SHS Web of Conferences **206**, 01024 (2024) https://doi.org/10.1051/shsconf/202420601024
ERPA 2024

The Effects of a STEM-Centered Curriculum on Seventh-Grade Students' Attitudes Towards Socio-scientific Issues

Esma Saçan[1*], *İlke* Çalışkan[2], and *Fitnat* Kaptan[3]

[1]Science Education, Şehit Ünal Olgun Science and Art Center, 06930 Ankara, Türkiye
[2]Science Education, Hacettepe University, 06800 Ankara, Türkiye
[3]Science Education, Hacettepe University, 06800 Ankara, Türkiye

Abstract. The purpose of the research was to reveal the effects of the STEM-centered program designed according to the Demirel model on seventh-grade students regarding socio-scientific issues. The research was conducted with 78 students at Melikşah Secondary School in the Sincan district of Ankara province, during the spring semester of the 2016-2017 academic year, for 19 weeks when a STEM-centered program was implemented. In the research, data were collected using the Attitude Scale Towards Socio-Scientific Issues (ASTSI). After the application of the pre-test, activities prepared within the framework of a STEM-centered curriculum were applied to the experimental group, and applications aimed at the achievements determined by the seventh-grade level of science applications course were applied to the control group for one semester. At the end of the semester, ASTSI was applied to both groups as a post-test. The data obtained in the research were analyzed by the t-test analysis technique. In the study, data were analyzed with a t-test. It was observed that there was a statistically significant difference in favor of the experimental group regarding the attitude towards socio-scientific issues after the Stem-centered program.

1 Introduction

Socio-scientific issues are defined as complex, open-ended, often controversial, and have no definitive answers [1, 2]. Since the events that may occur during the day constitute the content of socio-scientific issues, one of the main goals of science education is for students to understand and learn about these issues [3, 4, 5]. These are comprised in the science curriculum of some countries and the aim is to develop students' understanding of these issues [6].

Understanding socio-scientific issues plays an important role in helping students find solutions to problems they may encounter in daily life [3, 7, 8]. It also ensures that students are raised as active members of modern societies [9]. All these requirements point to STEM

* Corresponding author: esma193@hotmail.com

education so that students can be more active in decision-making processes on socio-scientific issues. Because decision-making processes followed for problem-solving are an important part of the STEM learning cycle. In addition, when the knowledge, media, and technology skills expected of individuals of the 21st century are examined, it is seen that interaction with socio-scientific issues should be increased.

Accessing sufficient and effective information for solving problems, evaluating information sufficiently and critically, using it correctly and creatively, and having a basic understanding of ethical and legal issues are among the characteristics expected from individuals. Therefore, increasing students' awareness of socio-scientific issues is very important. Increasing this awareness can be achieved within the framework of the STEM education program.

With the technology and engineering infrastructure, it is possible to implement interdisciplinary perspectives and knowledge. Thanks to STEM education, students can produce what they design in their minds and carry what they learn to different problem situations [10]. STEM education supports constructive learning and student-centered education. Being product and new invention-oriented, it aims to develop mental processes, entrepreneurship, and product development skills. Entrepreneurship is a process of taking risks and taking action, and it provides production skills. It is aimed at closing the qualified labor gap through R&D, innovation, and technical infrastructure [10].

One of the reasons why STEM education has started to be addressed as a priority in our country is that the results of exams such as TIMMS and PISA, which measure skills at an international level, are not at the expected level. According to the 2015-2019 strategic plan, the number of students who will receive education in the field of STEM education should be increased, R&D investments should be supported, and it is aimed for students to acquire 21st-century skills by receiving more qualified education together with STEM education [11].

It is desired that science education in Türkiye be supported with science fairs at primary and secondary school levels and activities for young people in the fields of space science, mathematics, science, and technology [12]. Based on these needs in our country, program development studies for the formal education system should be prepared in a more flexible and updatable way so that students can gain the skills of individuals of the 21st-century. Because when learning and renewal skills are examined within the scope of 21st-century skills that students should have, it is seen that program development studies following the Demirel model should be carried out for individuals to gain these skills in the areas of creativity and learning, communication and cooperation, critical thinking and problem-solving, and information literacy. In this regard, when the skills expected of individuals within the scope of creativity and renewal are examined, individuals are expected to demonstrate originality and creativity in their work, develop and implement new ideas, be adaptable to new and different perspectives, and provide concrete assistance with creative ideas in areas where innovation is developing.

2 Method

This research, which determined the effect of a model developed and implemented by the researcher that included a STEM-centered curriculum for the science applications course, on the attitudes of 78 students in two groups who participated in the application process, is a case study.

The research was conducted with the participation of 78 seventh-grade students in the branches of Melikşah Middle School in Sincan district during the second semester of the 2016-2017 academic year. In the research, branches 7-A and 7-B participated as the experimental group, while branches 7-C and 7-D participated as the control group.

In this research, which included a one-term (19 weeks) application, branches 7-A and 7-B, which were determined as cluster sampling units from four seventh-grade branches in the school that provided adequacy in adapting to the application of group work activities in science applications courses, constituted the experimental group of the research [13].

Table 1. Distribution of the Study Group from Which Quantitative Data Were Collected, by Gender

Group	Branch	Female	Male	Total	Evaluated
Experimental	7A	12	16	28	23
	7B	12	15	27	22
Control	7C	11	14	25	15
	7D	11	17	28	18

The scale consists of 30 items prepared in a 5-point Likert format (1= Strongly disagree; 5= Strongly agree). Since 9 items in the scale were negative in meaning, these items were reverse coded (1= Strongly agree; 5= Strongly disagree). As a result of the exploratory and confirmatory factor analyses, reliability coefficients ranged from 0.7 to 0.9, and it was a valid and reliable measurement tool [2]. It was observed that the scores were normally distributed according to analysis results. It was deemed appropriate to use parametric statistics in the analysis of quantitative data.

To eliminate the effect of the pre-test from internal validity threats before the research, the pre-test scores of the groups from ASTSI were tested in independent groups to ensure the equivalence of the groups.

3 Results

A t-test for dependent groups was used to determine whether there was a significant difference between the pre-test and post-test scores of the ASTSI in the experimental group to which the STEM-centered curriculum was applied. The results of the t-test are given in Table 2.

Table 2. Dependent Groups T-Test Results of ASTSI Pre-Test Post-Test Average Scores of Experimental Group

	N	Avg.	SD	df	t	p
Pre-Test	45	76,93	22,757	44	-	0,021*
Post-Test	45	87,00	15,584		22	

***($p < 0,05$)**

The post-test attitude score STEM-centered curriculum group is 87.00 but the pre-test attitude score is 76.93. So there is a significant difference was found (p<0.05).

The results of the t-test for Dependent Groups on ASTSI are given in Table 3.

Table 3. Results of T-Test for Dependent Groups on ASTSI Pre-Test Post-Test Average Scores of Control Group

	N	Avg.	SD	df	t	p
Pre-Test	33	77,09	20,734	32	-	0,417*
Post-Test	33	73,24	13,381		0,823	

***(*p* > 0,05)**

There is no statistically significant difference between the ASTSI pre-test and post-test score averages of the control group (p > 0.05). The post-test success scores of the control group students (=73.24) were found to be relatively lower than the pre-test scores (=77.09), but there was no significant difference. Results of the T-Test for Independent Groups on ASTSI Post-Test Average Scores were shown in Table 4.

Table 4. Results of T-Test for Independent Groups on ASTSI Post-Test Average Scores

	N	Avg.	SD	df	t	p
Experimental	45	87	15,584	76	4,084	0,000*
Control	33	73,24	13,381			

***(*p* < 0,05)**

A statistically significant difference was found between the attitude scores of the experimental group students measured after the application and the pre-test attitude scores measured before the application (p<0.05).

4 Conclusion

The post-test attitude scores of the experimental group students, who applied for a STEM-centered curriculum, were found to be higher than the pre-test attitude scores. The qualitative analysis findings of the study also support these findings. It is seen that the fact that the program was prepared with an interdisciplinary approach is reflected in the students' attitudes toward socio-scientific issues. In the interviews conducted with the students, the students associated various STEM activities, which include many disciplines such as Mathematics, Physical Education, Visual Arts, Technology Design, and unit and subject analyses were made within this scope, with other disciplines. At the same time, the students, who also associate these activities with socio-scientific issues, especially drew attention to the social and communal dimensions of environmental problems. The fact that the STEM education approach emphasizes technology and engineering provides children with an interdisciplinary perspective and ensures that information is put into practice concretely supports students in coping with problems related to socio-scientific issues such as energy saving, environmental protection, and health. In the image studies, there is a significant difference in the dimension of the students' reflection of elements related to mathematics, engineering, technology, and science in their studies in the drawings after the application and the inclusion of interdisciplinary approaches in the images before and after the application. When the studies conducted in the literature on socio-scientific issues are examined, it is seen that studies including argumentation, scientific thinking skills, and scientific literacy in science education of socio-scientific issues are intensively conducted. Gülhan and his colleagues, the effect of the socio-scientific argumentation method on students' scientific literacy, scientific discussion tendencies, sensitivity to science-society problems, and decision-making skills, the socio-scientific argumentation lot made great progress when compared to other lots in terms of scientific literacy, scientific discussion tendencies, sensitivity to science-society problems and decision-making skills [14]. Çoban and his colleagues concluded that the awareness of the participating teachers regarding the argumentation issue, the importance of which is emphasized in the Science Program [15], increased within the scope of the research they conducted with teachers, and that they understood the importance of argumentation and TPACK applications within innovative methods and approaches such as inquiry (STEM), and that they benefited from the collaborative nature of TPACK-based argumentation applications. From this perspective, the results of these findings are an important example for studies on STEM education applications and socio-scientific issues conducted with primary school students.

Since STEM education is a new approach, pre-service and in-service training should be provided to teachers and teacher candidates regarding STEM education. Supplementary measurement and evaluation should be given a lot of space in the STEM education process, and the criteria should be determined with the participation of students in the classroom. The integration of the steps in the engineering design process into rubrics should be ensured. Project planning of studies with institutions and organizations that provide support regarding the budgeting of activities such as robotics, which increase students' curiosity and develop higher-level thinking skills, and presentation of products should be carried out with a science festival. STEM education should be a part of the curriculum and should be associated with all disciplines. While preparing the curriculum, integrated program schemes should be drawn up with the integrity of objectives, content, learning-teaching, and measurement-evaluation elements. Horizontal and vertical connections in the curriculum should be continuously checked and controlled in STEM-centered activity and program designs. Since the programs of elective courses such as science applications have an uncertain framework, the STEM-centered curriculum should be prepared after the need analysis study as a program that includes STEM activities in the transition from theory to practice. In undergraduate teacher education, in pedagogical content knowledge courses, regarding the design of the STEM-centered learning-teaching process; activity designs that develop the scientific process skills of the teacher candidate should be developed, and activities aimed at establishing science-technology-society-environment relations and environmental protection awareness should be included in the activities. Students should be directed to develop social responsibility projects in which they will apply the scientific method with their peers in the classroom or out-of-class environments. While using science notebooks, teachers should follow the developments by comparing them with the students' previous notebooks. STEM education should not be seen as just a tool or commodity and should not remain as activities held only in science centers and fairs, and teaching programs with philosophy should be developed based on economic, psychological, and social foundations by conducting needs analysis studies. In the design of STEM activities, activities should be developed at all levels to provide students with computational thinking skills from an early age. Flexibility should be provided in terms of duration when developing lesson plans, and students should not be forced to be divided into 40-minute lesson blocks. Learning environments should be created where students can express themselves comfortably, are flexible, have access to their materials and products, are suitable for group work, and are spacious and technologically supported.

References

1. Sadler, T. D., Amirshokoohi, A., Kazempour, M., & Allspaw, K. Socioscience and ethics in science classrooms: Teacher perspectives and strategies. *Journal of Research in Science Teaching, 43*, 353–376, (2006).
2. Topçu, M. S. Development of attitudes towards socioscientific issues scale for undergraduate students. *Evaluation & Research in Education, 23*(1), 51-67, (2010).
3. Albe, V. Students' positions and considerations of scientific evidence about a controversial socioscientific issue. *Science & Education*, *17*(8-9), 805-827, (2008).
4. Nielsen, J.A., Arguing from Nature: The role of 'nature' in students' argumentations on a socio-scientific issue, *International Journal of Science Education*, 34(5), 723-744, (2012).
5. Walker, K., & Zeidler, D.L., Promoting discourse about socioscientific issues through scaffolded inquiry, *International Journal of Science Education,* 29(11), 1387-1410, (2007).
6. Oulton, C., Dillon, J., & Grace, M.M. Reconceptualizing the teaching of controversial issues. *International Journal of Science Education*, *26*(4), 411-423, (2004).
7. Kolsto, S.D., Patterns in students' argumentation confronted with a risk-focused socio-scientific issue. International Journal of Science Education, 28(14), 1689-1716, (2006).
8. Van der Zande, P.A.M., Empowering teachers to teach socioscientific issues: the role of teacher identity in teaching. D. J. Boerwinkel, and A. J. Waarlo, (Eds.). Genomics Education for Decision making, *FISME series on Research in Science Education*, 117-124, (2007).
9. Dawson, V.M, A case study of the impact of introducing socio-scientific issues into a reproduction unit in a Catholic Girls' school, *New York: Springer Dordect*, 313-345, (2011).
10. MEB (Ministry of National Education). *STEM education report*. Ankara: Ministry of National Education, General Directorate of Innovation and Educational Technologies (YEĞİTEK), (2016).
11. TÜSİAD (Turkish Industrialists' and Businessmen's Association). *Liability disclosure report 2014-2015*, (2014). Retrieved in October 2017 from http://tusiad.org/tr/yayinlar/raporlar/item/8658-tusiad-2014-2015-sorumluluk-bildirimi-raporunu-yayimladi.
12. Baran, E., Canbazoğlu-Bilici, S. and Mesutoğlu, C. Science, technology, engineering and mathematics (STEM) spot development event. *Journal of Research Based Activity* , 5(2), 60-69, (2004).
13. Büyüköztürk, Ş., Kılıç-Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. *Scientific research methods*. Ankara: Pegem Akademi, (2012).
14. Gülhan, F. ve Şahin, F. , Fen-Teknoloji-Mühendislik-Matematik entegrasyonunun (STEM) 5. sınıf öğrencilerinin bu alanlarla ilgili algı ve tutumlarına etkisi. *International Journal of Human Science*, 13(1), 602-620, (2016).
15. Çoban G., Akpınar E., Baran B. and Sağlam, Evaluation of "technological pedagogical content knowledge-based argumentation practices" training for science teachers. *Education and Science*, 41, 1-13, (2016).