together. Then put it on the ground and made a triangle so that the sides consisted of 3, 4 and 5 parts. 5 parts must be placed in a straight line with opposite angles to each side. The triangle whose sides are 3, 4 and 5 is called the Egyptian triangle.

It is possible to see how necessary mathematical knowledge is in practice for people since ancient times. There are many similar ideas in history. It is clear that all mathematical calculations arise from a certain need. The triangle raised from the top is also called "the sacred triangle of Egypt". This strength of the historical standard shows how mathematical knowledge has benefited from the practical needs of people and has been used by people since time immemorial to solve practical problems.

When learning a mathematical topic, they usually use the system, which is specially introduced into the main content, and not the individual elements of history. We preferred to consider the connection to the reader in future historical perspectives.

From a historical point *of view,* the authors bring ideas from the main content of the book to cover its history. A historical excursion is a type of system that briefly describes the main periods of development of a mathematical equation, a mathematical formulation, its founder, and determines the connection with the current state. A set of historical excursions united by a common idea is a historical article. Typically, historical articles are used in textbooks and in the classroom as an introduction to our conclusion of a mathematics course [9].

Another tool of historiography is a historical conversation, which is an exchange of opinions about historical-mathematical facts, which can take place by discussing its topics in the form of a conversation, discussion, presentation. In the case where a historical fact is added to a mathematical object, they are a mathematical concept, formula, theorem, problem, etc. tells about history in mathematical terms. The solutions of scientists are called given objects, mathematical objects. The solutions of scientists are called given objects, mathematical objects. It is better to study them using historical excursions while taking elements of biographies of scientists. Because the problems are often mathematical problems that need to be solved in the mathematical fields, the history of the mathematical problem is stopped in detail.

A historical fact in a mathematical task occurs when it is placed in the situation of the task (which is included in the text of the task).

Example 6. Let's recall Falec's famous answer about measuring the height of the Egyptian pyramids: "When the shadow of my rod is equal to the rod itself, the shadow of the pyramid is equal to the pyramid itself." But this is only once a day. Is it possible to measure the time of day using this equation?

Before answering this question, it is necessary to indicate one or more of the following circumstances, in addition to the task of the historical fact.

– The importance of account in the development of mathematics;

– The importance of mathematics in the development of other sciences;

– The role of the task in practice;

– The origin of the account;

– Effectiveness of the methods aimed at solving the problem;

– Concrete connections between mathematics and history (elements of biography, bibliography, ethnography, chronology, etc.).

Among the tasks given in this way, it is possible to identify several types that are often used in mathematics schools. Along with the historical records in classical literature, there are also ancient records. Historical problems are derived from historical mathematical sources, starting with ancient Egyptian mathematical papyri and ending with the collection of ancient domestic problems. Such examples, as a rule, cause interest because they contain useful practical and historical information.

Another tool of historiography is chronological dates, which do not specify the main periods of the historical development of any mathematical event, formulation, theorem, life and work. The source of historical-mathematical material is literature on the history of mathematics. Historical textbooks and textbooks are also an important tool of historical geography.

Discussion

In the period of rapid development of information technologies, constant updating of technical and scientific data, and rapid development of production, teachers of special subjects need purposeful work when presenting new material, taking into account interdisciplinary connections, this is the use of interactive pedagogical technologies of teaching, in particular, modern teaching tools, to make the material problematic.Includes the use of presentation of consideration in context [10].

Interdisciplinary connections:

– Development of students' skills in using knowledge of general education and general vocational subjects to master and understand special subjects;

– Optimization of the educational process using elements of modern pedagogical and information technologies;

– Providing educational material, using their educational potential, activating the thinking abilities of learners;

– To create opportunities for the integration of the necessary sciences for the future activities of specialists in industry and science.

The realization of interdisciplinary connections from didactic instructions helps to introduce facts and dependencies from other subjects for the introduction of abstract mathematical concepts, analysis and formation of practical skills. Currently, a great deal of work is being done to develop interdisciplinary connections between mathematics and other sciences. Some of them contain practical guidelines for opening interdisciplinary connections in mathematics classes, and some of them contain material of an interdisciplinary nature, which teachers use in their own classes. It is possible to highlight the main directions of internalization of interdisciplinary connections of mathematics to other sciences.

Results

From all of the above, the following conclusion can be drawn: there are many directions of interdisciplinary connections with other sciences of mathematics classes. The teacher's use of them in the classroom is an absolute advantage, and knowing how to use them effectively in school mathematics will help the students to fully develop and fully develop the skills of freely applying the acquired knowledge in practice. The signs of interdisciplinary research were identified during the research:

– A general research subject created specifically for specific interdisciplinary research;

– Addition to research methods specific to each of the sciences involved in research;

– Relying on theoretical positions belonging to the sciences to be integrated in research.

– To make a scientific contribution of the obtained results to everyone involved in interdisciplinary research.

Interdisciplinary communication in the current stage of the development of scientific knowledge plays an important role in pedagogical science. In addition, interdisciplinary education is a special vector for the integration of scientific knowledge in various fields of education, which gives special importance to the development of the conceptual and terminological apparatus of interdisciplinary studies in pedagogy and education. We analyzed a wide range of published results of interdisciplinary research in the field of mathematical science. However, this study is one of the areas of research classification in the development of the methodological apparatus of interdisciplinary research. It is necessary to carry out further logical and conceptual analysis in order to organize mathematical terms and systematize the ability to use them in interdisciplinary communication.

Conclusion

Creating a unified content of teaching by connecting mathematics with other subjects, strengthening its intra-subject connections, and increasing the importance of relations with those subjects.

Interdisciplinarity in education is considered as a didactic principle and a condition that includes the goals and objectives, content, methods, tools and forms of teaching various academic subjects [11].

Using the interdisciplinary system in the lesson to contribute to the development of an educated, qualified modern person who has formed a whole worldview, is able to organize his knowledge independently and is capable of solving various problems. This method of teaching is also very attractive for teachers: it helps them to better assess the child's ability and knowledge, to understand it, and encourages them to look for new, non-traditional forms and methods of teaching. This is a great field of creative expression for many people: teachers, methodologists, psychologists, all teachers who want to work and know, understand modern children, take into account their needs and interests.

Based on the obtained empirical data, it was possible to interpret the results of the research, which showed the high effectiveness of the implementation of the principle of interaction between the subjects of physics, Kazakh language and literature and history in the mathematics lesson. However, the data for statistical analysis showed that the level of interdisciplinary connection with physics prevails compared to the similar connection of mathematics with the subject of Kazakh literature. Thus, the implementation of the principle of interdisciplinary interaction contributes to establishing the connection between mathematics and other disciplines in terms of a deeper understanding of the characteristic features of the works of scientists of different eras, as well as the reasons for these features. In this regard, we believe that it is necessary to further introduce, deepen and expand this principle in school lessons, in particular in mathematics lessons. Analyzing the problem of interdisciplinary communication, we can say that all the work of teachers in the implementation of interdisciplinary communication should be directed to the creation of a system that helps to use the entire amount of knowledge accumulated in the study of some theoretical or practical problem in terms of the content and structure of the knowledge, skills, skill system of students. The use of interdisciplinary connections in the process of preparation for lessons requires a lot of time and the close cooperation of all teachers.

Author's contribution

The experimental part of the article included doctoral students of the Department of «Mathematics» of the Kazakh National Women's Teacher Training University The results and discussions of open lessons conducted by **A.B. Zheksembinova** and **J.S. Nurmukhambetova** on the school course of mathematics were obtained.

G.S. Bazarbaeva, Associate Professor of the Department of Higher Mathematics, L.N. Gumilev Eurasian National University, contributed to the Discussion and the final part of the article and made comments.

Acting Associate Professor of Kazakh National Women's Pedagogical University, Institute of «Physics, Mathematics and Digital Technologies» **A.B. Kokazhaeva** worked on the introductory, basic and methodological techniques of the article. In addition, responds to the design of the article and comments of the editors.

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Математиканы оқытуда пәнаралық байланысты жүзеге асырудың маңызы

Андатпа. Мақалада мектеп математика курсында оқушыларға пәнаралық байланыс арқылы білім мен тәрбие беру туралы, алған білімдерін жан-жақты қолдана білу дағдылары қарастырылған. Заманауи ғылым дамуының кезеңдері ғылымдардың өзара байланысымен сипатталады, сондықтан, оқу үрдісіндегі пәнаралық және пәнішілік байланыстардың маңызы өзекті мәселе болып отыр. Бұл байланыс оқушылардың білімін жүйелеуге, тереңдетуге және өзіндік танымдық іс-әрекет дағдыларын қалыптастыруға ықпал етеді. Сондықтан да пәнаралық және пәнішілік байланыстар мектеп оқушыларын оқыту мен тәрбиелеудегі кешенді тәсілдің маңызды шарты мен нәтижесі болып табылады. Сонымен қатар, зерттеуде жаратылыстану-математика пәндерін оқытуда оқушылардың білімі мен білігін қолданудың маңызы, әдіс-тәсілдері, ерекшеліктері қарастырылып, есептер жүйесін құрудың теориялық негіздемесі берілген.

Мақалада пәнаралық зерттеудің белгілері тұжырымдалды. Дидактиканың ғылым ретіндегі функциялары нақтыланды. Білім беру саласындағы пәнаралық зерттеулерді өзектендіру, олардың нақты әдіснамалық аппаратын қалыптастыру қажеттілігі және өзара байланысты ғылымдар мен ғылыми бағыттар есебінен дидактиканың зерттеу өрісін кеңейту негізделді.

Түйін сөздер: мектеп математика курсы, пәнаралық байланыс, дидактика, тарихи көзқарас, математикалық есептеулер, заманауи әдістер.

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Возможности осуществления межпредметных связей в процессе обучения математике

Аннотация. В статье рассматриваются знания и воспитание учащихся в школьном курсе математики через межпредметные связи, умения всесторонне применять полученные знания. Этапы развития современной науки характеризуются взаимосвязанностью наук, поэтому актуальность межпредметных и внутрипредметных связей в учебном процессе остается актуальной. Они способствуют систематизации, углублению знаний учащихся и формированию навыков самостоятельной познавательной деятельности. Поэтому межпредметные и внутрипредметные связи являются важнейшим условием и результатом комплексного подхода в обучении и воспитании школьников. Также рассмотрены важность, методы, особенности применения знаний и умений учащихся при изучении естественно-математических дисциплин, дано теоретическое обоснование построения системы задач.

Сформулированы признаки междисциплинарного исследования. Уточнены функции дидактики как науки. Обоснована необходимость актуализации междисциплинарных исследований в области образования, формирования их конкретного методологического аппарата и расширения исследовательского поля дидактики за счет взаимосвязанных наук и научных направлений.

Ключевые слова: школьный курс математики, межпредметные связи, дидактика, исторический подход, математические расчеты, новые методы.

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