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Learning model focused on STEM (knowledge, technology, engineering and mathematics) to achieve excellence in the field education in the Turkic-speaking world of the 21st century

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Abstract: In this article, the author talks about the main tasks of the STEM approach, which is currently being implemented at the state level in countries focused on the development of their scientific and technical elite

Key words: STEM technologies, innovative methods of teaching youth, STEM education, mathematics, engineering, knowledge.

In the last few years, in the field of innovative economy, creative industries associated with intellectual and creative activities have become increasingly important: computer technology, virtual reality, design, fashion, advertising, animation, etc. Creative industries around the world are becoming the driving force of economic growth , and youth employment in the creative industry already exceeds employment in the real sector. These changes pose new challenges for the education system, namely the need for greater inclusion of creative and artistic disciplines in the curriculum.

The modern world poses difficult challenges for education: learning must be interesting, knowledge must be applicable in practice, learning must take place in an entertaining form, and all this must certainly bring good results in the child's future - a well-paid job, self-realization, high intelligence scores.

Some parents and educators are still scratching their heads in search of solutions to all these issues, while others have made the right choice in favor of STEM education.

In the late 1990s, the STEM approach to education was born in the United States, which is now being implemented at the state level in countries focused on growing their own scientific and technical elite. The abbreviation STEM stands for Science - science, Technology - technology, Engineering - engineering, or engineering art, Mathematics - mathematics. Sometimes the letter R is added to this set, representing robotics, or the letter A, corresponding to the word Art. The idea and acronym STEM were first proposed in 2001 by scientists from the US National Science Foundation as a guideline for updating the system of training modern engineers and researchers in universities. The idea was supported by the government, public organizations and many US corporations. As a result, STEM principles began to be actively used to shape the educational programs of many American universities.

The average hourly wage earned by STEM workers in the United States is twice that of workers in other fields.

Educational institutions in France, Great Britain, Australia, Israel, China, and Singapore offer students certified state educational programs in the scientific and technical field and train STEM specialists. The Transform Singapore initiative was launched in 2002 to transform the city-state into a global center for creativity, innovation and design. Vietnam, Hong Kong, Türkiye, Qatar, Canada, Ukraine, etc. are also involved in the development of STEM.

"STEAM is a synergy of theory and practice. A strong theoretical base cannot be considered a guarantee of a successful career, because what is important for an employer is not just knowledge in the subject area, but also the ability to apply it correctly. People who have received education using the STEAM methodology are more independent and have more high career potential, which also affects the level of income," notes Artyom Kumpel, General Director of Severgroup Talent Tech. The main difference between the STEAM approach is that here children use both their brains and their hands to successfully learn a variety of subjects. The knowledge they receive is "mined" on their own.

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Students develop their willpower, creativity, flexibility and learn to cooperate with others. These skills and knowledge constitute the main educational task, i.e. what this entire education system strives for.

The most famous example of the STEAM approach is the Massachusetts Institute of Technology (MIT). The motto of this world university is "Menset Manus" ("Mind and Hand"). MIT has developed STEAM courses and even created STEAM training centers in some schools to give children the opportunity to learn and be exposed to the concept of STEAM early on [1].

STEM education is not the standard approach of rote learning, tests, and exams. This is a game that is fun, with materials and practice tasks that are easy to follow. Such training is based on a creative approach to problem solving, during which you can consolidate existing knowledge and gain new ones. That is why you can start at almost any age. The main thing is that the complexity of the tasks matches it.

According to experts, the STEM approach is based on four principles:

- *A project form of organizing the educational process, during which children are united in groups to jointly solve educational problems;*
- *The practical nature of educational tasks, the result of which can be used for the needs of a family, class, school, university, enterprise, city, etc.;*
- *Interdisciplinary nature of training: educational tasks are designed in such a way that their solution requires the use of knowledge from several academic disciplines at once;*
- *Coverage of disciplines that are key to training an engineer or a specialist in applied scientific research: natural science subjects (physics, chemistry, biology), modern technologies and engineering disciplines.*

Dr. Mehmet Aydeniz presented an article in the most popular newspaper Hurriyet and several other media in Turkey, where he questions the state of Turkish STEM education by analyzing the performance of Turkish students in international and national exams such as the Program for International Student Assessment (PISA), Trendsin International Mathematics and Science Study (TIMMS) and YGS (University Selection Examination in Turkey). It further explores and discusses the reasons for Turkish students' STEM learning in national and international performance tests. Most notably, he finds that reading skills, quality of instruction, access to early childhood education, and access to after-school resources play an important role in Turkish students' performance on national and international science and mathematics tests [2].

In the final chapter of the article, Dr. Aydeniz makes recommendations ranging from reforming the STEM curriculum, investing in teacher quality, providing differentiated and enriched instruction for gifted students, and closing the achievement gap between different groups of students.

Also, in recent years, in **Azerbaijan**, as in other countries, they are actively trying to adapt the educational system to modern challenges.

Project leader Igrar Nazarov, within the framework of STEAM, the use of various gadgets (smartphones, tablets, etc.) is encouraged so that students can take advantage of Internet resources and find a quick and correct way to complete a task, as efficiently as possible, while working in a team and sharing ideas with each other.

At the initial stage, the project started in 42 schools in Baku and covered about 6,000 students and more than 300 teachers who underwent special training before the launch of the project. The STEAM classes were also equipped with all the necessary equipment. Thanks to successful implementation, in the 2020-2021 academic year the project was expanded to 21 cities and regions of Azerbaijan (Ganja, Sheki, Zagatala, Guba and other regions) and covered about 20,000 students. 200 teachers were sent to Israel for advanced training. There they acquired the necessary knowledge in the field of nanotechnology, neurobiology, and studied the operating principles of 3D printers and CNC laser cutting devices. To date, more than 25 thousand students in grades 6-7 and 800 teachers from 147 secondary schools in 45 regions are participating in the project.

Today's students are tomorrow's specialists, who must now be adapted to innovative technologies and be able to apply the acquired skills and knowledge in practice. According to the project manager, STEAM lessons also broaden students' horizons; they can bring ideas into reality, using their imagination and going beyond a given algorithm, which teaches them to think outside the box at any

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time and in any situation. In accordance with their abilities and acquired skills, having received a quality education, talented students in the future determine the direction of development and progress, the principles of evolution and its pace. They are the bearers and inexhaustible resources of the national intellectual elite, and also serve as guarantors of our future, a safe and dignified life for humanity. We believe that today's STEAM students can transform our country from a technology consumer to a technology producer in the future.

Speaking about further plans for the development of the project, I. Nazarov noted that work is underway to create a unified electronic platform for schools and students who have joined the project. In addition, it is planned to connect both the project as a whole and individual schools to international STEAM networks.

Kazakhstan has also begun the active development of STEM education. There is positive experience of international cooperation in the field of STEM education [3]. For example, since 2014, the five-year UK-Kazakhstan Partnership Program "Newton-al-Farabi" has been implemented with a total budget of 20 million pounds sterling. The goal of the Program is interaction between the two countries in strengthening scientific and innovative potential, personnel exchange and the creation of joint research centers. Science and technology are rapidly changing our lives. STEAM education allows you to see new trends, highlight the main thing, combine knowledge from various fields and find the most optimal solution to a problem - from constructing bridges to global warming. This innovative system is sometimes called the "silver bullet" for education. As you know, the expression "silver bullet" symbolizes a universal method with which you can solve any problem. And in today's world with rapidly developing technologies, a "silver bullet" is needed more than ever, especially in the field of training professionals for high-tech industries.

Such tasks also face **Turkmenistan**, which has embarked on the path of digital transformation of all spheres of state and public life. The implementation of the Concept for the Development of the Digital Economy for 2019-2025 involves training specialists who are fluent in the digital environment, IT specialists, engineers, programmers who are capable of radically changing production models, giving them an innovative character.

In the city of Bishkek, on October 2, 2019, the Deputy Minister of Education and Science of the **Kyrgyz Republic**, Nadira Dzhusupbekova, met with the Deputy Head of the UNICEF Office in Kyrgyzstan, Munir Mamedzade, during which they discussed the STEM education program for girls, within the framework of which schoolgirls aged 15-18 years from rural localities, low-income families, and internal migrant families will be able to develop their skills through vocational training programs with the support of recognized women's business leaders in Kyrgyzstan.

Called by his contemporaries the "Lord of Sciences," advisor to the rulers of various countries of the Near and Middle East, Ibn Sina (Avicenna in Latin transcription) (980-1037) devoted many years to teaching and left many works, among which the "Book of Healing" stands out. It included treatises directly related to pedagogical theory: "The Book of the Soul", "The Book of Knowledge", "The Book of Directions and Instructions". Ibn Sina dreamed of comprehensive education and development, and above all, through the means of music, poetry and philosophy.

The authors of the textbooks were often prominent thinkers of the East. Thus, Biruni created an educational treatise "Tafkim" ("Admonition to the principles of stargazing"). This is a manual for teaching mathematics, astronomy and geography. The student could choose from several options for answers to the questions posed, the one that he considered correct.

On September 27, 2018, the first STEAM education school, Robooky, was opened in Tashkent (**Uzbekistan**) at the Galileika network of educational centers. Engineering, robotics and programming are successfully combined here. In honor of the opening, a series of free master classes on rocket science and mechanics were held, in which more than 150 people took part.

Robooky is a place where popular areas are successfully combined into one course: STEAM education, robotics and programming.

Training is presented in various modules:

aerospace engineering; Marine Engineering; construction engineering; environmental engineering; mechanical engineering; industrial engineering; electrical engineering; chemical engineering and others.

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The school program is structured in such a way that children sequentially study modules in engineering, combining them with robotics and programming. Each lesson is built in an interactive form: children solve interesting problems, apply the acquired knowledge in practice and create their own inventions. By studying at the Robooky school, children acquire skills that will help them when choosing a future profession and will give them a competitive advantage and success in the future.

During classes, children acquire:

knowledge in various fields of engineering; knowledge in robotics and programming; the ability to apply knowledge; engineering style of thinking; developed logic; analytical thinking; enthusiasm for knowledge (physics, chemistry, mathematics); teamwork skills; project management skills; presentation skill; problem solving ability; purposefulness and self-confidence.

Presidential schools were created in accordance with the decree of the President of the Republic of Uzbekistan Shavkat Mirziyoyev "On measures for the education of Presidential schools" dated February 20, 2019 and are aimed at creating a talent management system and training the country's future leaders. Presidential schools will become a kind of locomotive of reforms in improving the quality of education in our republic. The educational process at Presidential Schools is carried out according to the "STEAM Education" program, which will allow gifted youth to further develop thinking, willpower, creativity and flexibility. Lessons in these areas are conducted in the state language. Today, Presidential schools operate in Nukus, Khiva, Namangan and Tashkent. Experienced STEAM education teachers have been selected for these schools.

The beginning of the creation of presidential schools in a limited number was dictated by the need to test a completely new model of management in education. After testing, presidential schools will be created in Samarkand and other regions of Uzbekistan in 2020-2021.

As a preliminary filter to optimize the number of applicants, requirements for grades of applicants in STEM fields have also been established. Students who have completed 4th grade must have a grade of 5 "excellent" in subjects such as "mathematics" and "natural history". Graduates of fifth grades, in addition to the above two subjects, must have an "excellent" grade in computer science and information technology, sixth grade graduates - computer science and information technology, physics.

Those students who have completed grades 7-9 can submit their documents if they have a grade of 5 in algebra, geometry, computer science and information technology, physics, chemistry and biology. "Large-scale reforms in the field of education have begun in our country. The main goal of the reforms is to educate educated and competitive personnel. Such activities can motivate children to acquire knowledge and that acquiring knowledge can be fun. Teachers get the opportunity to learn about modern and interesting teaching methods," noted the Minister of Public Education of Uzbekistan Sherzod Shermatov.

The President of the Republic Shavkat Mirziyoyev instructed the Minister of Education, together with the Minister of Culture, to organize a Cultural Center in all schools of the Republic and include the study of musical instruments in the school curriculum. In a word, mastering music education at school is also another task of the benefits of STEAM education.

In the school curriculum, along with natural subjects, the inclusion of learning chess games can be considered a path to a higher potential for mastering the comprehensive knowledge of students.

The Agency for the Development of Presidential, Creative and Specialized Schools (PIIMA) has established cooperation with the Ministry of Public Education. As part of this cooperation, foreign teachers of Presidential Schools share their experience and knowledge with local specialists, as well as the methodology for teaching STEAM subjects. Foreign experts shared their methodology for teaching physics and mathematics, as well as their experience. It is noted that now it is necessary not only to provide high-quality knowledge, but also to develop the competencies of children.

The first international festival of modern educational methods in Uzbekistan was organized by the Association of Non-Governmental Educational Institutions with the support of the Ministry of Public Education of Uzbekistan. The partners of the event were the companies MIND Champ (Uzbekistan) and New Generation (Ukraine) [4]. The purpose of the festival is to popularize natural sciences among young people and study the experience of foreign countries in the field of STEAM education.

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The best non-state educational institutions of the city of Tashkent, authors of modern educational methods and foreign companies presenting their solutions in the field of STEAM education took part in the STEAM Fest. Among the foreign participants of the festival are representatives of the companies GIGO (Russia), Robolab (Belarus), LegoEdu (Kazakhstan), Cool Science (Ukraine). Foreign and local experts presented lectures on improving critical thinking skills in children using STEAM, 3D technologies and robotics , use of Internet resources during lessons, etc.

The festival organizers also presented more than 50 master classes in various areas of STEAM education. These master classes showed children that education can be interesting and exciting.

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