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GOALS AND CONDITIONS FOR CREATING STEAM COURSES, FUNCTIONS OF THEIR MATERIAL AND TECHNICAL SUPPORT

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Abstract. The digitalization of education is making its own adjustments to the learning process of students and the learning process of teachers. The STEAM format is one of the directions that successfully combines digitization, integration, and project activities. This format is widely discussed by modern educators, psychologists, methodologists, and teacher-practitioners. STEAM-education, STEAM-technologies, STEAM-courses, STEAM-methodologies - all this is just a small list of terms with definitions and recommendations for use in the educational process. The presence of ambiguous definitions of individual terms and the lack of a definition of «STEAM courses» defined the purpose of our study - to highlight the components of the educational STEAM environment, to convey the essence of the process of STEAM courses creation, as well as the objects of material and technical support. As a result of the study, the article identifies three main components of STEAM courses: equipment and material and technical base, subjects of the learning process, and training programs. The equipment and material-technical base are STEAM resources, which are represented in the form of various constructors, robotics in virtual environment (virtual laboratories) and real environment. When describing the subjects of the educational process, a special place is given to the teacher and his competencies in the field of STEAM technologies, i.e. digital technologies. Curriculum is an important component of STEAM courses, which determine the content of a particular subject area and the degree of development of the educational environment in the classroom - STEAM. The relevance and lack of development of the problem led to the choice of research topic: «Objectives and conditions of STEAM courses, functions of their material and technical support». The aim

of the review article: theoretical justification, research of the structure and conditions of STEAM courses, as well as the functions of their logistical support. Object of the study: the process of creating STEAM courses. Subject of the study: STEM knowledge as an innovative approach to the formation of research skills.

Keywords: STEAM courses, research, goals, creation conditions, logistics, process

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STEAM КУРСТАРЫН ҚҰРУДЫҢ МАҚСАТТЫ МЕН ШАРТТАРЫ, ОЛАРДЫ МАТЕРИАЛДЫҚ-ТЕХНИКАЛЫҚ ҚАМТАМАСЫЗ ЕТУ ФУНКЦИЯЛАРЫ

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Аннотация. Білім беруді цифрландыру оқушылардың оқу үдерісіне және мұғалімдерді оқыту үдерісіне өз түзетулерін енгізеді. STEAM форматы — цифрландыруды, интеграцияны және жобалау қызметін сәтті үйлестіретін бағыттардың бірі. Бұл форматты қазіргі педагогтар, психологтар, әдіскерлер, практик-мұғалімдер кеңінен талқылайды. STEAM-білім беру, STEAM-технологиялар, STEAM-курстар, STEAM - әдістемелер - барлығы қазіргі кезде оқу-тәрбие процесінде қолдануға арналған анықтамалар мен ұсыныстар бар терминдердің аз ғана тізімі. Жеке терминдердің екіұшты анықтамаларының болуы және «STEAM курстар» ұғымының анықтамасының болмауы біздің зерттеуіміздің мақсатын анықтады — білім беру STEAM-ортасының компоненттерін бөліп көрсету, STEAM-курстарды, сондай-ақ материалдық-техникалық қамтамасыз ету объектілерін құру процесінің мәнін беру. Зерттеу нәтижесінде мақалада STEAM курстарының үш негізгі компоненті көрсетілген: жабдық және материалдық-техникалық база, оқу процесінің субъектілері, оқыту бағдарламалары. Жабдық және материалдық-техникалық база — бұл виртуалды ортада (виртуалды зертханалар) және нақты ортада әртүрлі конструкторлар, робототехника түрінде ұсынылатын STEAM ресурстары. Оқу-тәрбие процесінің субъектілерін сипаттау кезінде зерттеуде мұғалімге және оның STEAM-технологиялары, яғни цифрлық технологиялар саласындағы құзыреттілігіне ерекше орын беріледі. Оқыту бағдарламалары STEAM курстарының маңызды құрамдас бөлігі болып табылады, ол белгілі бір пәндік саланың мазмұнын және сабақтағы білім беру ортасын — STEAM жобалау дәрежесін анықтайды. Мәселенің өзектілігі мен жеткіліксіз дамуы зерттеу тақырыбын таңдауды анықтады: «STEAM курстарын құрудың мақсатты мен шарттары, оларды материалдық-техникалық қамтамасыз ету

функциялары». Шолу мақаласының мақсаты: STEAM курстарының құрылымы мен шарттарын, сондай-ақ оларды материалдық-техникалық қамтамасыз ету функцияларын теориялық тұрғыдан негіздеу және зерттеу. Зерттеу нысаны: STEAM курстарын құру процесі. Зерттеу пәні: STEM білімі зерттеу дағдыларын қалыптастырудағы инновациялық тәсіл ретінде.

Түйін сөздер: STEAM курстары, зерттеулер, мақсаттар, құру шарттары, материалдық-техникалық қамтамасыз ету, процесс

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ЦЕЛИ И УСЛОВИЯ СОЗДАНИЯ STEAM КУРСОВ, ФУНКЦИИ ИХ МАТЕРИАЛЬНО-ТЕХНИЧЕСКОГО ОБЕСПЕЧЕНИЯ

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Аннотация. Цифровизация образования вносит свои коррективы в учебный процесс учащихся и процесс обучения учителей. Формат STEAM — одно из направлений, успешно сочетающее в себе оцифровку, интеграцию и проектную деятельность. Этот формат широко обсуждается современными педагогами, психологами, методистами, учителями-практиками. STEAM-образование, STEAM-технологии, STEAM-курсы, STEAM-методологии — все это лишь небольшой список терминов с определениями и рекомендациями для использования в учебном процессе. Наличие неоднозначных определений отдельных терминов и отсутствие определения понятия «STEAM курсы» определили цель нашего исследования — выделить компоненты образовательной STEAM-среды, передать сущность процесса создания STEAM-курсов, а также объектов материально-технического обеспечения. В результате исследования в статье выделены три основных компонента курсов STEAM: оборудование и материально-техническая база, субъекты учебного процесса, программы обучения. Оборудование и материально-техническая база — это ресурсы STEAM, которые представлены в виде различных конструкторов, робототехники в виртуальной среде (виртуальные лаборатории) и реальной среде. При описании субъектов учебно-воспитательного процесса особое место отводится учителю и его компетенциям в области STEAM-технологий, т. е. цифровых технологий. Учебные программы являются важным компонентом курсов STEAM, которые определяют содержание конкретной предметной области и степень разработки образовательной

среды в классе - STEAM. Актуальность и недостаточное развитие проблемы обусловили выбор темы исследования: «Цели и условия создания STEAM курсов, функции их материально-технического обеспечения». Цель обзорной статьи: теоретическое обоснование, исследование структуры и условий курсов STEAM, а также функций их материально-технического обеспечения. Объект исследования: процесс создания курсов STEAM. Предмет исследования: знание STEM как инновационный подход к формированию исследовательских навыков.

Ключевые слова: STEAM курсы, исследования, цели, условия создания, материально-техническое обеспечение, процесс

Introduction

Many people recognize that today education is mainly aimed at successful passing of exams in the form of tests. Students are “trained” to pass the test for a certain number of points based on many theoretical data and facts in different subjects. After graduating from secondary school, pupils often do not understand how all these subjects are related to each other and how their knowledge of mathematics, physics or any other subject in real life will benefit them. That is, the arrival of specialists in the world labor market, who cannot provide the work of highly technical enterprises and make scientific discoveries and achievements in the areas of science that mankind sorely needs. Therefore, steam courses are currently gaining such popularity and are growing year after year, and the leading ideas of STEAM are the integration of subjects into a single field of human knowledge and the mandatory application of this unified knowledge in practice. However, despite the popularity of STEAM knowledge, the fact that it is supported by states from different countries seeking scientific and technological leadership remains unclear.

The basis for training such specialists should be in the general secondary and higher education process. Also, to fully integrate the STEAM approach into the educational space, teachers who know and master the methodology of organizing training in STEAM logic are required. Therefore, the STEAM course is relevant in the preparation of modern specialists - future teachers on a competency basis. The interest in STEAM education appeared in the innovative landscape of modern education system in different countries (Mukhtar, 2018). Universities were engaged in the development of the STEAM — model of education, general secondary schools began experiments with curricula, methodological literature, various STEAM initiatives, business representatives were based on the implementation of effective STEAM course projects. Applications called “STEM+” have appeared, which means that they have additional components:

1. STEAM is knowledge that focuses on the world of art.
2. eSTEM - additional ecology.
3. STEM - additional medicine.
4. STREM - additional robotics, etc.b.

In the article, we adhere to the term STEAM - education, focusing on the creativity and synthesis of the humanities and social sciences. The current focus on the content of natural science education will shift from the basic concepts of individual subjects to the development of “metamen”, research and engineering practice. The creation of STEM courses should not be separate from the study of natural sciences, social and humanities, art.

The purpose of the review article is to theoretically justify and investigate the structure and conditions of the STEAM courses, as well as the functions of their material and technical support. Research Object: The process of creating STEAM courses.

Scientific process. The following research methods were used to achieve the goal:

- at the theoretical stage of research: analysis of psychological and pedagogical literature on research, modeling of the process of formation and creation of STEAM courses.
- qualitative and quantitative analysis of research activities of teachers.
- in the productive and generalization stage: comparison and generalization of results, systematization, and interpretation of data.

The study of the topic "Organization of STEAM courses" is important in modern education for several reasons:

1. Preparation for the future work: in the modern world we need more staff with skills that combine different subject areas. STEAM courses help participants develop mixed skills, including technical and creative thinking, problem solving, communication and collaboration. This makes them competitive and ready for modern work requirements.

2. Development of critical thinking and creativity: STEAM courses contribute to the development of critical thinking and creative potential of students. They teach participants to look at problems from different angles, find unconventional solutions and apply creative approaches to tasks. This will help to develop innovative abilities and encourage participants to develop new ideas and concepts.

3. Support for integrated learning: STEAM courses contribute to the integration of subjects and education. They help participants understand the connection between different subjects and apply this knowledge in specific situations. Integrated learning develops a deep understanding of subjects and promotes the development of universal skills that can be used in different areas of life.

4. Solving complex problems and difficulties: STEAM courses prepare participants to solve difficult problems and challenges in the future. Training in the STEAM methodology will allow to develop system thinking, analysis of complex situations, the ability to identify connections and causal connections. This will help participants to develop effective and innovative solutions to various problems.

Key results. The main idea of STEAM is to unite areas that are traditionally considered separately and to use their interconnected principles, methods to solve specific problems and tasks. The organization of STEAM courses includes the creation and conduct of educational programs that combine different aspects of science, technology, engineering, art, and mathematics. The value of organizing STEAM courses is in the following aspects:

1. Goals and objectives: The main purpose of the STEAM courses is to develop the comprehensive approach of participants to knowledge and the ability to apply knowledge in different fields to solve specific problems. The courses set the task of developing critical thinking, creative thinking, joint skills, problem solving skills, relationships, and other basic competencies (Johnson et al., 2020).

2. Integration of disciplines: The peculiarity of STEAM courses is the integration of science, technology, engineering, art, and mathematics. Instead of exploring these areas separately, they will be integrated into a single training course, where each branch will complement and interact with others. This will help participants understand how to apply knowledge and skills in different fields in real life.

3. Project-oriented training: STEAM courses often use a project-oriented teaching approach. Participants will be able to apply their knowledge and skills in practice by working on specific or imitation projects. This will help them to develop practical expertise, creative thinking, problematic thinking and the ability to work in the group.

4. Interactivity and practical activity: STEAM courses focus on interactivity and practical activities. Participants will be able to conduct experiments, create models, program, design and create artificial objects.

5. Research approach: STEAM courses stimulate a research approach to teaching. Participants will face specific questions and challenges, their task is to conduct research, collect data, analyze and summarize information. This will develop their skills in self-study, critical thinking and informed decision-making.

6. Group work: STEAM courses actively attract group work items. Participants often work in groups, solve tasks together, develop projects and exchange knowledge and ideas, group work contributes to the development of communication skills, leadership, the ability to listen and respect the opinions of others.

7, Technological support: STEAM courses require appropriate technological support. This may include computers, modeling and design software, 3D printers, robotic sets, multimedia tools and other equipment needed for practical lessons and experiments.

8. Active role of the teacher: The teacher in the STEAM courses plays an active role as a fascilitator and mentor. This will help participants to develop research questions and objectives, provide support and guidance in the educational process, stimulate creative thinking and independence. The teacher also evaluates and provides feedback, contributing to the development of participants.

9. Interaction with the real world: STEAM courses try to establish a connection between teaching and the real world. Participants will have the opportunity to study and solve specific problems, implement projects of practical or social importance.

In Kazakhstan, the number of STEAM initiatives in education is growing rapidly. In general, all initiatives can be grouped in five directions:

- initiatives of individual teachers or school groups.
- private, commercial courses and schools.
- technical (innovation and technical) creative centers.
- resource and training centers at the level of individual structures of the Ministry of Science and Higher Education of the Republic of Kazakhstan (universities, general secondary schools).
- initiatives of business representatives.

It is necessary to return to the knowledge of STEAM and explain the main purpose of this approach. The main objective of “STEAM courses” is to form the following five main competencies:

1, Conceptual understanding. Participants’ awareness of concepts, relationships, and operations.

2. Operating freedom. Mastering the skills of the participants in performing different operations quickly and flexibly.

3. Strategic competence, which allows participants to see, conceptualize and solve problems.

4. Adaptive understanding. Development of logical thinking, reflection, explanatory and proofability.

5. Productive consciousness. The ability to consider a topic useful, valuable, and profitable (Ospanov, 2016).

Sondyktan, we consider steam courses in two aspects. On the one hand, it is knowledge that allows to implement the principle of personal orientation of the pedagogical pro-

cess. To implement this principle, it is necessary to identify conditions that ensure that students with different needs and opportunities have access to the planned results of the program's development. On the other hand, this is a separate way of considering individual characteristics. Defining a course program as a personal trajectory act as its leading characteristic. This interpretation allows us to form our own model of how to achieve certain competencies (Brown, 2018). Considering the formation of the trajectory of private education, it is necessary to realize psychological, pedagogical and subject knowledge and identify specific tasks when creating STEAM courses. For this purpose, three main criteria are divided:

1. The first is that the course should be aimed at a specific person who is studying. This means that the creation of a private educational trajectory within the framework of the program should consider the potential of the cognitive process.

2. The second criterion predicts the need to compare the opportunities for the development of the information and educational environment, that is, modern technologies. This means that the implementation of the STEAM course is constantly identifying and adjusting the conditions of rapidchanges in the environment and the tasks that are equal to the prospects for the development of education.

3. The third criterion indicates a careful personal choice of pedagogical technology, through which the initiated creation of the trajectory of private education is carried out.

In the implementation of these criteria, the creation of the trajectory of private education is based on age and psychological characteristics, as well as the differentiation of activities depending on the type of activities. At the same time, the course of private education can be established at different levels, from certain classes to the development of the general program. For example, within the framework of the STEAM course, when implementing the educational program "I am a researcher", a separate course of education will be created in each lesson. As an example, we give the lessons of "control". The lesson consists of three main stages:

1. "Proof" (observation" as a method of scientific research).

2. "Study" and "define" (lesson structure).

The first two stages will be held in all classes of the Invariant and STEAM course. The creation of private educational routes begins during the "research" period, where each student can choose the route that works best for him or her, for example:

- Version 1. Consider the finished structure of the lesson → create a graphic of the lesson.

- Version 2. Prepare the lesson yourself → write down the stages and specifications of the lesson.

- Version 3. Prepare a copy of the teacher yourself → divide the class into tasks → create an evaluation system.

If the participant selects version 3, then the next stage for this is "parse" enabled. At the same time, material and technological support contributes to the development and implementation of STEAM knowledge in several ways:

- use technologies as a tool for the preparation and organization of STEAM education;

- Direct use of digital technologies in the implementation of STEAM-education.

Convergent technologies play a leading role in the creation of private educational routes for students in the context of STEAM-education (Eszhan, 2019). The purpose of these projects is:

- to ensure that students understand the growing role of natural sciences and scientific research in the modern world on the basis of convergence (convergence) of the four global directions of modern science and technology;

- formation of skills of safe and effective use of high-tech equipment for accurate measurements;

- stimulation of interest in obtaining a specialty related to technology and further work in the areas of modern science in the industry.

At the same time, it is necessary to form the following technological thinking in accordance with the tetrada:

"The goal → necessity is → method (technology) → results".

Within the framework of the STEAM courses, the routes of private education will be created independently during the implementation of the project. For example, they choose the most interesting service for themselves:

- preparation of leaves and stems as a template (biologists);
- preparation of reagents (chemists);
- illumination / display of images (physics);
- analysis of the results (analytics);
- presentation of results received and project protection.

Thus, you can provide a technological map of steam courses (table 1).

Table 1. Technological map for the implementation of STEAM courses

STEAM Course Stages	Course Driver Service	Activities of participants
Knowledge Updating	Education of participants in subject area to be revived	Revitalize the necessary knowledge of subjects
Guide	Provides instructions for performing tasks	Accept a list of suggested suggestions
Practical work	Monitors the progress of designing products, helps you present the results of the task	Performs a lesson build, presents the results of a completed task

Studying the modeling of the STEAM course, it is presented in the form of an interrelated process starting with the analysis of the object of study (to separate the components of the object, to study their properties and relationships), to present the resulting information in the form of schemes, formulas, etc. (Sakenova, 2020). This process will end with a verification of the model's compliance with the object under investigation. This whole process should be presented in the form of a schema (figure 1).

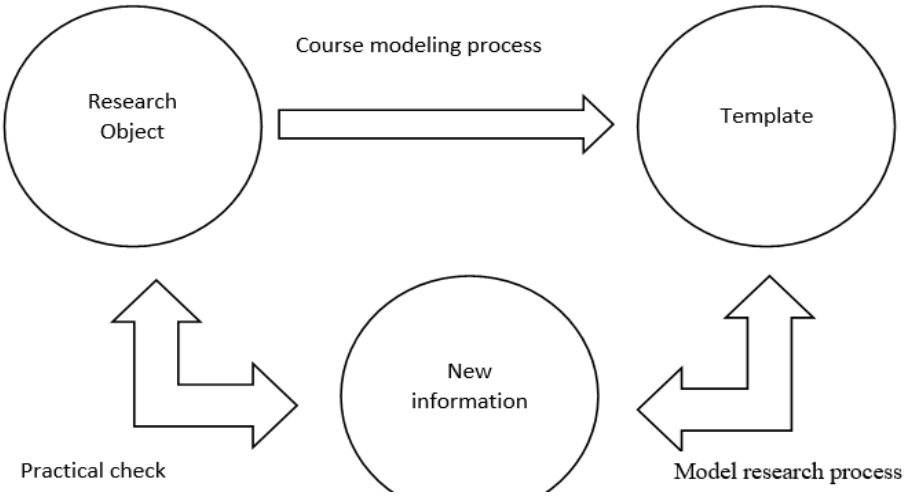

Figure 1. Schema of steam course modeling process

The objectives of the STEAM courses include the development of creativity, problem solving, critical thinking, cooperation and technological literacy. These courses will allow participants to study specific issues, participate in practical activities and apply their knowledge in natural science, technological, engineering, artistic and mathematical subjects. It is difficult to imagine modern pedagogy and didactics without the use of modeling methods, so you can provide a description of the STEAM course as well as a learning service (figure 2).

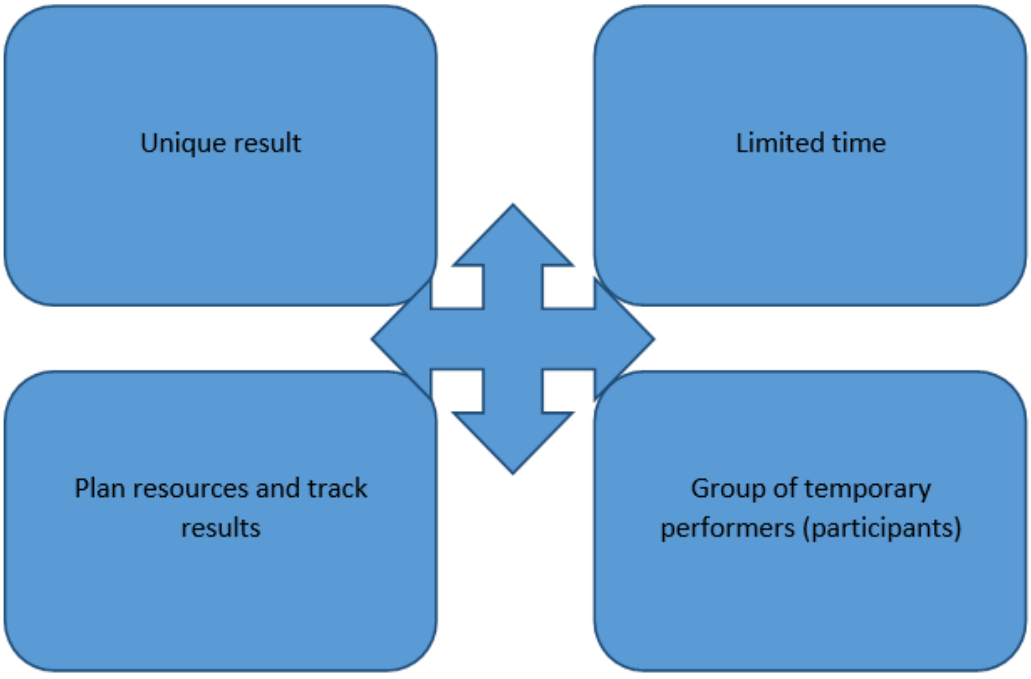

Figure 2. STEAM Training Course Specifications

Based on the description of the STEAM course, you can offer educational programs that combine different aspects of science, technology, engineering, art and mathematics (Smith, 2019). That is, creating STEAM courses involves several important milestones:

1. Target audience: find out who the course is intended for. Consider the age group of participants, the level of education, and the projected level of knowledge;

2. Educational goals: Identify the main goals and expectations that you want to achieve through the course. Explore what competencies and skills participants should acquire after completing it;

3. Curriculum: develop a detailed curriculum, including all the necessary topics and modules to be considered during the course. Set the reading order and structure the materials so that participants can easily track the reading process;

4. Interactive materials: prepare a variety of interactive materials for training, add the following:

- video lectures;
- presentations;
- interactive tasks;
- visual illustrations;
- demonstrations and other materials to help participants master the subject area (Baibekova, 2020).

5. Practical tasks: adding practical tasks that allow the participants of the course to apply what they have received in practice. This can be project work, laboratory research, programming, creative tasks and other practical tasks;

6. Joint training: stimulation of cooperation and interaction between participants of the course. Add discussion forums, group tasks, or projects, as well as collaboration and experience sharing capabilities;

7. Delivery format: decide what format the course will be given. You can choose an online learning platform where participants can access materials, tasks, and relationships with teachers. Also, face-to-face lessons, вебинарлардың немесе әртүрлі оқыту форматтарының комбинациясын қарастыруға болады;

8. Experts and teachers: select qualified experts and teachers who will conduct the course. They need to have deep knowledge of STEAM and experience teaching or working in the relevant fields;

9. Interactive tools: develop or select appropriate interactive tools that allow participants to interact with materials and apply what they have received. It could be virtual laboratories, modeling, programming, multimedia tools and other technological resources;

10. Support and feedback: provide support and feedback mechanisms for participants. This may include access to teachers or course assistants, forums for asking and discussing questions, and a feedback system that allows participants to get constructive feedback about their work;

11. Update and support: Provide a course upgrade system so that it stays relevant over time. Review your materials regularly, make changes that are consistent with the region's development and participant feedback.

Accessibility: ensuring the availability of courses for different groups of participants, including persons with disabilities. Consider universal design principles and, if necessary, provide alternative training formats (Mann, 2019).

Material and technical support for STEAM courses is critical to creating a real and

exciting learning experience. The functions of material and technical resources include ensuring access to tools, equipment and technologies related to STEAM and art disciplines, promoting experimentation and prototypes, collecting and analyzing data, stimulating innovation and creativity. encourage their active participation in the educational process. In addition, in the preparation and direct implementation of STEAM courses in education, there are several promising areas for the use of digital technologies:

- methods of working with graphics, video, audio content (computer graphics and its role in the design of STEAM lessons, interactive video, etc.);
- visual communication;
- online services for steam training;
- ways of working with the interactive whiteboard;
- computer modeling;
- laboratory modeling;
- visualization of information;
- digital conversation;
- software for the organization of project training;
- objects-oriented languages;
- virtual experiments.

Thus, the logistical support of STEAM courses plays an important role in ensuring full-fledged training and allows participants to actively interact with the content of the course, so here are some functions that can provide this:

- Computers and laptops: computers are an integral part of the material and technical support of STEAM courses. They allow participants to learn software, perform tasks, conduct research and create projects. Laptops provide flexibility and mobility to work outside the classroom or laboratory.

- interactive whiteboard or projector: interactive whiteboard or projector allows educators to present materials and interpret concepts visually, interactively. They can also be used to display software, visualize data, and interact with participants.

-3D printers and scanners: 3D technologies are becoming popular in the steam industry. 3D printers allow participants to create and print physical models, prototypes and parts for projects. The scanners allow you to scan specific objects and create their 3D models for further work.

- robotic sets: robotic sets allow participants to learn and experiment with robotics. These include robot designers, sensors, microcontrollers and programming, control software (Petrova, 2019).

- laboratory equipment: it is important to have the appropriate laboratory equipment for the implementation of experiments and practical tasks. This may include microscopes, chemical reagents, electronic components, measuring instruments and other special domain-related equipment.

- multimedia resources: Multimedia resources are an important component of the material and technical support of STEAM courses. This can be access to online databases, electronic libraries, video recordings, audio recordings, interactive educational programs, and other digital content that enriches the learning process, providing participants with additional learning and research materials.

- Interactive input devices: Depending on the direction of the STEAM course, you can use interactive input devices such as tablets, stylus, or special peripheral devices. They

allow participants to create digital graphics, programming, work with graphics and visualize concepts (Maimataeva, 2022)

- Software: STEAM courses may require the use of specific software. This can be modeling and design, programming, data visualization, image and audio editing software, and other tools specific to a specific domain.

- Internet connection: reliable and fast Internet communication is necessary to provide access to online resources, interaction with web applications, exchange of information and communication between participants and teachers.

- communication tools: You can use communication tools such as video conferencing, chats, email, forums, and file-sharing platforms to ensure effective course communication. They allow participants to ask questions, discuss topics, work together and receive support from teachers and colleagues.

It should be remembered that the material and technical support of STEAM courses must be adapted and in accordance with the specifics of the subject area, the level of training and the needs of the participants. In order to successfully implement STEAM courses, certain conditions must be met, which include the development of a comprehensive curriculum for teachers, administrators and policymakers, coordination of cooperation and efforts to provide sufficient resources, funding and professional development opportunities for teachers, and effective teaching strategies such as project-based learning, demand-based learning and technology integration are interesting and interactive reading plays acrucial role in the creation of a center.

Conclusion

Based on all of the above, we can conclude that the organization of STEAM courses and the use of its technology in the learning process will effectively influence the formation of research skills. At the same time, considering STEAM courses, the formation of these skills will allow fulfilling the demand of the state and social society for future highly qualified specialists in technical direction, increase the interest of modern youth in engineering professions, significantly improve the quality of education and prepare students for real life. The STEAM course does not always yield the result, and creative ideas do not always emerge in the process of new learning, or the final material product is produced. Perhaps because of the course, the researcher comes up with a new original idea, so it can be considered an educational product. Such values can complement the bank of ideas used in the educational process. The objectives of the STEAM courses are related to the development of critical skills and the promotion of interdisciplinary learning, which require suitable support conditions such as a well-thought-out curriculum, professional development of teachers and appropriate resources, material and technical support plays a crucial role in creating interesting learning experience, creating conditions for practical action, and stimulating innovation. Using STEAM knowledge, educational institutions can allow participants to be ready for the future, solve complex problems and contribute to scientific and technological progress.

STEAM technologies create a rich educational environment in which the student participates more in the learning process, becoming an active subject of learning rather than a passive observer of the process. The educational environment of the STEAM course creates special conditions for the development of cooperation and communication skills. They learn how to communicate productively with teachers, teachers, partners in project work. The organizational aspect of the model should allow to adjust in the process of implementing individual trajectories at each stage of the work in the case of changing the configuration

of needs and the need to set new learning, research, or design tasks.

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