Migration Letters

Volume: 20, No: 6, pp. 429-439

ISSN: 1741-8984 (Print) ISSN: 1741-8992 (Online)
www.migrationletters.com

The Role of Stem Education in Preparing Students for the Workforce

Sarkhan Jafarov[1]

Abstract

Purpose: This research aims to study the essence and peculiarities of STEM education and identify the critical elements of embedding this mechanism in the learning process in the world and Azerbaijan.

Research Methods: Study of literature and other sources of information; text analysis; formulation of conclusions.

Results: The STEM education movement is clearly impacting the international scene. However, serious doubts persist about its foundations, nature, and implementation, which should make us reflect on the danger that it may become an innovation that can be diluted. Here we have: (1) characterized those models of STEM education proposed by educational research; (2) provided a valid STEM education model based on a valid model of STEM education that is supported by the research.

Contribution to literature: The study contributes to the current research literature by systematizing the existing evidence and grouping the reasons for the importance of STEM education according to specific indicators and criteria. The study also presents a set of practical recommendations to all interested educational institutions on how to organize the process of STEM education for its effectiveness, taking into account all previous mistakes made by the world experience.

Keywords: *STEM-education, technologies, innovations, natural sciences, development of schoolchildren and students, organization of STEM-process.*

Introduction

The education system in the world, in general and Azerbaijan in particular, is undergoing significant changes. They are overdue because profound transformations are occurring worldwide and within different countries. Progress does not stand still, presenting new requirements for educational programs and the quality of education of new specialists. These processes are accompanied by outdated material and technical bases in schools and universities and the lack of proper motivation among schoolchildren and students, which presents significant problems for the modern education system.

As each state is still interested in the fact that the national education system prepares increasingly qualified personnel adapted to the high level of scientific and technological progress, such a phenomenon as STEM education is becoming increasingly relevant.

The key objective of this research is to study the essence and peculiarities of STEM education and identify the critical elements of embedding this mechanism in the learning process in the world and Azerbaijan.

[1] PhD, Senior lecturer, Guba branch of Azerbaijan State Pedagogical University, Western Caspian University, Baku, Azerbaijan, sarxan_cafarov@mail.ru, https://orcid.org/0000-0002-1835-0709

Hypothesis of the study: STEM-education system contributes to meeting the demand for engineering and scientific-technical specialists capable of bringing innovation and technological progress to a qualitatively new level in the future.

In the educational field, some studies conclude that there is no consolidated criterion when referring to STEM education (Martín-Páez et al., 2019), nor a common conception of STEM, at least at the university level (Breiner et al., 2012). Characterize the models of STEM education proposed from educational research, focusing mainly on:

a) what definition of STEM education is adopted;

b) what is the objective (or objectives) proposed for this educational approach;

c) at what educational stages of education is STEM education being adopted;

d) what are the objectives (or objectives) proposed for this educational approach;

e) what are the educational stages of STEM education?

To provide a theoretical framework for STEM education, supported and agreed with those common elements of the reference frameworks analyzed. Previous works have presented conclusions on the definition of STEM education, considering it as an educational approach that integrates knowledge and/or skills from various disciplines implied in the acronym, oriented to problem-solving and contextualized in situations with different levels of authenticity (Aguilera et al., 2021). In this communication, we focus on its objectives.

Methods

The systematic review follows the guidelines of the PRISMA Statement (Moher et al., 2009). The search was conducted in the first half of January 2020. The Social Sciences Citation Index, Arts & Humanities Citation Index, and Emerging Sources Citation Index collections of the Web of Science (WOS), and the Social Sciences and Arts and Humanities categories of Scopus were considered. The period reviewed was 1990-2022, given that the STEM movement began in the 1990s (Sanders, 2008), and the search keys included the Boolean words and operators: model OR models OR framework, joined by the AND operator to the keywords STEM OR STEAM. Since this study ultimately aims to formulate a theoretical framework resulting from the review of those proposed previously, the term STEAM was included in the search key, given the similarities between STEM education and STEAM education.

Research Methods:

1. Study of literature and other sources of information;

2. Text analysis;

3. Formulation of conclusions.

The role of STEM education

First of all, let's decipher the abbreviation STEM. It came into all world languages from the English language and represents the first letters of such English words as Science, Technology, Engineering, Mathematics.

At the same time, researchers of this phenomenon emphasize that the understanding of STEM education is not limited only to deciphering the words included in it. In itself, this concept directly relates to such a way or method of learning, which provides an integrated study of the above-mentioned subjects (MacKinnon et al., 2017). If one component is removed, STEM education loses all meaning.

Historically, STEM-education emerged in 2010 in the USA. The fact is that the American authorities at that time through a series of extensive experiments established that schoolchildren from American educational institutions have a lower level of knowledge than schoolchildren from other developed countries in such subjects as science and math. This year, innovative educational concepts were introduced into the U.S. education system, the most significant of which was the concept of STEM-education. It initially implied the following specifics: American preschoolers, schoolchildren and students studied science, technology, engineering and mathematics in both mainstream and extracurricular activities. A great deal of emphasis was placed on free time activities, because such sections could be called less formal, resulting in easier and more relaxed learning for American children.

If we consider the phenomenon of STEM education in a broad sense, a number of scholars present it as an integrated approach to education, which is inherent in the presence of several scientific disciplines. However, these subjects can act as integrated ideas in the educational process or as a set of isolated subjects that exist independently (Hsu & Fang, 2019).

Such open definitions could have provoked the need to add some qualifiers in order to concretize its meaning, finding terms such as "integrative STEM education" (Sanders, 2008) and "integrated STEM education" (Thibaut et al., 2018) that suppose, in our opinion, a redundancy as the acronym already alludes to disciplinary integration. Alongside the trend of adding qualifiers to the term STEM education coexists an alternative that consists of adding new disciplines to it. In this line, we find STEAM education (Yakman & Lee, 2012) and STREAMS education (Krug & Shaw, 2016), without ruling out that new acronyms have been coined or are being considered. As we have already noticed, STEAM education incorporates the "A" in order to make the artistic and humanistic disciplines visible. For its part, STREAMS education - with the "R" for Knowledge Integration and the "S" for Sustainability Education - (Krug and Shaw, 2016) aims to orient the teaching-learning process towards the integration of knowledge, creativity and education for sustainability. In our opinion, if STEM education is approached in all its complexity and integration, most of the demands and foundations of artistic and humanistic disciplines are answered, and these may be the generators of problems and phenomena, so we do not consider it entirely a priority to position ourselves in a STEAM education. About STREAMS, STEM education already alludes in its principles and precepts to the integration of knowledge and, in addition, the fact of conceiving it as an approach oriented to the resolution of real problems implies addressing different social, cultural, and environmental issues, including Sustainability.

Obviously, like the introduction of any new system, the embedding of the STEM education concept has not gone smoothly in all countries. For example, British educators noted difficulties when trying to embed the STEM education strategy into British educational programs in schools and universities (Erduran, 2019). Having analyzed the main difficulties cited by American, British, and German researchers, the author of this article has combined them and compiled a list. It is as follows:

1. The teaching staff in these countries had only limited skills in working with modern innovative equipment that is provided in STEM education;

2. Teachers needed a lot of time to master the complex STEM education concept.

3. not all schools and universities (not to mention kindergartens) had the necessary technical capabilities in the form of modern equipment to work on STEM education methods;

4. Educational institutions in many countries have not developed timely methodological manuals that would help teachers adapt more quickly to the STEM education system;

5. Often, teachers of the old formation experienced stress and fear of transition to new technologies within the framework of STEM education implementation.

From these challenges, the researchers conclude the skills that teachers need to possess in STEM education. These can include the following activities:

1. The state should train teachers and educators on how to utilize modern technology. It is essential to organize workshops for them to learn about nanotechnology and innovation in STEM education;

2. Training the teaching staff in the theory of STEM education and practice is crucial. This can be training on mastering various cases from the life of actual commercial companies, etc..;

3. It is also essential to provide teachers with self-study in STEM education;

4. It is necessary to monitor and control how teachers teach children within the concept of STEM education (Bunge, 1987).

STEM technology provides the skills needed in today's world. These include the acquisition of computer and technological literacy, communication and communication skills, "soft skills" such as initiative, flexibility of character, and curiosity, as well as the development of creativity, critical thinking, leadership, charisma, and business qualities of a businessman in pupils and students.

STEM education is a pedagogical approach that integrates the fields of Science, Technology, Engineering, and Mathematics into the teaching and learning process. Unlike traditional education, which tends to treat these disciplines in isolation, STEM education seeks to create connections between them, fostering an interdisciplinary and holistic approach.

Science focuses on exploring and discovering new knowledge through observation, experimentation, and analysis. Technology focuses on the practical application of scientific knowledge to develop innovative solutions and valuable tools in our daily lives.

In turn, in the course of learning about engineering, it is necessary to understand that it implies carrying out design and construction work through the broad application of scientific and technical principles. As for mathematics, in STEM education, it provides the student and teacher with the necessary tools that can be used to solve mathematical and logical problems, as well as to model world and scientific processes.

STEM education is the most comprehensive education a person can imagine today. Its most important element is a focus on practice. That is, on practical cases and situations rather than theoretical ones. Pupils and students in STEM education acquire not only not so much knowledge of the theory of various sciences, but also learn and even take part in practical activities on their own. Thus, This strategy allows them to try their hand in life and practice applying mathematical and scientific knowledge to solve practical problems. Accordingly, as mentioned above, this once again proves that STEM education develops critical thinking and a non-trivial anti-crisis view of different situations. In order for all this to work, STEM education simply has to be moved from school classrooms and student classrooms "on the street", into real business. These diverse learning modalities enrich the students' experience and provide them with opportunities to explore and develop their skills more broadly.

The ability to think critically, the ability to make a decision is the foundation of innovation. Innovative thinkers are the driving force that can change the world. Preparing today's children to become the innovators and inventors of tomorrow starts with STEM education programs.

STEM emphasizes closing learning gaps by putting children at the center of the experience, transforming them from passive listeners to active learners.

STEM encourages children to experiment, make mistakes, and learn from their own experiences to achieve the right results, rather than relying on what the textbook says (Chu et al., 2019).

Logical analysis, inquiry, and project-based learning are key elements of STEM education. It increases children's curiosity, making learning engaging, relevant, and continuous.

It is a paradigm shift from traditional education, which vitally lacks hands-on learning, to learning that is much better and deeper.

STEM education naturally fosters the development of key skills needed in today's and tomorrow's world.

STEM Education Examples

Designing and building a bridge: Students can work in teams to design and build bridges using materials such as popsicle sticks, paper, cardboard, etc. This will allow them to learn about structural engineering principles, strength of materials and geometry.

Science experiments: Students can conduct simple science experiments to explore concepts such as density, solubility, electricity or chemical reaction. For example, mixing baking soda with vinegar to create an erupting volcano.

Programming and robotics: Introduce students to programming and robotics through educational kits or specific software. They can program robots to perform specific tasks, which will help them develop skills in logic and algorithmic thinking.

School garden: Students can participate in the planning, designing, and maintaining a school garden. This activity will teach them about plant science, life cycles, nutrition, and sustainability.

Model building: Students can create buildings, ecosystems, or solar systems models. This will help them understand math, geometry, and science concepts and improve their problem-solving skills and creativity.

Design Challenges: Present students with design challenges, such as creating a vehicle that travels as far as possible, building a bridge that will support a certain weight, or designing a device to collect rainwater. This will encourage their ingenuity and critical thinking.

Promoting collaboration and communication: Collaboration and effective communication are essential skills in an increasingly interconnected world. STEM education encourages teamwork and collaboration among students, as many of these projects require the participation and contribution of different perspectives and skills. In addition, students learn to communicate their ideas and findings clearly and effectively, both orally and in writing. This promotes presentation, argumentation and negotiation skills, which are valuable in the academic and professional environment.

Researchers often ask the question, what is the opposite of STEM education? The most common answer is that the opposite of STEM education is isolated, non-comprehensive education. The main disadvantage of the latter is that teachers and, subsequently pupils and students do not know how to use theoretical knowledge to solve practical life problems. The isolated learning process (without including several sciences and tools as in STEM education) has a one-sided result. It produces theorists, not practitioners.

In this context, STEM education is a "red ribbon" that ties together the learning process, the future job of the graduate, and his or her career advancement in the long run. That is, this innovative strategy in education contributes to the fact that students graduating from higher education have all the skills to work and live in a world characterized by a high level of technological development.

STEM education in this case will act as a kind of curriculum that has been created with a focus on the applied and interdisciplinary aspect of any learning process in the usual sense of the word. Important for all this is the fact that in addition to classical sciences, schoolchildren and students are trained to interact with new generation robots, get acquainted with robotic conveyors in production, comprehend the essence of programming with a reliance on how it can benefit in a simple daily routine (Chu et al., (2019).

Researchers point out the following positive aspects of embedding STEM education programs into classical education:

1. Students develop an interest in technical disciplines because STEM education implies an emphasized reliance on innovation and technological progress.

2. pupils and students develop more active and improved communication. This is because STEM education is primarily about working in teams rather than alone. As a result, socialization develops, team-building takes place, children learn to work in teams and to work together towards a goal.

3. STEM education involves solving unusual mathematical and logical problems, automatically leading to the sustainable formation of critical thinking in children and youth. Hence, stronger stress resilience in adulthood, when future professionals have to face non-standard problems (Hsu et al., 2019).

Despite the fact that basic education in the world is currently undergoing major changes, moving towards applied knowledge utilization and a qualitatively new way of learning science, few projects imply such a new education. STEM learning is truly unique in this respect.

Children ages 3 to 6 actively engage with their environment to develop a fundamental understanding of the phenomena they observe and experience. These basic scientific concepts and the scientific process skills thus begin to develop from infancy, and the sophistication of children's competence develops with age (Piaget & Inhelder, 2000). A Recommendation issued in 2019 by the 2019 European Council highlights that: 'Education and care from the earliest stages have an essential role to play in learning to live together in heterogeneous societies [...] as children in their early years shape the foundation and capacity for lifelong learning.' (Council of the European Union, 2019).

There is a theory that it is necessary to develop a child's talent and aptitude for natural sciences in childhood, namely at an early age, better in kindergarten or school. This is why there is talk in the world today about introducing STEM education as early as possible (Brandwein, 1995).

A number of researchers add to this thesis that in the early preschool age children are more successful in learning communication skills necessary for later life if they are taught with STEM programs (Keeley, 2009). They emphasize that children are much more enthusiastic about STEM education in the preschool years. Then as they get older, interest gradually wanes and drops to literally zero by school age (especially middle school).

An interesting aspect to study is the issue of women's position in STEM education. After all, it is commonly believed that men are more successful in technical specialties than women. Especially since, according to research, women's choice of technical specialties has been declining recently. In this regard, the surge of female interest in the exact sciences was observed in the 1990s, when women held 23% of technical positions in various companies around the world. However, this figure has only increased by 2% to date, meaning that the flow of women into technical professions, while not drying up, has slowed down. For example, in 2020, only about 25% of women will be employed in the STEM industry.

Researchers are actively investigating the reasons for this imbalance. They have found that it is primarily due to cultural and social barriers to hiring in STEM occupations. Because of the barriers, women themselves are reluctant to choose this "man's world."

Let's look at the main barriers:

1. Pay differences. It is well known that men will often receive more than women in the same company in equal job positions. Statistics show that men earn 30% more in STEM industries than women. This is also due to the fact that women are less likely to be appointed to management positions, and also women themselves are more likely to choose lower-paying positions (for example, in the medical field, which is also a STEM industry, women are more likely to be in positions such as nurses rather than surgeons, dentists like men).

2. Gender Stereotypes. Because of societal stereotypes, girls are convinced by 2nd grade in school that they are less capable of math than their male classmates. This is instilled in them by society. But research suggests otherwise. It is believed that at the age of 7-8, girls are more capable of solving math problems, not boys.

3. Women's Priorities. Culturally, women more often perceive themselves as keepers of the hearth, wives, and mothers. And subconsciously, they refuse to choose complex technical specialties.

Results and Discussion

The STEM education movement is clearly making an impact on the international scene. However, serious doubts persist as to its foundations, nature and implementation, which should make us reflect on the danger that it may end up becoming an innovation that can be diluted. Here we have: (1) characterized those models of STEM education proposed by educational research; (2) provided a valid STEM education model based on a valid model of STEM education that is supported by the research.

STEM education model based on the common elements of the frameworks analyzed.

Within the framework of STEM education, the study reveals another "bottleneck", namely the disputes in the international scientific community about which disciplines should be included in this paradigm. After all, science, technology, engineering, or mathematics represent, although generally comprehensive, but rather one-sided approach to the formation of a completely new modern education system (Jafarov, S. & Aliyev, Y., 2022).

In the opinion of the study's author, the most demanded would be such a concept of STEM education, which could include various disciplines as needed. That is, it should be highly flexible. In this context, the following aspects should be taken into account when forming a strategy for STEM education:

1. The skills that it is essential to teach children and youth in a particular country based on the needs of its economy;

2. The ability level of the students in a particular group;

3. The country's existing knowledge and experience in these areas;

4. The resource base, technical support, and facilities available to the country and the institution.

Designing an educational experience under the STEM approach could be more manageable if we are clear about the role of each discipline. In this sense, MacKinnon, Rawn, Cressey, and He (2017) propose to conceive:

1. Science as a type of scientific knowledge that serves the student's or students' understanding of the world around them;

2. Technology is represented as a kind of mechanism for adapting or adjusting to the world around them;

3. Engineering is expressed as a tool that helps to design and generate ways of solving urgent, vital problems;

4. Mathematics serves to enable children, and later adults, to analyze the world and environment using mathematical methods and formulas.

The adoption of a specific role for each discipline in the STEM approach leads us toward a dilemma already posed by Akerson et al. (2018): does STEM education have a nature of its own, or does it take the Nature of Science (NOS), Technology (NOT), Engineering (NOE) and Mathematics (NOM)? In their paper, after reviewing the state of the art on NOS, NOT, NOE, and NOM, they concluded that STEM education does not have a nature of its own. Despite agreeing with them on this idea, we must not forget that STEM education is not a discipline with a body of knowledge of its own -something that Akerson et al. (2018) acknowledge at the end of their reflection-, so we cannot teach STEM. However, we can contribute to the teaching-learning of disciplines from a STEM approach. Thus, we argue that it would be more accurate to describe what visions of Science, Technology, Engineering, and Mathematics STEM education should convey, which in our opinion, are as follows.

Nature of Science (NOS) STEM educational approach should address the consensus ideas on NOS of Eflin, Glennan, and Reisch (1999), as well as the guidelines of McComas, Clough, and Almazroa (1998) for working on it in the classroom, emphasizing that the student understands that doing Science is a creative process (creativity is a relevant skill in the scientific field) and showing the close relationship of science with ethics, cultural traditions and History (characteristics of Science that reinforce the idea that the "A" of STEAM is inherent to the rest of the disciplines of the acronym). Nature of Technology (NOT) STEM education must show that: (1) Technology is not the mere application of scientific knowledge; (2) it is oriented to achieve the correct and continuous operation of instruments and systems; (3) the construction of scientific knowledge has been and continues to be indebted to Technology; and (4) modern Science has contributed to a remarkable technological development (Ferreira-Gauchía, Vilches and Gil-Pérez, 2012).

Nature of Engineering (NOE) STEM educational approach could contribute to improve students' understanding of NOE, especially regarding the following issues: (1) Design is a defining characteristic of Engineering; (2) Engineers concretize needs in a design process whose end is the creation of a new practical and functional technological element; (3) Engineers apply the appropriate constraints to the design process and describe the specifications of their creations; and (4) Engineering makes use of knowledge from the different Sciences and Mathematics, although its purpose differs from these, as it is production-oriented. Likewise, Technology is a broader and more comprehensive discipline than Engineering, looking beyond the design process of a technological element, so that it considers and analyzes its impact on society and the natural environment (Florman, 1994).

Nature of Mathematics (NOE) In the context of STEM education, mathematics's most prominent meaning is social construction. According to this, mathematics provides a mode of expression and representation, a set of notions and skills that allow us to interpret the environment, provide strategies for inventing and solving problems, and promote logical and critical thinking. It is consistent with a functional vision of school mathematics, in which modeling is one of the major contributions to the tasks framed in STEM education (Maass et al., 2019).

Final reflection

The design of tasks from the STEM education approach entails granting a certain role to each of the disciplines involved, for which it is necessary to consider the particularities of Science, Technology, Engineering, and Mathematics. Since we are referring to an educational approach, to this should be added the particularities of Education, those of Psychology and, also, those referring to Society. This composition could be considered a system (Bunge, 1987), given that: (1) all the components are linked to each other; (2) any change in one of them would affect the others and, therefore, the system; and (3) properties different from those of its components emerge from the system. In this sense, glimpsing the complexity of STEM education, Erduran (2019) already suggested that conceiving it from a systemic approach could help to clarify its theoretical-practical aspects. That is our next objective.

References

Abduljawad, S. (2023). Social Development Strategies of English as Second Language Learners for International Management. Revista De Gestão Social E Ambiental, 17(7), e03519. https://doi.org/10.24857/rgsa.v17n7-017

Akerson, V.L., Burgess, A., Gerber, A., Guo, M., Khan, T.A., & Newman, S. (2018).

Disentangling the meaning of STEM: implica tions for scie nce e duca tion a nd scie nce te a che r e duca tion. Journa l of Scie nce Te a che r E duca tion, 29(1), 1-8. https://doi.org/10.1080/1046560X.2018.1435063

Babayev, N. G., Imrani, Z. T., & Zakirova , A. R. (2023). Ethnos with Turkish Ancestry in the Toponymic Background of the Territory of Azerbaijan. Revista De Gestão Social E Ambiental, 17(7), e03512. https://doi.org/10.24857/rgsa.v17n7-009

Bre ine r, J.M., Ha rkne ss, S.S., Johnson, C.C., & Koe hle r, C.M. (2012). Wha t is

STE M? A discussion a bout conce ptions of STE M in e duca tion a nd pa rtne rships. School Scie nce a nd Ma the ma tics, 112(1), 3-11. https://doi. org/10.1111/j.1949-8594.2011.00109.x

Bunge , M. (1987). Cie ncia y de sa rrollo. Bue nos A ire s: Siglo XX. Bybe e , R.W. (2013). The ca se for STE M e duca tion: Cha lle nge s a nd opportunitie s. A rlington, VA : NSTA Pre ss. 1455 29th E xpe rime nta l Scie nce Dida ctics Me e tings a nd 5th Doctora l Schools

Chu, H.E ., Ma rtin, S.N., & Pa rk, J. (2019). A the ore tica l fra me work for developing an inte rcultura l STE A M progra m for A ustra lia n a nd Kore a n stude nts to e nha nce scie nce te a ching a nd le a rning. Inte rna tiona l Journa l of Scie nce a nd Ma the ma tics E duca tion, 17(7), 1251-1266. https://doi.org/10.1007/s10763-018-9922-y

Erdura n, S. (2019). Unde rsta nding STE M for STE M E duca tion: Towa rd a Syste ms Approa ch. In Y.S. Hsu a nd Y.F. Ye h (E ds.), A sia -Pa cific STE M Te a ching Pra ctice s (pp. 205-213). Singa pore : Springe r.

Fe rre ira -Ga uchía , C., Vilche s, A ., & Gil-Pére z, D. (2012). Te a che rs' conce ptions about the Nature of Technology a nd the Science -Technology-Socie ty-E nvironme nt re la tionships. Scie nce E duca tion, 30(2), 197-218. https://doi.org/10.5565/re v/e c/v30n2.557

Gözüm, A.İ.C., Kandır, A. Digital games pre-schoolers play: parental mediation and examination of educational content. Educ Inf Technol 26, 3293–3326 (2021). https://doi.org/10.1007/s10639-020-10382-2

Hsu, Y.S., a nd Fa ng, S.C. (2019). Opportunitie s a nd Cha lle nge s of STE M E duca tion. In Y.S. Hsu a nd Y.F. Ye h (E ds.), A sia -Pa cific STE M Te a ching Pra ctice s (pp. 1-16). Singapore: Springe r.

Imrani, Z. & Jafarov, S. (2023). Economic-Geographical Model of Sustainable Development in Manufacturing and Education. International Journal of Innovation and Economic Development, 9(1), 47-54. https://doi.org/10.18775/ijied.1849-7551-7020.2015.91.2004

Imrani, Z., & Jafarov, S. (2023). Strategic Objectives of Sustainable Development Model in Production and Education. Journal of Law and Sustainable Development, 11(7), e1328. https://doi.org/10.55908/sdgs.v11i7.1328

Jafarov, S. (2021). Basic principles of school policy, educational development and organization of public education systems. "Teacher" Publishing House, 123–127. https://doi.org/10.5281/zenodo.5831806

Jafarov, S. (2023). History and research of intonation in English and American linguistics. Revista De Investigaciones Universidad Del Quindío, 35(1), 317–327. https://doi.org/10.33975/riuq.vol35n1.1192

Jafarov, S., & Aliyev, Y. (2022). Innovative approaches and methods in Azerbaijani education. Dilkur Academy, 11–16. https://doi.org/10.5281/zenodo.7108972

Jafarov, S., Imrani, Z., & Aliyev, Y. (2023). Main Directions of Sustainable Development in Education. Journal of Law and Sustainable Development, 11(7), e1071. https://doi.org/10.55908/sdgs.v11i7.1071

Jafarov, S. (2023). New challenges in education. Logika+ LLC, 2(89), 7–11. https://doi.org/10.31618/ESSA.2782-1994.2023.2.89.350

Jafarov, S. (2023). Synergetic and innovative approaches to education. Revista De Investigaciones Universidad Del Quindío, 35(1), 415–430. https://doi.org/10.33975/riuq.vol35n1.1191

Jafarov, S. (2022). The Current State of Foreign Trade Relations of the Republic of Azerbaijan. Dilkur Academy, 52–58.

Jafarov, S. (2022). What Causes Culture Shock? Dilkur Academy, 398–402.

Jafarov, S. & Aliyev, Y. (2022). Education Policy and Leadership. International Journal of Innovation and Economic Development, 7(6), 14-23.

Jafarov, S., & Aliyev, Y. (2022). Innovative approaches and methods in Azerbaijani education. Dilkur Academy, 11–16. https://doi.org/10.5281/zenodo.7108972

Ke lle y, T.R., & Knowle s, J.G. (2016). A conceptua l framework for integrated STEM education. International Journal of STEM Education, 3(1), 1-11. https://doi.org/10.1186/s40594-016-0046-z

Kriswanto, D., Noermijati, Rofiaty, & Rofiq, A. (2023). The Effect of Market Orientation, HR Competence, Knowledge Management on Competitive Advantage, Mediated by Company Performance. Revista De Gestão Social E Ambiental, 17(8), e03677. https://doi.org/10.24857/rgsa.v17n8-021

MacKinnon, G.R., Kate, G., Rawn, E., Cressey, J., and He, W. (2017). Employing STEM Curriculum in an ESL Classroom: A Chinese Case Study. K-12 STEM Education, 3(1), 143-155.

Mercan, Z. and Gözüm, A.İ. C. (2023). An Examination of STEAM Engineering Designs in the Pre-School Period. International Online Journal of Education and Teaching (IOJET), 10(4), 2652-2664.

Mercan, Z., & Gozum, A. İ. C. (2023). INNOVATION POTENTIAL OF TOYS MADE IN STEAM MAKERSPACES: REFLECTIONS FROM TEACHERS. International Journal of Education, Technology and Science, 3(3), 583-599.

Mercan Z, Papadakis S, Can Gözüm Aİ, Kalogiannakis M. Examination of STEM Parent Awareness in the Transition from Preschool to Primary School. Sustainability. 2022; 14(21):14030. https://doi.org/10.3390/su142114030

Papadakis S, Kalogiannakis M and Gözüm AİC (2022) Editorial: STEM, STEAM, computational thinking, and coding: Evidence-based research and practice in children's development. Front. Psychol. 13:1110476. doi: 10.3389/fpsyg.2022.1110476

Sarkhan Jafarov, & Yusif Aliyev. (2022, February 27). Formation of learner's research competence based on using multimedia technologies. The XXIII International Scientific Symposium "Integration of cultures and multiculturalism", Kars, Turkey. https://doi.org/10.5281/zenodo.6332195

Sarkhan Jafarov, & Zaur Imrani. (2021, July 26). Comparison of the Azerbaijani Education System with the US Education System (XX-XXI centuries (1960-2015)). "World Science: Problems and Innovations" The XVI International Scientific Symposium, East Lansing (Michigan, USA). https://doi.org/10.5281/zenodo.5895028