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STEAM-BASED STRATEGIES FOR INTEGRATING PHYSICS EDUCATION. LITERATURE REVIEW.

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Abstract

This article discusses the main features of teaching the course "robotics" using the STEM system in the integration of physics. In addition, a comprehensive review and justification of the course "Robotics", which is taught within the walls of a general secondary school and university, will be made. In the subject integration, the analysis of how many hours are allocated for the course "Robotics" in high school, and how many hours are allocated in the walls of the university is carried out based on the main programs. However, specialists in the pedagogical, natural, engineering, and social sciences are working to identify how problems develop, as well as technological changes to alleviate them. That is, the problem that follows from this is always the effective use of knowledge in the direction of integration. Because as if it were one of the main requirements of today. Currently, if the subject system is integrated, the student will be able to understand the subject in a wide range, not limited to this subject. A wide range of types and methods of using the STEM system in the integration of the subject of physics in this direction is considered. We know that the word STEM itself is used in the direction of integration. STEM education (science, technology, engineering, mathematics) has an integrated approach to teacher training, which allows you to provide the future teacher with modern technologies for teaching students in engineering, technical, and natural sciences areas. That is, the modern STEM system has been used to improve students ' ability to learn in various subjects. Research in this area is still focused on the search for suitable methodologies, tools, and evaluation mechanisms for the development of learning systems that have a great impact on student performance. Education is based on the socialization of a different methodology using the STEM system in teaching physics to students and high school students. Adapting and expanding knowledge in today's conditions, developing problem-solving strategies, acting in teamwork, communicating with people, and making recommendations in difficult situations - it can be seen that the development of integration at any time, both at the

University and at school, in the workplace, has become widespread. The main goal of the general education centers of the Republic of Kazakhstan is to train the STEM system. And in what direction and in what way to integrate it, the relevance of the article is. The course "STEM" can be considered as the most important way to develop integration in this direction. This is because it can be taken as a subject course whose full content has not yet been disclosed.

Keywords: STEM, integration, science, philosophy of the history of Science, Mathematics, Physics.

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Introduction.

Like climate change, which is changing in the world, the path of Science and education today, the rare world problems that are happening in public policy, do not cease to change from day to day. Innovative changes in the modern technological environment and updating the technical activities of society should be reflected in the content of education in educational centers. Training should be aimed at the formation of knowledge, qualifications, and competencies that allow the younger generation to successfully integrate into modern socio-technical systems, and effectively use and develop the scientific and technical potential of society. In this regard, depending on the direction of integration innovation, the direction of robotics can be taken. When designing the curriculum of profiles of general education institutions, it is necessary to understand that the profile is a way to immerse schoolchildren in updated social and industrial practices. The concept of profile goes beyond the curriculum, a certain composition of academic disciplines, and the educational space of the school. With this in mind, the approximate basic educational program of general secondary education since 2016 is different from the composition of the profiles: technological, Natural Science, humanitarian, socio-economic, and Universal. The theoretical and methodological basis for this can be the results of pedagogical research on the theory of educational activities and teaching methods. This means that the times are striving for integration, that is, to increase students ' interest in subjects, to make them want knowledge. Science does not stand still, but modern education is also changing. Of course, schools have long moved away from the learning model,

when a student only passively listens and remembers information, now it is important not only to be able to apply the knowledge gained but also to independently create new solutions, critically revise the available data and reveal the possibilities of Science and technology that were not used before. STEM technologies have great opportunities in training aimed at developing practical skills, forming the readiness of school graduates to continue the implementation of creative ideas in educational institutions and further professional activities. In the lessons, students independently create product prototypes using modern materials and equipment based on simple and affordable engineering solutions. To create the final product, learners can use parts from existing equipment or make a model out of plastic and cardboard, but in any case, have experience in combining different materials, learn to take into account the properties of objects, and understand how best to combine the structural components of the model to make it as functional and efficient as possible. However, a lot of project work can be done with the STEM system in the integration of physics. For example, in conducting the discipline" molecular physics", project work on the topics" internal energy", and" thermodynamics " can be given to students as homework. And we know that this will undoubtedly increase students ' interest in the subject and the STEM system. In turn, the interdisciplinary nature of the preparation of future teachers for the development of students ' cognitive interest in teaching physics contributes to the penetration of scientific ideas, concepts, and values, as well as the formation of a holistic view of the environment. In this regard, we will briefly focus on the robotics course, one of the STEM programs.

Robotics is an applied science that deals with the development of automated technical systems and is an important technical basis for intensifying production. Robotics relies on disciplines such as electronics, mechanics, computer science, radio engineering, and electrical engineering. (Paraskevov A.V., Levchenko A.V. 2014). Robot is a word that is often used in our modern world. And this is not in vain, because during the period of his existence, a person tried to make life more comfortable, modern, and progressive. It is this definition that is based on an integrated knowledge system, that is, it is the main developmental path of integration. In this regard, our main goal will be determined. In the development of the integration of Science in the teaching of robotics courses in several disciplines, for example, physics, biology, chemistry, and computer science, there are a lot of functions that robots perform, that is, efficiency prevails.

More specifically, we know that physics-based modeling provides a fast and safe process for testing and testing robot control algorithms. However, at the moment, only in a few schools in some regions of Kazakhstan, such optional courses in educational robotics are included in the educational program (Yermekova Z et al 2021).

Literature review

The perspective of STEM programs is the use of problem-based learning. Science, technology, engineering, and Mathematics (STEM) education is being driven by concerns about the decline in the number of students enrolled in STEM fields in higher and vocational education, which provide a high-quality workforce for the country's competitiveness and prosperity (Brown, R et al 2011). Therefore, a large number of natural science studies have shown good results, and in the implementation of STEAM approaches, solving problem situations, finding the right answers, and overcoming obstacles to the planned solution can be done in the best possible way. An important point here is the formation of a special style of mental activity, research activity, and independence of students. STEM education has become a topic of international discussion over the past decade. This is due to changes in the global economy and labor demand, which indicates a shortage of STEM-trained workers and teachers around the world. However, views on the nature of STEM education and the competencies that need to be developed are developing more differently than ever (Lyn D. English: 2016).

To use machine learning to develop artificial intelligence-based robots, physics-based simulations can produce a large number of established learning data in a short time (C.Karen Liu and Dan Negrut: 2021). The effectiveness of creating many phenomena in physics, especially laboratory work and demonstration videos, is very great. As for the integration of robotics with biology. For example, robots linked to the human body can help repair damaged objects (Gupta and O'Malley, 2006; Kim and Deshpande, 2017; Yun et al., 2017), help people complete many tasks and enhances physical interaction and can reflect virtual and augmented reality (Choi et al.,2016). These robotic systems work by providing the effort with a physical interface between the robot and the human. In biology, it can be seen that the services of robots are very effective. Now let's see the relationship with the subject of chemistry. The comprehensive system of Chemical Research proposed by IBM gives an idea of how artificial intelligence, robotics, and

medicine can change the development prospects. This is the best moment to see a breakthrough in any area. The world is still struggling with the COVID-19 pandemic, and the race to find a vaccine against the dangerous new coronavirus has not yet had reliable results. That's why the new IBM system, called RoboRXN, used deep learning algorithms, the IBM Cloud, and robotic labs to automate the entire process and help chemists work in a research lab without the need for a physical presence. That is, chemistry and IBM Research Reborn can be described as combining the right elements to solve a pressing problem. The main theories that formed the basis for teaching robotics are the constructive theory and constructionism (constructivism) of this teaching. For school-age children, it was shown that holding objects, and doing things with them, promotes the formation of knowledge (Piaget, 1974). The formation of knowledge, whether it is a fortress made of sand on the shore or a technical object, has shown that students are more efficient in the environment in which they are engaged in the construction of a public entity (Papert, 1980). In recent years, interest in the robotics course has begun to increase and many of its applications have become popular (Tamada H et al 2009). Among the many applications, educational robotics has increased interest in education at all levels (Johnson J:2003). The integration of robotics into education involves the use of robotics in school education or the use of education in robotics; the latter has been pointed out as referring to the preparation of teachers for the use of robotics for educational purposes (Alimisis D, 2012). However, it is important to implement these aspects with the curriculum, taking into account the motivation and training of teachers. In this sense, the maximum use of didactic methodologies and information and communication technologies, such as robotics, consolidates the pedagogy that is developing in schools as a task for the future.

Next, in the process of integrating Physics with computer science, we will fully describe the course "robotics" as a method of using the STEM system

Research methodology.

Science and technology play an important role in modern society. A certain amount of scientific and technological literacy is required to overcome the difficulties and possibilities of many products, devices, and processes available to humans. Robotics-proof of this (Slangen L.An et al 2011). How robotics works is hidden behind its appearance, which can be similar to a coffee maker, a baby doll,

or a thermostat. People may learn to press the right buttons, but they don't know what's going on under them. In robotics, we study, design, and create different robotic systems, studying how robots interact with the environment, objects around them, other robots, or the people they help. Particularly important tools in the field of computer science include artificial intelligence, physical modeling, and complex sensor processing (such as computer vision). We are working to create robots that can improve our world: help people with disabilities, work together in large groups, move in difficult conditions, consciously manipulate objects, deliver medicines to the human body, remove harmful pollutants from the Earth and ocean, provide useful information to people and become more resistant to useful work here.

In the research methodology, we studied the analysis and methodology of the level at which the course "Robotics" in the school curriculum and the university curriculum takes place.

The rapid growth of integrated STEM education in schools is due to interdisciplinary interaction between STEM subjects, which helps students improve many types of learning outcomes (Batdi et al., 2019). This will allow schoolchildren to understand the integrated world instead of reading fragments of knowledge and applying it.

In secondary schools, classes are planned by the educational program. The program is based on the law of Education. The programs have a positive impact on the results of teaching science based on the 5e learning model. In 2022, the results of a systematic review of 74 empirical studies on the 5e learning model in scientific education showed that the 5e model is enriched when used in conjunction with various processes (Koyunlu Ünlü, Z.; Dökme, İ:2022)

In high school, students use computers and other smart devices every day, but this does not teach them to become programmers or IT engineers. They use devices only as a means of exchanging information. They do not create new values, although computers are very powerful tools.

In the case of robotics, students cannot simply use robots, they must be created and tested. This is an important difference between the use of robotics and computers. Within the framework of the course, students study the basics of engineering and technology, integrating their knowledge and skills in Mathematics, Physics, Computer Science, etc.

The course uses LEGO ® MINDSTORMS EV3 sets of training constructors 45544 and 45560. This means that there is an extensive collection of manuals on the design of robots (NXT and EV3), some of which are built and the video movement is uploaded to YouTube. At the same time, more videos contain explanations, and you can see how robots work, despite language barriers. Inside the EV3 microcomputer is an ARM 9 processor that uses the Linux operating system. It has 4 input ports and 4 output ports. You will be offered 16 MB of flash memory and 64 MB of RAM.

The LEGO Mindstorms EV3 training version of the software allows you not only to create a program but also to collect statistical data from sensors and write them to the microcomputer memory or send them in real time via USB cable, Wi-Fi, or Bluetooth. You can analyze the collected data and create tables with their help. There are multimedia classes designed to help students and teachers. Consequently, students get acquainted with the details, sensors of EV3, and the principles of their operation. Develops models of robots for various tasks, and writes a special program for them. As exercises for robotics competitions, practical tasks such as walking along the black line, moving without going outside the ring, twisting, searching for an object, walking to an object, etc. are provided. Students work in groups, collect complex robots, and practice writing a special program. The content of the course provides for robot competitions. In general, 34 hours are given to pass the course "Robotics" in a secondary school, during a year of study (1 – table)

1 – table. "Robotics" program

№	Topics	Hours
1.	What do we know about the robot?	1
2.	Introduction to robotics	1
3.	Types of robots and their use	1
4.	The history of robotics and its prospects	1
5.	Program for a robot	1
6.	Robot movement	1
7.	Robot wheel rotation	1
8.	Robot forward movement	1
9.	Movement to move the robot backwards	1
10.	Labyrinth	1

11.	Exit the maze	1
12.	Touch sensor	1
13.	Robot movement	1
14.	Programming robot movement	1
15.	Running the program for the robot	1
16.	Sound for robot	1
17.	Creating a "dancing robot"	1
18.	Program "dancing robot"	1
19.	Assembly of the robot "Robo-hand".	1
20.	Robot arm movement	1
21.	Cycle block	1
22.	Assembly" robot-garbage collector"	1
23.	Color sensor	1
24.	Traffic light-robot	1
25.	Ultrasound sensor	1
26.	Project "crossing the barrier". Practical work	1
27.	Kegelring	1
28.	Kegelring. Project work	1
29.	Gyroscopic sensor	1
30.	Turns	1
31.	Creating a model of your own robots	1
32.	Movement of the robot along the line.	1
33.	Robo-sumo competition	1
34.	Project work	1
	Total hours	**34**

In the course of the University "robotics", that is, in the direction of the University "fundamentals of educational robotics", the total hour of the curriculum is 150 hours, that is, 30 hours for 15 weeks of lectures, 30 hours for laboratory hours and 90 hours for independent work of the student.

This means that many hours are allocated for independent work of students. Many studies have seen a positive change in favor of encouraging STEM learning in high school students with evidence-based STEM actions (Dönmez, i et al 2022). That is why students work here from the walls of the University, at home. That is, the teacher explains only about the program in the lecture lesson, and in the laboratory lesson he starts his work in the same direction

and finishes it as homework. Then we mean that the student performs 90 hours out of 150 hours of independent work.

If we analyze the curriculum" fundamentals of robotics in education" (2 - table)

2 – table. Curriculum" fundamentals of robotics in education"

Purpose of the discipline	Education on the implementation of the use of Lego Mindstorms EV3 and Arduino UNO set dachiks in the design work using a computer.
Objectives of the discipline:	Study of educational methods with Lego Mindstorms EV3 sets, design modeling with Lego Mindstorms EV3 and Arduino UNO sets, search for solutions, disclosure of basic concepts and study of basic models of robotics.
Expected learning outcomes	1. considers the areas and types of methods of application of robots; 2. shows the principles of types and capabilities of robotic constructors; 3. determine the data structure when creating, designing a robotic device; 4. uses libraries of standard programs included in the assembly of individual Assemblies of a robotic device; 5.compares programming technologies, methods and models and their instrumentation. 6. designs and builds a robotic device to perform certain actions; 7.applies teamwork techniques that support tolerant and communicative communication in project work or teaching activities.
Training methods and technologies	1. a teaching method that considers the student as the central object of learning, which is also based on the reflexive attitude of students to the learning process; 2. qualification-oriented training; 3. role-playing games and educational discussions in different formats; 4. Case Study(Analysis of specific situations); 5. method of projects.
Prerequisites of the	Object-Oriented Programming, C++, Turbo C, Delphi

discipline:	Application software support
Post-requisites of the discipline:	pre-graduate practice, defense of the diploma work

Curriculum content

№	Type of lesson	Content of the discipline	Number of hours	Literature
1	**Lec**	LEGO Mindstorms EV3 education robotics first steps	2	[1, 3]
	Lab	LEGO Mindstorms EV3 education robotics structure . Assembly and programming of the balanced robot Lego mindstorms ev3, Assembly of robots "robot tank", " snap	2	[2,12]
2	**Lec**	Using mechanisms in LEGO robots	2	[1, 3]
	Lab	LEGO Mindstorms EV3 education robotics sensors.	2	[2,12]
3	**Lec**	Using mechanisms in LEGO robots	2	[1, 3]
	Lab	EV3 module interfaces. Robot sorter LEGO Mindstorms ev3 Assembly and programming.	2	[2,12]
4	**Lec**	LEGO robot tools and blogs	2	[1, 3]
	Lab	Creating tasks using blocks and interfaces for robots. Robot puppy Lego Mindstorms ev3 Assembly and programming	2	[2,12]
5	**Lec**	Action blocks.	2	[1, 3]
	Lab	Module control buttons. Lego Mindstorms ev3 robot manipulator arm assembly and programming	2	[2,12]
6	**Lec**	Action blocks. Mechanism blocks	2	[1, 3]
	Lab	Algorithmization in blocks. Implementation of the project" cargo transport robot " in teamwork on assigned tasks.	2	[2,12]
7	**Lec**	Action blocks. Data block.	2	[1, 3]

	Lab	Tasks of world competitions and their programming. Assembly of the robot "gyroboy".	2	[2,12]
8	**Lec**	Algorithm for finding moving objects	2	[1, 3]
	Lab	Determining the number of randomly placed items by location. Assembling the" color sorter " robot.	2	[2,12]
9	**Lec**	Working in the program environment" robotrak".	2	[1, 3]
	Lab	"Robots in human life": development of social projects. LED control via Arduino microcontroller.	2	[2,12]
10	**Lec**	Development of social projects "robots in human life"	2	[1, 3]
	Lab	Working with temperature and humidity sensors on the Arduino microcontroller	2	[2,12]
11	**Lec**	Arduino microcontroller	2	[1, 3]
	Lab	Analysis of ways to know the Arduino platform and its development environment. Control of step motors and servomotors via Arduino microcontroller	2	[2,12]
12	**Lec**	**Arduino development environment**	2	[1, 3]
	Lab	Analysis of how to control different engines. Research on adding a clock button to the Arduino platform	2	[2,12]
13	**Lec**	The main elements of Arduino Uno. Program code.	2	[1, 3]
	Lab	To consider how to measure the distance to an object using the example of an ultrasonic sensor. Study of the working principle of ultrasonic distance sensor	2	[2,12]
14	**Lec**	Description of Arduino Uno and Mega ADK.	2	[1, 3]
	Lab	To consider ways to check the types of clock buttons and how to connect them to the Arduino platform. Study of the principle of operation of the acceleration sensor	2	[2,12]

15	**Lec**	Adding levers in Arduino.	2	[1, 3]
	Lab	Learning how to work with measuring sensors using the example of a humidity and temperature sensor. Study of the working principle of the atmospheric pressure sensor	2	[2,12]

University students will work with alternative LEGO Mindstorms EV3 programs, LabVIEW Development Center, and RobotC (a version of the C, 4x version of the program development language, using robots EV3 and NXT). At robots, students can test the robot in a virtual world. Here is officially s++, Lua, Node.js, Python, and Edge developers use the Google Go, C, and Clojure languages.

What we have observed from the basic analysis of these two curricula is that some of the topics are the same. However, although the themes are the same, they will have the initial, middle, and final day. That is, in the walls of the school, Lego lessons are taught only on the initiative of working, as an answer to questions about what it is and how we understand it. And under the university program, the same Lego will begin to build robotics.

In the course of studying the two-way guidelines and plans for teaching the course "robotics" at the general educational institution, we can see that the main topics are unique. However, it should be noted that their training is peculiar.

Conclusion

In conclusion, it should be noted that the integration of the discipline in all educational institutions requires mastering the STEM education system. Strengthening the STEM education system in the integration of the discipline prepares students to become strong competitive specialists in the future. In addition, STEM education, which emphasizes an interdisciplinary approach, is very important for solving global and local problems. Robotics applied to science and mathematics and integrated are needed to develop technology capable of solving problems in the real world.

The main aspects of the inclusion of the STEM program in the educational process were noted. STEM experience shows that once a clear link is established between educational needs for the future of the economy, the desire for the

widespread use of such programs increases. Currently, the system of specialized education at school is moving towards the teaching, that is, integration of physics, the implementation of relevant interdisciplinary knowledge, obtaining the basics of engineering and technical training, and practice-oriented and project-based training. The effectiveness of teaching the course "Robotics" in the effective implementation of STEM education in high school, as we mentioned earlier, was noted. Explanations were given on how the course" robotics " is taught in a two-way educational environment. In any case, regardless of what approaches the educational organization chooses, the implementation of an integrative idea and interdisciplinary interaction in a modern school when designing a STEM strategy requires a non-template approach and "good adjustment" from the teaching staff of the school.

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СТРАТЕГИИ ИНТЕГРАЦИИ ФИЗИЧЕСКОГО ОБРАЗОВАНИЯ НА ОСНОВЕ STEAM-ПОДХОДА. ОБЗОР ЛИТЕРАТУРЫ.

Аннотация

В данной статье рассматриваются основные особенности преподавания курса "робототехника" с использованием системы STEM при интеграции физики. Кроме того, будет проведен всесторонний обзор и обоснование курса "Робототехника", который преподается в стенах общеобразовательной средней школы и университета. При предметной интеграции анализ того, сколько часов отводится на курс "Робототехника" в старшей школе, и сколько часов отводится в стенах университета, проводится на основе основных программ. Однако специалисты в области педагогических, естественных, инженерных и социальных наук работают над выявлением путей возникновения проблем, а также технологических изменений для их устранения. То есть, проблема, которая из этого вытекает, всегда заключается в эффективном использовании знаний в направлении интеграции. Потому что, как будто это одно из главных требований сегодняшнего дня. В настоящее время, если система предметов интегрирована, учащийся сможет понимать предмет в широком диапазоне, не ограничиваясь этим предметом. Рассматривается широкий спектр видов и методов использования системы STEM при интеграции предмета физики в этом направлении. Мы знаем, что само слово STEM используется в направлении интеграции. STEM-образование (наука, технологии, инженерия, математика) отличается комплексным подходом к подготовке преподавателей, который позволяет предоставить будущему преподавателю современные технологии для обучения студентов инженерным, техническим и естественнонаучным направлениям. То есть, современная система STEM была использована для улучшения способности студентов к обучению по различным предметам. Исследования в этой области по-прежнему сосредоточены на поиске подходящих методологий, инструментов и механизмов оценки для разработки систем обучения, которые оказывают большое влияние на успеваемость

учащихся. Образование основано на социализации другой методологии, использующей систему STEM для преподавания физики студентам и старшеклассникам. Адаптация и расширение знаний в современных условиях, разработка стратегий решения проблем, командная работа, общение с людьми и выработка рекомендаций в сложных ситуациях - можно видеть, что развитие интеграции в любое время, как в университете, так и в школе, на рабочем месте, получило широкое распространение. Основной целью общеобразовательных центров Республики Казахстан является обучение системе STEM. А в каком направлении и каким способом ее интегрировать, в этом и заключается актуальность статьи. Курс "STEM" можно рассматривать как наиболее важный способ развития интеграции в этом направлении. Это связано с тем, что его можно рассматривать как предметный курс, полное содержание которого еще не раскрыто.

Ключевые слова: STEM, интеграция, наука, философия истории науки, математика, физика.

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ФИЗИКА БІЛІМІН ИНТЕГРАЦИЯЛАУДАҒЫ STEAM-ГЕ НЕГІЗДЕЛГЕН СТРАТЕГИЯЛАР.ӘДЕБИЕТКЕ ШОЛУ.

Аңдатпа

Бұл мақалада физиканы интеграциялау кезінде STEM жүйесін қолдана отырып, "робототехника" курсын оқытудың негізгі ерекшеліктері қарастырылады. Сонымен қатар, жалпы білім беретін орта мектеп пен университет қабырғасында оқытылатын "Робототехника" курсына жан-жақты шолу және негіздеу жүргізіледі. Пәндік интеграция кезінде орта мектепте "Робототехника" курсына қанша сағат бөлінетінін және университет қабырғасында қанша сағат бөлінетінін талдау негізгі бағдарламалар негізінде жүзеге асырылады. Алайда, педагогикалық, жаратылыстану, инженерлік және әлеуметтік ғылымдар саласындағы мамандар проблемалардың туындау жолдарын, сондай-ақ оларды жою үшін технологиялық өзгерістерді анықтау үшін жұмыс істейді. Яғни, осыдан туындайтын мәселе әрқашан интеграция бағытында білімді тиімді пайдалану болып табылады. Өйткені бұл бүгінгі күннің басты талаптарының бірі сияқты. Қазіргі уақытта, егер пәндер жүйесі біріктірілген болса, студент тақырыпты осы тақырыппен шектелмей, кең ауқымда түсіне алады. Физика пәнін осы бағытта интеграциялау кезінде STEM жүйесін қолданудың көптеген түрлері мен әдістері қарастырылады. STEM сөзінің өзі интеграция бағытында қолданылатынын білеміз. STEM-білім беру (ғылым,

технология, инженерия, математика) болашақ оқытушыға студенттерді инженерлік, техникалық және жаратылыстану ғылымдары бойынша оқытудың заманауи технологияларын ұсынуға мүмкіндік беретін оқытушыларды даярлаудың кешенді тәсілімен ерекшеленеді. Яғни, заманауи STEM жүйесі студенттердің әртүрлі пәндер бойынша оқу қабілетін жақсарту үшін пайдаланылды. Осы саладағы зерттеулер әлі де оқушылардың үлгеріміне үлкен әсер ететін оқыту жүйелерін әзірлеу үшін қолайлы әдістемелерді, құралдарды және бағалау механизмдерін табуға бағытталған. Білім студенттер мен орта мектеп оқушыларына физиканы оқыту үшін STEM жүйесін қолданатын басқа әдістемені әлеуметтендіруге негізделген. Қазіргі жағдайда білімді бейімдеу және кеңейту, проблемаларды шешу стратегияларын әзірлеу, топтық жұмыс, адамдармен қарым - қатынас жасау және қиын жағдайларда ұсыныстар жасау-университетте де, мектепте де, жұмыс орнында да кез-келген уақытта интеграцияны дамыту кең таралғанын көруге болады. Қазақстан Республикасының жалпы білім беру орталықтарының негізгі мақсаты STEM жүйесін оқыту болып табылады. Ал қай бағытта және оны қалай біріктіру керек, бұл мақаланың өзектілігі. "STEM" курсын осы бағыттағы интеграцияны дамытудың маңызды әдісі ретінде қарастыруға болады. Себебі оны толық мазмұны әлі ашылмаған пәндік курс ретінде қарастыруға болады.

Кілт сөздер: STEM, интеграция, ғылым, ғылым тарихының философиясы, математика, физика.