Examining the Impact of STEAM Education Reform on Teachers' Perceptions about STEAM in Uzbekistan

Yumi Lee | ORCID: 0000-0003-2412-9522

Department of Russian Education, Tashkent State Pedagogical University,
Bunyodkor 27, Chilonzor, Tashkent, Uzbekistan

krmutine@gmail.com

Received: 12 February 2021 | Revised: 26 April 2021 | Accepted: 4 May 2021

Abstract

In an effort to reform education, Uzbekistan has adopted STEAM education as a basic principle of educational reform. However, as these efforts are largely being made from a top-down manner, knowledge about STEAM education in schools and informal settings is not yet well known. This paper introduces Uzbekistan's general education status and shares findings from surveys and interviews with in- and pre-service teachers, and professors about STEAM education. In addition, newspaper articles and government documents about STEAM education were analyzed to understanding how education reforms are being established. STEAM education is explored as a potential tool for helping to improve science teaching and learning in the Uzbekistan education system. Using survey responses and interviews, this paper shares how teachers think of STEAM education and makes suggestions for how the government can more effectively achieve reform goals related to STEAM education.

Keywords

Uzbekistan education – STEAM education – presidential schools – educational reform in Uzbekistan

1 Introduction

Uzbekistan is a country with a long history and tradition, whose population accounts for more than 40% of the population of Central Asia. Uzbekistan is an Islamic country, but it was under the control of the Russian Empire and the Soviet Union for more than 100 years, so the influence of socialism remains throughout the society. After the current President Shavkat Mirziyoyev was elected in 2017, Uzbekistan began to make efforts to reform education based on the belief that education was the key to national development. Although there are currently problems with education in Uzbekistan, the low academic ability of teachers and students is one that the government is working to hard to improve. According to the Education Sector Plan published by the government (2019), the quality of school education is unknown. There is no information on the specific guidance for teachers on conducting or monitoring classroom assessment activities and no regular system-level assessments of learning outcomes at the national level.

The government of Uzbekistan has set improving academic ability and fostering talent for the future society as the biggest current educational goal. As a means of doing this, they decided to participate in international academic comparative evaluations, such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS). Uzbekistan is expected to participate in both assessments in the near future as the results of these assessments can help the government to consider how to improve the quality of learning in reading, math, and science. In addition, the government has introduced science, technology, engineering, arts, and mathematics (STEAM) education methods to try to improve student achievement in these areas. Recently, the government established new Presidential Schools in Tashkent and each major region. These schools advocate for STEAM education. In addition, STEAM education is being encouraged to be introduced in general school education programming.

The idea of STEAM is to integrate science into one single area of human knowledge and apply that knowledge in practice (Pardabarov, 2020). STEAM education can link scientific inquiry by formulating questions that are answered through investigation to help stimulate students' learning processes before they engage in the engineering design process to solve problems (Kennedy & Odell, 2014). Students' experiences with STEAM have been shown

to be effective in both cognitive and affective learning (Kang, 2019). While various studies have been reported on STEAM education in science education research in the last decade, in Uzbekistan there is not yet much awareness about STEAM education. To some degree, the success or failure of STEAM education is up to teachers as STEAM education can be successful only when teachers support and understand its use. In order to successfully introduce STEAM education, it is necessary to first examine teachers' perceptions of inclusive education and STEAM methods. In the case of Korea, there were several studies on the perceptions of educators at the beginning of the introduction of STEAM education (Shin & Han, 2011; Son, Jung, Kwon, Kim, & Kim, 2012; Kang, Lee, & Kang, 2013). Research from Korea has been particularly persuasive to argue that given sufficient support from the government, an effective reconstruction of the national curriculum, and significant changes in the national assessment system, STEAM education can be an effective method for improving student content learning overall (Korea Foundation for the Advancement of Science and Creativity [KOFAC], 2014; Park, Byun, Sim, Han, & Baek, 2016; Kang, 2019).

1.1 *Research Questions*

Drawing from such previous research, STEAM education is explored in this paper as a potential tool for helping to improve science teaching and learning in the Uzbekistan education system. To prepare for STEAM education in Uzbekistan, it is necessary to determine what teachers think of such teaching methods and it is necessary to see what efforts the Uzbekistan government is making to realize the importance of education reform and to achieve the reform in a short period of time. To meet this goal, this study aims to learn what STEAM education methods may be appropriate for Uzbekistan by addressing the following three research questions:

1. What do Uzbek teachers currently think about STEAM education?
2. What should teacher educators consider when introducing STEAM training?
3. What efforts has Uzbekistan been making to apply STEAM education for educational reform?

2 *Background*

2.1 *Education in Uzbekistan*

According to the 2018 UNESCO statistics, Uzbekistan has a total population of 32,476,000, of which nearly 10 million are students. The student population is roughly the same as the combined total population of neighboring countries Kyrgyzstan and Turkmenistan. The education system in Uzbekistan still has

aspects of the Soviet education system. Except for some private kindergartens, all educational institutions are public. Uzbekistan's education budget exceeds 30% of the total national budget (Mushtaq, 2015) with currently eleven years of education being provided for free for elementary and secondary students. Due to the influence of civil education during the Soviet era, the literacy rate close to 100% (UNESCO, 2018). Uzbekistan has a basic social welfare system with not only a high literacy rate, but also a high level of enthusiasm for education (UNESCO, 2015), and a high willingness to reform for educational development. However, since gaining independence in 1991, the level of education has deteriorated due to reduced investments in education. To address these concerns, the Uzbekistan government has opened special universities with government departments, such as the University of World Economy and Diplomacy, University of Heavy Industry, and Tashkent Institute of Irrigation and Agricultural Mechanization Engineers. All of these universities are directly operated by each government department with the goal of teaching students the academic disciplines related to these fields of work. These universities were established despite it not having been easy to fund these expensive programs due to difficult economic conditions. Recently, however, the finances of existing universities have become worse, which has resulted in a decline in the quality of education (Sung, 2018).

In an attempt to address these concerns, the Ministry of Education published the Education Sector Plan (Uzbekistan Government, 2019) in collaboration with UNESCO and the Global Partnership in Education (GPE) to begin educational reform and development. This study analyzed the Uzbekistan education system and presented problems and suggested directions, and plans to move forward in the future (World Bank, 2018). This research identified several problems in education in Uzbekistan, including, a) there is limited scope for innovations in the teaching-learning process; b) students perform better on knowledge, but less well on the application and critical thinking and problem-solving areas; and c) there is a need to speed up and ensure curriculum balances in content and competencies.

To address these findings, the government is implementing various reform measures to solve these problems. The aims of the reform involve three areas. First, specialized schools should be established to target improved learning in key areas. For example, a specialized Astronomy School and Presidential Schools have been established to educate high-achieving students. These schools provide good teaching and learning facilities, provide dormitories for students to live in, and invite excellent teachers from abroad.

Second, an educational evaluation was conducted. So far, no education evaluation system has been prepared for Uzbekistan schools. The level of students' academic ability has remained low due to poor evaluations of students'

academic ability. International comparative evaluations such as PISA and TIMSS will be conducted to evaluate Uzbekistan students' comparison objectively. Students will also be supported to actively participate in International Olympiads to demonstrate their excellence.

Third, STEAM education was introduced. The basic principle of instruction for all schools is to improve the educational ability of students in general classrooms, as well as in gifted and specialized education schools. Methods for educational reform and development include introducing advanced foreign expertise and modern and innovative teaching methods. STEAM education was selected as a pedagogical innovation being used in developed countries.

In addition to these three areas for innovation, there have been some general changes. For example, the Russian Cyrillic script was abolished in official documents and replaced with Latin script, and the Uzbek Language University was established. Since Uzbekistan is a multi-ethnic country, textbooks are produced in seven ethnic languages, including Uzbek, Russian, Qoraqalpoq, and Tajik. In addition, the system is shifting away from the Russian-style education system to the Western style. An example of this is that universities have changed class hours from the Russian time system to the credit system. In addition, English has become a compulsory subject, replacing Russian and several topics such as, spiritual education, national ideology, and Uzbek education have also been strengthened.

In the section that follows, attention is paid to science education in Uzbekistan to provide an overview of what content is taught and at which grade levels and how instruction has traditionally proceeded prior to the government's new focus on STEAM education.

2.2 *Science Education in Uzbekistan*

In Uzbekistan, science education is centered on textbooks. All textbooks are state authored and classes involve generally notebook writing. The separation of each area of science is clear, and classes are focused on scientific knowledge in the traditional subjects of physics, chemistry, biology, and geography. The numbers of hours of instruction for all subjects, including science classes for each grade, are shown in Table 1 (MoPE, 2020).

First and second graders study society and nature in the subject of "the world around us", and third and fourth graders learn the subject of "nature". Starting with botany in the fifth grade, students begin to study various science subjects. Science subjects by grade are listed below.

TABLE 1 Number of hours of science lessons by grade level

Subject	Hours per week (2020–2021)											Total units
Grade	1	2	3	4	5	6	7	8	9	10	11	
I. Language	10	11	11	11	11	11	10	10	10	9	9	113
II. Social studies	1	1	1	1	3	3	4	5	5	4	4	32
III. Mathematics and IT	5	5	5	5	6	6	6	6	7	7	7	65
IV. Science and economy	1	1	1	1	2	6	8	9	9	9	10	57
Physics and astronomy						2	2	2	2	2	3	13
Chemistry							2	2	2	3	3	12
Biology					1	2	2	2	2	3	3	15
Geography and economy	1	1	1	1	1	2	2	3	3	1	1	17
V. Arts and sports	4	4	4	4	6	6	6	4	4	3	2	47
Total hours in each grade (All subjects)	21	22	22	22	28	32	34	34	35	32	32	314

- First and second grades: the world around us (integrated with social studies)
- Third and fourth grade: nature
- Fifth grade: botany and geography
- Sixth grade: physics, botany, and geography
- Seventh grade: physics, zoology, geography, and chemistry
- Eighth grade: physics, human body and health, and chemistry
- Ninth grade: physics, cytology, genetics, and chemistry
- Tenth grade: physics, biology, geography, and organic chemistry
- Eleventh grade: astronomy, physics, biology, and general chemistry

Students begin science classes in the fifth grade. Subjects are subdivided into traditional areas such as general biology, botany, zoology, and the human body. In science subjects, achievements in scientific history, especially of Uzbek great scientists, are important. The national standards for biology include (MoPE, 2017): “Enriching the content of biological education with ... the great scientists who have lived and worked in ancient times, and biology studies of our current scientists through national independence and patriotism in a spiritual sense” (p. 11). In this way, science textbooks detail past and modern Uzbek scientists and their achievements.

Science textbooks consist of one main textbook without an activity book or workbook. The textbook is explanation oriented, and a few questions about explanation and experimental methods are briefly introduced. Video class materials are provided on the website of the internet Ministry of Education.

2.3 STEAM Education Research in Uzbekistan

STEAM education in Uzbekistan is still in its introductory stage. There have been few studies about it, and the content is at the level of introducing concepts. The research papers on STEAM education in Uzbekistan up to now are shown in Table 2.

Since STEAM education has only recently been introduced in Uzbekistan, most research about it has dealt with the concept and necessity of STEAM education. Munimov (2019), Hakimov (2020), Abduraximovich (2020), Padabaev (2020), and Naviyev (2020) all explained the meaning of STEAM education, arguing for the introduction of STEAM education as a method of educational reform in Uzbekistan. According to those studies, future societies will need people who are creative and able to use advanced technology (information and communications technology [ICT]) and who are able to understand science and humanities by integrating them.

TABLE 2 Academic papers about STEAM education and educational reform in Uzbekistan

Theme	Year	Author	Topic of paper
Introduction of STEAM education	2019	Munimov, A.	Meaning and necessity of STEAM education
	2020	Hakimov, N. et al.	Establishment of STEAM Presidential School
		Abduraximovich, N. Pardabaev, J. Naviyev, F.	
	2020	Lee, Y.	Case study of STEAM education classes in a Korean elementary school
Education reform	2014	Tolipov, U., et al.	Effective integration of humanities, natural sciences, and professional knowledge for teachers
	2015	Kulmatov, B.	Need for changing the system of education
	2019	Egamberdievich, S., et al.	ICT-centered educational innovation
		Government report	Analysis of education status and plan of education until 2030

The most appropriate training method to educate such people has been described as STEAM education, which is currently being implemented in the Presidential Schools. Most recently, scholars have been invited to provide examples of how teachers in other contexts are implementing actual STEAM education. Some papers on the necessity and process of educational reform in Uzbekistan include Tolipov (2014), Kulmatov (2015), and Egamberdievich (2019), who presented the direction of education reform that needs to be flexible in the education process and application of ICT technology. The Uzbekistan government analyzed the overall status of education and revealed its goal of developing education by 2030 in the Education Sector Plan (Uzbekistan Government, 2019) report. In this report, STEAM education is presented as the basic principle of general school education.

In 2020, a conference on education reform was held at Tashkent Pedagogical University, where there were presentations on STEAM education and educational reform (MoPE & TSPU, 2020). For example, a research (Lee, 2020) described STEAM implementation at an elementary school in Korea by highlighting how integrated curriculums of various related subjects such as science, mathematics, Korean, practical science, music, and art could be used to plan STEAM classes and the researcher presented examples of students work produced in STEAM classes. This kind of professional development is new and has the potential to influence teachers' perceptions of STEAM.

3 Research Method

This study is divided into two parts. The first part of the study included the implementation of a survey that was developed to examine Uzbekistan educators' perceptions of STEAM education. The items for the survey were first developed in Korean and then translated into Uzbek-Russian for the participants in the study. The translators had master's degrees in Korean language education and also have experience as Korean-Uzbek-Russian interpreters. However, since STEAM and integrated science education are unfamiliar to them, interpreters needed to understand the concepts correctly. To accurately translate the survey into Uzbek-Russian, two training sessions on STEAM education were conducted for interpreters and translators to ensure correct interpretation and translation of the survey items. More information will be provided about the survey below.

The second part of the study focused on an analysis of newspaper articles describing the process of education reform related to STEAM education. Newspaper articles were used to analyze educational reform efforts because

newspapers are a representative medium of general civic education and contain accurate and proven articles, which have great influence (Lee, Shin, Kim, & Son, 2012; Choi & Shin, 2011). Various education-related studies have been conducted through newspaper analysis. Examples of studies analyzing newspaper articles include analysis of future education trends (Seo & Lee, 2018), Korea's school violence problem (Kang, Yu, & Kang, 2013), the real-life application of scientific concepts (Ko, 2011), and 20th century scientific discovery (Lee & Han, 2005). Newspapers can be useful as they may deal with topics in-depth and may offer fair and objective information about facts and phenomena that can be used to understand how people view events and content (NIE Korea Committee, 2010).

3.1 *Survey on Perceptions of STEAM Education*

3.1.1 Participants

The study included a total of 57 participants. A total of 51 people completed the questionnaire and 6 people participated in an interview. Survey participants included professors in science education departments at a pedagogical university, pre-service teachers who were studying science education and Korean education, and in-service teachers teaching at general schools and high schools in Tashkent participated. In Uzbekistan, pedagogical universities are located in the major regional cities, all of which are national universities. The professor and pre-service teacher participants' university plays a pivotal role in teacher education. As it is considered to be representative of teacher education, survey participants were limited to professors and students at this university. The in-service teachers involved in the survey were science teachers with 5 to 20 years of experience, working at public general and high schools in Tashkent. A total of 6 in-service teachers were also interviewed. These participants were selected based on the recommendation of professors in the Departments of Science and Korean Education. The criteria for recommendations were that participants be public school teachers with more than 5 years of experience majoring in science education. The participants are shown in Table 3.

3.1.2 Questionnaire

The survey focused on exploring educator's perceptions of STEAM education. Data was collected in two ways: online surveys using Google Forms and via interviews. University professors and students (pre-service teachers) were familiar with internet programs, so they were able to use Google Forms for the survey. The questionnaire items were originally prepared in Korean language by the researcher and were then translated into Uzbek and Russian, which are the languages used by the participants in the study. Participants were able to

TABLE 3 Information about respondents

Respondent classification	Affiliation	Number of participants	Department and subject	Survey method
Professor	Pedagogical university	9	Science education (9)	Questionnaire
In-service teacher	General school and lyceum (training courses at higher education institutes)	6	Science (6)	Interview
Pre-service teacher	Pedagogical university	42	Science (31), Korean (11)	Questionnaire

respond in their native languages and the responses were then translated into Korean. Respondents could select from a pre-set options for responses and they could also provide additional narrative replies. For example, for each question, three to seven options were given, and if necessary, participants could explain more via an open-ended responses.

Prior to this survey, a pilot test was conducted. Before the test, STEAM education was described briefly. After the test, the questions were analyzed and scored by researchers and master’s students who were proficient in Korean. The pilot test showed that most of the respondents did not know about STEAM education. Therefore, rather than determining the statistical meaning of the results, researchers aimed at determining what teachers should focus on in introducing STEAM education by grasping the general trends in how teachers think about STEAM education, which is unfamiliar to them. The questions were organized based on what the focus should be on when introducing STEAM education, and the respondents’ responses were reflected in these options. The questions are related to Research Questions 1 and 2. The content of the question is shown in Table 4.

To help participants understand STEAM education, a brief description of STEAM was provided in the preface of the questionnaire. In-service teachers were not given this questionnaire, but only interviews, so the interview results of in-service teachers were excluded from the statistics.

3.1.3 Interview

Since it was difficult for the in-service teachers to use internet programs that they did not normally use, interviews were conducted to determine their

TABLE 4 Survey questions

Related research question	Items
<i>Research Question 1:</i> The meaning of STEAM education	<ol style="list-style-type: none">1. Do you know anything about STEAM education?2. STEAM education is a combination of five subjects. Do you think this kind of education is necessary?3. What is your opinion about the most important purpose of STEAM education?4. What is the biggest advantage of STEAM education?5. What is the biggest disadvantage of STEAM education?
<i>Research Question 2:</i> Opinions about STEAM education	<ol style="list-style-type: none">1. If we have to do STEAM education, what should we do first?2. What is the most important thing to do for STEAM education?3. What is your opinion about the most difficult part of STEAM education?

opinions. The content of the interviews included the same questions as the survey questionnaires, and other questions about science education in general and education reform were also asked, but in this study, only the content related to STEAM education was analyzed. Due to COVID-19, the methods used by the in-service teachers were video conferencing (Zoom), written interviews, and face-to-face interviews. Table 5 shows the interview questions.

3.2 *Newspaper Data Collection*

Although the government of Uzbekistan decided to apply STEAM education as a method of education reform, it has been difficult to find existing research on the process of STEAM education being because STEAM education was not introduced by researchers or educators, but rather by the government. The government’s process of introducing STEAM was confirmed through laws and newspapers. The relevant laws were identified on the Ministry of Public Education website (<http://www.uzedu.uz/oz/>). For analysis, newspaper articles from the educational newspaper *Education in Uzbekistan* (In Uzbek, *Ma’rifat*) were used. The newspaper provides the most articles on educational laws, movements of high-ranking officials, and educational events. A search for the keyword “STEAM” was performed on the newspaper website (<http://marifat.uz/>), and the results were classified into three categories: general education, Presidential School, and other.

TABLE 5 Interview questions

Interview questions about integrated science education	Interview questions about STEAM
1. As science develops, communication between disciplines becomes more difficult. What do you think about it?	1. Are you familiar with STEAM education, which has been introduced in the Presidential School and school curriculum?
2. Is interdisciplinary integration necessary in modern society because the boundaries among domains are ambiguous?	2. What do you think STEAM education is?
3. What should be done to integrate subjects in school classes?	3. Why do we need STEAM education?
	4. What would be the difficulties involved in implementing STEAM education?
	5. What is the most urgent issue in implementing STEAM education?
	6. What is the most important problem?
	7. The most important thing in STEAM training for teachers is:
	8. What are the biggest benefits?
	9. What are the biggest disadvantages?

4 Research Results

4.1 RQ 1: *What Do Uzbek Teachers Think about STEAM Education?*

4.1.1 Recognition and Necessity of STEAM Education

The initial question was whether STEAM education was known and necessary. Most professors and pre-service teachers were not aware of STEAM education. More than 80% of the respondents said they did not know about it or did not know it well, with less than 16% saying they knew about it. The next question was about the need for STEAM education, which was acknowledged by 62.7% of professors and pre-service teachers despite the response that they were not familiar with STEAM education.

The results of participant responses related to this first question are reported in Table 6 (below).

Professors and students of the Pedagogical University agreed with the need for education reform. The newspapers said that the current president of Uzbekistan was pushing for educational reform and that the Presidential School was being established for students to study using the STEAM education

TABLE 6 Recognition of STEAM education

Questions	Strongly agree, agree (%)	Neither agree nor disagree (%)	Disagree, strongly disagree (%)	Total
Are you familiar with STEAM?	8 (15.7)	3 (5.9)	40 (78.4)	51
Is education of this kind necessary?	32 (62.7)	10 (19.6)	9 (17.6)	51

program. Discussions on STEAM education were started at university conferences, and it was stipulated as a basic principle in the curriculum that had already been announced by the Ministry of Education. Although very few participants knew yet what STEAM education is, educators agreed with the need for concrete ways to reform and develop education in some way.

All in-service teachers answered in the interview that they did not know that STEAM education was being applied in Presidential Schools and was the basic principle for the 2020 school year and also answered that they did not understand STEAM education. However, they answered that they sometimes run integrated subjects and that they considered STEAM education positively.

4.1.2 The Purpose of STEAM Education

Table 7 shows the responses from professors and pre-service teachers to the question of what they thought was the most important purpose of STEAM education.

TABLE 7 Professors and pre-service teachers' responses about the purpose of STEAM education

What do you think is the most important purpose of STEAM education?	Number of responses (%)
Nurturing the talent of students for the future society	20 (39.2)
Improving teaching methods	14 (27.5)
Enhancing students' interest in their studies	7 (13.7)
Improving students' academic performance	6 (11.8)
Other	4 (7.8)
Total	51 (100)

Professors and pre-service teachers felt that the most important purpose of STEAM education was to develop the talents of students who will live in the future society. The second most common response was that the purpose was improvements in teaching methods in science subjects, which shows that STEAM education was considered a way to improve the science subject teaching rather than a holistic view of the various subjects in STEAM education.

Narrative responses included “I don’t know” and mentions of the difficulty of integration. In-service teachers’ replies included “I can educate highly talented students better” and “make students think broader”. These responses supported the findings that many teachers felt that STEAM could be useful to enhance students’ capacity for dealing with the future society or to enhance students’ interest in learning.

4.1.3 Advantages and Disadvantages of STEAM Education

Responses to the advantages of STEAM education varied. Although “increasing student interest” was the most common response, the numbers of respondents who chose “self-directed learning ability”, “fostering the right personality”, and “improving student academic performance” decreased by one for each option. The responses to the advantages and disadvantages of STEAM education are shown in Table 8 and Table 9.

Respondents expected a similar level of “personal characteristics” and “improve academic achievement”. In-service teachers responded that especially for students who are good at computers, STEAM education methods will allow students to make something better and achieve more.

As shown in Table 9, university professors and pre-service teachers most commonly chose the integration of subjects as the biggest disadvantage of

TABLE 8 Professors and pre-service teachers’ responses about the advantages of STEAM education

What is your opinion about the biggest advantage of STEAM education?	Number of responses (%)
Increase students’ interest in study	12 (23.5)
Self-directed learning ability	11 (21.6)
Foster the right personality	10 (19.6)
Improve students’ academic performance	9 (17.6)
Become a person of convergence ability	7 (13.7)
Other	2 (3.9)
Total	51 (100)

TABLE 9 Professors and pre-service teachers’ responses about the disadvantages of STEAM education

What is your opinion about the biggest disadvantage of STEAM education?	Number of responses (%)
The integration of subjects	23 (45.1)
The knowledge of each subject	19 (37.3)
Lack of time for preparing the lessons	8 (15.7)
Other	1 (2.0)
Total	51 (100)

STEAM education. The second most common response was a lack of knowledge, followed by a lack of preparation time.

That is because “integration”; or “convergence”; is an unfamiliar concept, and teachers have not had much experience with it. Since the curriculum of the Department of Science Education in the Pedagogical University emphasizes the acquisition of knowledge in fields of science such as biology, chemistry, and physics rather than science teaching methods, they thought that they must know all of the knowledge of all subjects to teach STEAM.

In-service teachers had similar ideas, and they raised fear of change and lack of knowledge as difficulties. They felt that STEAM education was necessary, but that they were not familiar with it, so they were concerned about teachers’ lack of ability in its practical application. In-service teachers did not know about STEAM education, and even if they had heard of STEAM, they could not express their opinions on its meaning or methods. The interviews with the in-service teachers showed that they thought about neither STEAM education nor integrated education. This lack of understanding made it difficult for respondents to give accurate opinions.

4.2 *RQ 2: What Should Be Considered When Introducing STEAM Education?*

4.2.1 Urgent Action for STEAM Education

There were five options with optional narrative response. The most selected response was the “development of teaching methods”. Table 10 shows responses to the question about urgent action necessary for STEAM education.

In Uzbekistan, discussions on integrated education have not been very active. In the curriculum (Ministry of Higher and Secondary Special Education, 2020)

TABLE 10 Professors and pre-service teachers' responses about urgent action for STEAM education

If we have to do STEAM education, what should we do first?	Number of responses (%)
Development of teaching methods	26 (51.0)
The creation of a STEAM course at university	12 (23.5)
Providing STEAM material	10 (19.6)
School teacher training	3 (5.9)
Other	0
Total	51 (100)

of the Department of Science Education at the Pedagogical University, there are no courses on integrated education in science or other subjects. Little understanding of integrated or convergent education means that STEAM education will therefore be difficult. Professors and pre-service teachers considered the development of teaching methods and the creation of lectures on STEAM the most urgent issues. In contrast, in-service teachers said in interviews that teacher training and teaching methods are the most urgent.

In the narrative responses, there were negative views on subject integration, and participants discussed the need for publicity and facilities. Here are examples of these opinions:

- Each subject should be taught separately, and interdisciplinary integration should be developed.
- Each science must be used separately ...
- It should not affect the special subjects at all.
- If you want to run STEAM, you need to promote it more.

4.2.2 The Most Important Thing in STEAM Education

Teachers were asked to consider what was the most important thing for STEAM Education. Table 11 shows the professors' and pre-service teachers' responses to questions about the most important thing in STEAM education.

The responses to this question are consistent with the question regarding what was “the most urgent thing”. There was no difference between the meaning of the urgent and the important. However, in-service teachers who teach students at schools answered that teacher training is the most important. For this population, “How to teach” was the biggest concern. In-service teachers

TABLE 11 Professors and pre-service teachers' responses about the most important thing in STEAM education

What in your opinion is the most important thing for STEAM education?	Number of responses (%)
Development of teaching methods	22 (43.1)
The creation of a STEAM course at the university	14 (27.5)
Providing educational materials	8 (15.7)
School teacher training	7 (13.7)
Other	0
Total	51 (100)

had different opinions in the interviews, including, the need for teacher training, classroom resources, such as computers, and the need for more innovative teaching methods.

In an article on STEAM education published by the Presidential School (Marifat, 2019), modern school facilities such as well-equipped computer labs, language labs, and laboratories and smart education were emphasized. Because STEAM education includes engineering and technology, teachers said that STEAM education would require resources, such as computers and video equipment. In-service teachers said that STEAM education would be difficult due to lack of equipment.

4.2.3 Difficulties in Implementing STEAM Education

Table 12 shows the professors' and pre-service teachers' responses to questions about the difficulties in implementing STEAM education. There were seven options in this question.

Professors and pre-service teachers ranked teachers' teaching ability as the most difficult point in implementing STEAM education, followed by the understanding of STEAM education. This suggests that STEAM education depends on the understanding and teaching ability of in-service teachers.

The narrative responses showed that there were opinions that STEAM education was being resisted, indicating that implementing STEAM education based on the government's promotion of it was not easy, and that its implementation should be preceded by its understanding by the members of the pedagogical university, who should take the lead in science education reform. The in-service teachers said that the change itself would be difficult because

TABLE 12 Professors and pre-service teachers' responses about the difficulties of STEAM education

What is your opinion about the most difficult part of implementing STEAM education?	Number of responses (%)
Teaching ability of teachers	18 (35.3)
Understanding of STEAM education	14 (27.5)
Support and preparation of teaching materials	10 (19.6)
Academic ability of students	3 (5.9)
Subject convergence	3 (5.9)
Lack of time for preparing lessons	2 (3.9)
Other	1 (2.0)
Total	51 (100)

they have long adhered to traditional methods in science class. Both in-service teachers and pre-service teachers said it would not be easy to accept these changes.

To help with the survey and interview, the meaning and methods of STEAM were briefly explained beforehand. Because STEAM education includes technology and engineering, in-service teachers thought that STEAM education's aim was to create something using modern resources and technologies. They said that STEAM education would be difficult because schools do not have such facilities. Some respondents were negative about the integration of subjects, and stated that each subject in science should maintain its own place. Although not presented in the above analysis, there were cases where participants felt that the purpose of STEAM education was positive while they opposed integration and convergence education. To improve the quality of school education, the government aims to participate in international comparative evaluations and create conditions for schools to participate in these. They established Presidential Schools that meet international requirements and began to educate students according to the Cambridge international curriculum (Cambridge Assessment, 2021) and use STEAM education methods.

In the curriculum, STEAM education methods were proposed as a basic principle starting in 2020, but they have rarely been used. Since the academic field remains divided into traditional subjects, and there has been no consensus on the necessity for convergence and integration between subjects, a great deal of effort will be required for STEAM education to be applied to the actual

classroom. Along with the fact that the Presidential Schools, which were newly established in major regions in 2019, have already been teaching using STEAM methods, STEAM education has also been proposed as a basic principle in the general school curriculum. However, there has not been agreement among the educators who are in charge of implementing these methods.

To apply STEAM education, there needs to be research done on it and teachers should be trained in it. In addition, STEAM education can likely be applied more easily and quickly by referring to the materials and content that have already been developed in countries such as Korea, where STEAM education has been conducted for more than 10 years (Son & Jeong, 2019; Choi, 2019).

4.3 *RQ 3: What Efforts Has Uzbekistan Been Making to Apply STEAM Education for Educational Reform?*

As stated above, Uzbekistan established Presidential Schools in major regions to provide STEAM education and proposed STEAM education as the basic principle in the school curriculum. It took a relatively short time from the introduction to the application of STEAM education. This was due to the strong will and support of the government, including the president. In this study newspaper articles were analyzed to determine what efforts had been made to introduce STEAM education.

The most popular internet site for Uzbekistan's education-related articles is the newspaper *Ma'rifat* (marifat.uz). In *Ma'rifat*, articles were searched using "STEAM" as the search term. STEAM education was introduced after the inauguration of the current president and began to appear in articles in 2018. STEAM education symbolizes Uzbekistan's educational reform and was intended to be applied not only to school classes, but also to out-of-school activities. Newspaper articles generally promoted the government's policies. From 2018 to early 2019, articles on changes in school education and the establishment of Presidential Schools began to appear. In 2019, there were 10 Presidential School articles, twice as many as the five general education articles. Since the Presidential School was settled in a stable position by 2020, the majority of the articles since then have been on public education reform. Articles were categorized into three categories: general education, Presidential School, and other. The number of articles by category retrieved from the *Ma'rifat* site are shown in Table 13.

The topics of articles related to STEAM education are classified in Table 14. This table represents the range of content reported about STEAM education from 2018–2020.

Several articles appeared related to the Presidential Schools, which selects and educates high achieving students. The Presidential Schools first invited

TABLE 13 Number of STEAM-related articles per month

Year and month	Number of articles		
	General school	Presidential School	Other
2018-08	1		
2018-09	1		
2018-11		1	
2019-01	2		3
2019-02		1	
2019-05		1	
2019-07		1	1
2019-08	1	1	1
2019-09	1	2	
2019-10	2	2	2
2019-11	1		1
2019-12		2	1
2020-01	1		
2020-02	2	1	1
2020-03	2		
2020-04			1
2020-06	1		
2020-11	1		
Total	16	12	11

foreign teachers to start STEAM education with the goal that these teachers will be able to model STEAM education and pass it to general school teachers. For example, one article shared an interview in which a Presidential School teacher invited from abroad explained the meaning and methods of STEAM education. Another article described the STEAM education program intended to be provided in a Barkamol Avlod, a type of public school. Most of the articles focused on the reporting of legislation about STEAM education and its related implementation. The only article discussing research on STEAM education was a report describing the activities of an academic conference taking place at Tashkent State Pedagogical University.

Based on the contents of the articles and on analysis of legislation, the major educational reform processes that have been reported since the inauguration of the current president are summarized in Table 15.

TABLE 14 The contents of STEAM-related articles

Year	General school	Presidential School	Other
2018	Introducing STEAM The presidential decree of the school system	Plan for the Presidential School	
2019	Introduction of advanced STEAM education standards and teacher training Participation in international Olympiads Introducing STEAM to the teacher training centers Retraining plans for teachers Organization of inter-school STEAM laboratory	Invitation of teachers from foreign countries Entrance examination The opening of the school Explaining STEAM education at the school School curriculum basis of the STEAM program Opening schools in Khiva and Nukus	Robo-craft class STEAM Olympiad Out-of-school (Barkamol Avlod)
2020	A presidential decree on school innovation until 2030 Inviting specialists for teacher training Seminar on education quality assessment Address of the President of Uzbekistan on the development of science education Teacher evaluation system with STEAM	Discussion of the STEAM program	Exposition of robots

The Astronomy School and the Presidential School were newly established to educate high-achieved students. The School of Astronomy was named after Mirzo-Ulugbek to commemorate the great Uzbek monarch and astronomer of the 15th century. Along with the Ibn Sino Medical School, the schools were named after famous scientists in Uzbeki history to help students be proud of their scientific history. In order to improve the academic level of these students, these schools decided to participate in various international academic evaluations and the International Olympiad. Out-of-school activities were also encouraged with STEAM education being suggested for both general education schools, out-of-school activities, and the Presidential Schools.

TABLE 15 Educational reform process by year

Year	Implementation of the reform
2017	Establishment of astronomy boarding school: Recruitment of 200 seventh grade students in 2018 Inviting foreign experts to develop and provide innovative educational services
2018	Participation in PISA, TIMSS, and PIRLS assessments Introduction of advanced foreign experiences in the public education system Innovative teaching methods Modern teaching skills in the curriculum, including basic and applied science research.
2019	A plan to establish a continuous system for recognition of gifted and talented students: Encourage participation in the International Olympiad Increase the effectiveness of out-of-school education in the public education system: Children's libraries, children's school installation, robotics club expansion, broadband internet connection, the introduction of STEAM education in 2020–2021 school year Establish Presidential School: creative technical school to conduct STEAM education
2020	STEAM education as a basic principle in secondary schools

The major direction of educational reform appears to be increasing students' academic ability and the article analysis suggests that the government expects STEAM education will be able to improve students' academic ability. Other examples included the establishment of Presidential Schools to foster excellent talent and implementing assessments of comparative international academic ability to measure and then begin to raise the level of students' achievement. However, these measures will take time.

The plan to bring foreign teachers in to instruct teachers about STEAM at the Presidential Schools will also take a long time to become extended beyond the Presidential School and to move into the general education schools. While STEAM education is stated as a basic principle for the education system, it is not yet available in all schools. In addition, while classes in robot design are being taught in the name of STEAM education in informal education settings, these are also not widespread. For this reason, while there is a commitment to STEAM education for advancing education in Uzbekistan, there is not yet enough widespread support and resources available to fully realize this goal.

As it is, there is a risk that STEAM education may be misunderstood as technical education if STEAM education is first encountered by teachers, students, and the public in realms outside of the public education system. Even within the public education system, there is a concern that STEAM education, along with a comparative evaluation of international academic ability, will be recognized as a method for improving academic ability over time.

5 Conclusion and Suggestions

Since gaining independence from the Soviet Union, there have been various problems with Uzbekistan's education, and there is widespread acknowledgment of the necessity for reform (Sung, 2018). Since the inauguration of President Shavkat Mirziyoyev's government in 2017, the government has made an effort to reform and develop the education system. The most important goal for this administration was to raise the level of students' academic achievement, and along with reforms of the school system, the government took various measures to improve teacher education (Uzbekistan Government, 2019). An important area for examination has been STEAM education.

This research offered an introduction to STEAM education in Uzbekistan by sharing some of the historical advances made by the government to establish STEAM in schools and by sharing educator's perspectives about STEAM education. Based on an analysis of available documents and newspaper articles, this study found that the Uzbekistan government has made three major efforts to reform education: establishing STEAM presidential schools; participating in international comparative evaluations; and presenting STEAM education as a basic principle of education in public schools and informal education settings.

Although STEAM education has become a basic principle of education, this research found there has not been enough discussion about STEAM education in the Uzbekistan education system. Specifically, this study found that educators in Uzbekistan were generally not well aware of the concept of and necessity for STEAM education, but they generally believed that STEAM education is a useful method for developing student talents. An investigation of the opinions of professors and pre-service teachers from a pedagogical university and in-service teachers found that they generally lacked understanding of STEAM education and there were also some negative opinions about the value of integrating subjects. However, STEAM education was, for the most part, viewed positively and seen as a way to improve teaching methods. Especially educators believed that the development of teaching methods for STEAM education is important and necessary as teachers' teaching ability and

integration of subjects was seen as potentially problematic for implementing STEAM in the classroom. The educational reform process was also examined by analyzing articles in an educational newspaper. The contents of the newspaper articles mainly reported on government regulations and the actions of government personnel related to STEAM education. As the government began to emphasize STEAM education, it first started using the name of STEAM education in informal education settings and then began describing the goals of implementing STEAM education in public education settings.

Based on the survey results, several suggestions for STEAM education in Uzbekistan can be offered. First, more discussion about STEAM education is needed. STEAM education has been set as a method of education reform, but there has not been enough discussion on what it is and specifically how to do it. In countries where STEAM education is practiced to some extent, researchers and educators have established it through a great deal of research and trial and error (Chae, Moon, & Kim 2014). In Uzbekistan, however, few people are familiar with STEAM education in schools or universities.

In addition, it is recommended that the Uzbekistan Government will have to prioritize teacher training. According to newspaper articles (see Table 14), more classes are allocated to teachers with STEAM certificates than those without (marifat.uz, 11/08/2020). This shows that the perception people have about STEAM education is that it is a topic for which teachers can obtain a certificate to know and be able to do, rather than understanding that STEAM education refers to a teaching curriculum and pedagogical method. Because STEAM education requires the reorganization of several subject curricula and converging subjects, it is difficult for a teacher to be able to do it alone (Bae, Yun & Kim, 2013). At schools where each class subject is taught separately, one teacher is generally in charge of each class. In such cases, the schedules for each class time must be adjusted as convergence education requires the cooperation of several teachers. While it may be possible to distinguish between teachers who have received instruction in STEAM education and those who have not, it is important to recognize that having obtained a STEAM education certificate does not guarantee the teacher will be able to successfully implement STEAM education. Therefore, it is necessary to continue to expand both the promotion and training of teachers so that more teachers can become aware of and pursue STEAM education with interest.

Second, having educators agree on the necessity for convergence education is helpful. The term “academic convergence” is unfamiliar to educators and teachers may resist instructing their subject content as an integrated course. To teach using STEAM education methods, educators should first agree on why it should be done. In addition, the special historical and social contexts

of Uzbekistan and the education system also needs to be considered. It is true that reform for the development of education is urgent and it can be positive to introduce and apply experiences and knowledge learned from more developed countries. However, for STEAM education to be successful, there needs to be sufficient discussion and research established at the pedagogical universities so there can be agreement about the value of STEAM education and so that educators can oversee the development of the field.

Third, there needs to be sufficient conditions for implementing STEAM education in real classroom settings. In-service teachers worried about the lack of school facilities for STEAM education. Because the experimental and practical laboratory facilities are not enough, teachers currently rely on textbook-based activities rather than implementing real experiments in science class. Although STEAM education does not require special facilities, the basic facilities and resources needed for implementing some hands-on activities should be available. In addition to understanding STEAM education methods, also teachers need to be able to exercise their creativity with students and to practice both hands-on and mind-on education. However, it is not easy for the government to both prepare school facilities, development provide learning materials, and also simultaneously improve teacher education and professional development activities. Education costs already account for the largest portion of the government's budget (Sung, 2018), so it may be difficult to spread these resources further.

Fourth, teacher training should be conducted as soon as possible. STEAM education is already a basic principle in the curriculum. Nevertheless, teachers are not familiar with it. Teacher training is not easy considering the reality that not many university level educators understand STEAM education. There may be a way to invite foreign teachers with experience in STEAM education, for example, teachers from abroad are already visiting the Presidential Schools to participate in lectures. Recently, experienced foreign teachers invited to the Presidential Schools have been attempting to demonstrate STEAM classes to local teachers and to share experiences by holding workshops (Presidential School, 2021; *Uz Daily*, 2020). In addition, in February 2021, Tashkent Pedagogical University invited a STEAM education expert from Turkey who is expected to play an important role to link different departments working to establish a STEAM education program.

Also, it is possible to refer to the STEAM education materials already developed in countries, such as Korea. Teachers in Uzbekistan could work to reorganize these materials to fit the conditions of local schools using resources such as the Ministry of Public Education website Edu-portal, which allows teachers

to upload teaching-learning materials and class videos to help others. With the onset of the COVID-19 pandemic, online classes have become more commonplace. As a result, it is more possible now to develop and implement online lectures to provide widespread teacher training in a short period. By sharing materials with a broad group of teachers, a STEAM education plan that is suitable for Uzbekistan's varied school situations could be developed more easily. In Uzbekistan education, there has not been enough discussion on integrated subjects. For the sake of STEAM education, as well as for the development and preparation of society in the future, discussions on the current education system, academic convergence, and convergence education are needed.

Uzbekistan is a country with great potential for development and there have been many changes in the system in recent years. Cooperating with countries where education reform has a longer history can be an effective way to support education reform efforts over time.

Abbreviations

GPE	Global Partnership in Education
MoPE	Minister of Public Education
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
STEAM	Science, Technology, Engineering, Art and Mathematics
TIMSS	Trends in International Mathematics and Science Study
UNESCO	United Nations Educational, Scientific and Cultural Organization

Acknowledgements

I wish to express my gratitude to the students who participated in this study as well as the colleagues who supported it. And I would like to thank the anonymous reviewers for their helpful suggestions and feedback.

Ethical Considerations

The data collected from this project has obtained the necessary clearance from the participants involved in the study.

About the Author

Yumi Lee is a Professor in the Department of Russian Education at Tashkent State Pedagogical University in Tashkent, Uzbekistan. Lee received a bachelor's and master's degree from Seoul National University of Education and a doctorate from Dankook University in Science Education. She is studying science education in Uzbekistan and Central Asian cultural studies. She is interested in the relationship between Korea and Central Asia and convergence of science education and culture.

References

- Abduraximovich, N. (2020). STEAM – This is integrated educational technology. *Physical and mathematical Science*, 3(1), 16–18.
- Bae, J., Yun, B., & Kim, J. (2013). The Effects of Science Lesson Applying STEAM Education on Science Learning Motivation and Science Academic Achievement of Elementary School Students. *Journal of Korean Elementary Science Education*, 32(4), 557–566.
- Cambridge Assessment (2021). International curriculum. Retrieved 11/04/2021 from <https://www.cambridgeinternational.org/why-choose-us/benefits-of-a-cambridge-education/international-curriculum/#:~:text=The%20Cambridge%20international%20curriculum%20sets,by%20universities%20and%20employers%20worldwide.&text=They%20also%20gain%20the%20essential,and%20in%20their%20future%20careers.>
- Chae, D., Moon, B., & Kim, E. (2014). Development and Application of a Subject Substitute STEAM Lesson in Elementary School Science Education. *Journal of Korean Society of Earth Science Education*, 7(3), 327–337.
- Choi, H. & Shin, D. (2011). An Analysis of a Newspaper Article about the Ecosystem Changes in Relation to Climate Change. *The Energy and Climate Change Education*, 1(1), 23–31.
- Choi, S. (2019). A Comparative Study on the Perception of STEAM Education in the Elementary Science Class between General Teachers and Teacher in STEAM Education Research Group. *The Journal of Education*, 39(1), 109–122.
- Egamberdievich, S., Sattorovich, R., Amrillojonovich, R. & Rustamovna, U. (2019). Smart School In Uzbekistan. 2019 *International Conference on Information Science and Communications Technologies (ICISCT)*, Tashkent, Uzbekistan, 1–5. doi: 10.1109/ICISCT47635.2019.9011904.

- Hakimov, N., Sadikov, A., Abdumalikov, A., Rustamov, I., & Iminov, B. (2020). Reforming the education system in the conditions of a new state of development. *International Journal of Psychosocial Rehabilitation*, 24(6) 4384–4395.
- Kang, C., Lee, S. & Kang, K. (2013). Secondary School Teachers' Perception on STEAM Education and Their Satisfaction on Teachers' Training Program. *Journal of Educational Research Institute*, 15(2), 1–12.
- Kang, N.H. (2019). A review of the effect of integrated STEM or STEAM (science, technology, engineering, arts, and mathematics) education in South Korea. *Asia-Pacific Science Education*, 5(1), 1–22. <https://doi.org/10.1186/s41029-019-0034-y>.
- Kang, Y., Yu, H. & Kang, T. (2013). An Analysis of School Violence Issue on Korean Daily Newspapers and Educational Weekly Newspapers. *Journal of Communication Science*, 12(2), 5–40.
- Kennedy, T. & Odell, M. (2014). Engaging students in STEM education. *Science Education International*, 25(3), 246–258.
- Kim, Y. (2018). *Development of Evaluation Model for STEAM*. Research report of Ministry of Education and Korean Foundation for the Advancement of Science & Creativity.
- Ko, H. (2011). Analysis of Newspaper Articles into Science Concepts and its Implication for Science Education. *Journal of Education & Culture*, 17(2), 367–384.
- Korea Foundation for the Advancement of Science and Creativity [KOFAC]. (2014). *Development of evaluation tool for outcome of STEAM*. Seoul: KOFAC.
- Kulmatov, B. (2015). Essential problems of management in the system of education in Uzbekistan. *The Advanced Science Journal*, 2015(6), 88–91. DOI: 10.15550/ASJ.2015.06.088.
- Lee, B., Shin, W., Kim, H. & Son, J. (2012). Content Analysis of Energy and Climate Change Demonstrated in Newspaper Articles. *The Energy and Climate Change Education*, 2(1), 29–66.
- Lee, J. & Han, I. (2005). An Analysis of 20th Century Scientific Discoveries Cited in High School Science Textbooks, Articles of Newspaper, and Book Publication. *Biology Education*, 33(3), 249–257.
- Lee, Y. (2020). *An example of STEAM education in Korea*. Tashkent State Pedagogical University International Scientific and Practical Remote Conference material. 24 Apr/ 2020 Tashkent. 23–35.
- Marifat.uz. (2019). Presidential schools are the basis for training personnel who will give a strong impetus to the development of the country. Retrieved 12/10/2019 from <http://marifat.uz/marifat/ruknlar/yoshlar/3671.htm>.
- Marifat.uz. (2019). Robotics courses at Barakamol Avlod. Retrieved 11/01/2021 from <http://marifat.uz/uchitel-uz/rubriki/vneshkolnoeobrazovanie/2265.htm>.

- Marifat.uz. (2020). Now the division of lesson is determined by the previous activity of the teacher. Retrieved 11/08/2020 from <http://marifat.uz/marifat/ruknlar/umumii-urta-talim/4797.htm>.
- Minister of Public Education. (2020). *Order of the Minister of Public Education of The Republic of Uzbekistan about approval of the basic curriculum for general secondary schools for the academic year 2020–2021*. Tashkent: Ministry of Public Education.
- Ministry of Higher and Secondary Special Education (2020). Working Curriculum 4 Course. Tashkent: Tashkent State Pedagogical University.
- Ministry of Public Education, Ministry of Higher and Secondary Special Education, & Republican Council of the Trade Union of Education, Science and Culture of Uzbekistan. (2015). Gazeta Marifat. Retrieved 11/12/2020 from <http://marifat.uz/marifat/ruknlar/umumii-urta-talim/4797.htm>.
- Ministry of Public Education of the Republic of Uzbekistan & Republic Education Center. (2017). *State Educational Standards and Curriculum for General Secondary Education*. Tashkent: Ministry of Public Education.
- Ministry of Public Education of the Republic of Uzbekistan & Tashkent State Pedagogical University. (2020). Improving the Quality of Modern Continuous Education: Innovation and Prospects. International Scientific and Practical Remote Conference Material. 24 Apr/ 2020 Tashkent.
- Muminov, A. (2019). Reforms in the Education of Uzbekistan: State and Prospects. *Bulletin of Science and Practice*, 8, 202–208. DOI: 10.33619/2414-2948/45.
- Mushtaq, S. (2015). Contemporary Educational System in Uzbekistan. *International Journal of Social Science and Humanities Research*, 3(1), 136.
- Naviyev, F. (2020). STEAM – the integrated education technology. *Physical and Mathematical Sciences*, 3, 16–18.
- NIE Korea Committee (2010). *Understanding and Practice of Newspaper In Education*. Seoul: Korean Association of Newspaper.
- Pardabaev, J. (2020). “STEAM”-Education as an Innovative Approach to the Development of vocational training for students. *European Journal of Research and Reflection in Educational Sciences*, 8(3), 101–105.
- Park, H., Byun, S., Sim, J., Han, H., & Baek, Y. (2016). Teachers' Perceptions and Practices of STEAM Education in South Korea. *Eurasia Journal of Mathematics, Science & Technology Education*, 12(7), 1739–1753. DOI: 10.12973/eurasia.2016.1531a.
- President School. (2021). I Touch the future, I teach. Retrieved 18/02/2021 from <https://pm.piima.uz/i-touch-the-future-i-teach-christa-mcauliffe/>.
- Seo, H., & Lee, J. (2018). Analysis of Future Education Trends Using Semantic Network Analysis. *The Journal of Educational Information and Media*, 24(4), 649–678.

- Shin, Y. & Han, S. (2011). A Study of the Elementary School Teachers' Perception in STEAM (Science, Technology, Engineering, Arts, Mathematics) Education. *Journal of Korean Elementary Science Education*, 30(4), 514–523.
- Son, M. & Jeong, D. (2019). Limits of STEAM education and its Improvement Alternative: Based on the Viewpoints of STEAM Expert Teachers. *Journal of the Korean Association for Science Education*, 39(5), 573–584.
- Son, Y., Jung, S., Kwon, S., Kim, H. & Kim, D. (2012). Analysis of Prospective and In-Service Teachers' Awareness of STEAM Convergent Education. *Humanities and Social Sciences Research*, 13(1), 255–284.
- Sung, D. (2018). Analysis on Educational System and Education Environment in Uzbekistan after Independence. *Central Asian Studies*, 22(2), 199–226.
- Tolipov, U., Tsoy, M., & Tolipova, F. (2014). Pedagogical education in Uzbekistan. *The Advanced Science Journal*, (2014 special issue for China), 251–256. DOI: 10.15550/ASJ.2014.08.252.
- UNESCO. (2015). *Education for All 2015 National Review Report: Uzbekistan*. Tashkent: UNESCO Tashkent Office. Accessed at <https://eduportal.uz/Eduportal/Barchasi/33>.
- UNESCO (2018). Uzbekistan Education and Literacy. Retrieved 12/12/2020 from <http://uis.unesco.org/country/UZ>.
- Uz Daily. (2020). Teachers of the Presidential School in Tashkent share their experience with local specialists. Retrieved 28/12/2020 from <http://www.uzdaily.com/en/post/62725>.
- Uzbekistan Government. (2019). *Educational sector plan 2019–2023*. Tashkent: Government of Uzbekistan.
- World Bank. (2018). Uzbekistan Education Sector Analysis. World Bank. Retrieved from <http://documents1.worldbank.org/curated/en/379211551844192053/pdf/Uzbekistan-Education-Sector-Analysis.pdf>.