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AN EFFECTIVENESS EVALUATION OF A TUBITAK PROJECT PROGRAMME ABOUT STEM EDUCATION FOR GIFTED STUDENTS

(Research article)

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Abstract

The primary purpose of this research is to increase the interest of earthquake survivor students in the fields of Geology and Science, Technology, Engineering, and Mathematics (STEM), to enable them to develop their knowledge and skills in these fields, to promote scientific knowledge-based thinking in society, and encourage future scientists. This research is based on an education project funded by The Scientific and Technological Research Institution of Türkiye (TUBITAK). For this purpose, 24 gifted students from Science and Art Centres (BİLSEM) were selected from Hatay, Kahramanmaraş, Osmaniye, and Adana provinces, which were most affected by the earthquake in Türkiye. The participants were selected via criterion sampling method, one of the purposeful sampling methods, and they were trained for five days adopting a pre-test and post-test process. In addition, the data were collected through a response evaluation questionnaire and an interview form regarding the efficiency of all elements of the project and the trainers. The obtained data were analysed using "The Kirkpatrick Training Programme Evaluation Model" (Kirkpatrick, 2006) The results revealed that the participants' reactions to the training process were positive and that they liked the trainers, topics, materials, presentations, and the training environment in the project training process. In addition, it was noted that the training extensively and positively affected the acquisition of knowledge, skills, and attitudes. According to the participants' statements, the gains from the training have provided them with skills that can be transformed into practice in their life-oriented experiences and show that the feasibility level is high. As a result, it shows that the project effectively meets student needs and has a solid infrastructure to increase student satisfaction.

Keywords: STEM; TUBITAK; gifted students; project evaluation; project effectiveness

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1. Introduction

Recently, it has been frequently emphasized that the interest in STEM (science, technology, engineering, and mathematics) fields has increased, and individuals educated in these fields have an essential role in the global competitive environment. It has been supported by various studies that STEM education, especially in early childhood, has a decisive effect on the development of children's skills such as critical thinking, problem-solving, and creativity (Bybee, 2013; Nyutu, 2023). In this direction, introducing children to STEM will contribute to their future academic and professional success.

However, whether the STEM approach positively affects academic achievement and cognitive and social skills needs to be examined in more detail. How children's analytical thinking and creative problem-solving abilities improve with this kind of education is essential in understanding the long-term effects of STEM education.

For example, a study by Allen, Eisenkraft, and Cohen (2016) showed that children who participated in STEM-focused education programs significantly improved their critical thinking and problem-solving abilities compared to other students. Similarly, Sarama and Clements' (2009) research revealed that STEM education contributes to developing cognitive skills such as mathematical thinking and spatial awareness, especially in the early age group.

In this framework, increasing the number of studies examining the effects of STEM education on children more comprehensively and reflecting these findings on educational policies will contribute to designing more effective academic programs. Obtaining more scientific data on STEM education is critical to test the accuracy of existing assumptions about this approach and identify best educational practices.

Many countries, such as the United States, the United Kingdom, Singapore, and South Korea, emphasize STEM education to succeed in Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMMS) exams. When the countries' education systems ranked high in these exams are examined, it is seen that most of these countries have integrated STEM education into their curricula (Yıldırım, 2018).

When STEM-related studies in Türkiye are examined, it is seen that the 2015-2019 Strategic Plan of Ministry of National Education (MoNE) aims to strengthen STEM education (MoNE, 2015), the STEM Education Report prepared by MoNE states that STEM education should be provided to all students, and MoNE emphasizes that STEM education action plan should be developed with institutions such as universities, The Scientific and Technological Research Council of Türkiye (TUBITAK) and Turkish Industry and Business Association (TUSIAD) and in-service training should be provided to teachers by establishing STEM centers (MoNE, 2016). In addition, it was observed that the 2018 Science Curriculum included science, engineering, and entrepreneurship practices, unlike previous years (MoNE, 2018).

The vision of the science curriculum has set science literacy as the ultimate goal. In this direction, it has adopted the mission of "raising all students as science literate individuals ."In this context, it is aimed for students to be "individuals who research, question, make effective decisions, solve problems, have self-confidence, are prone to co-operation, communicate effectively, have an awareness of sustainable development and are lifelong learners ."In addition, it is aimed at students to develop knowledge, skills, positive attitudes, perceptions, and values related to science; to gain awareness about the relationship of science with technology, society, and the environment; and to acquire psychomotor skills (Science Curriculum, 2013, p. 1). In this context, science literacy is extremely important for science education.

Eraslan, Koç Şenol, Kılınç, and Böyük (2013) carried out science activities with sixth and seventh-grade students using Lego Mindstorms NXT Robotic Education Set and found that students were significantly satisfied with science education with robots. These findings show that robots are helpful for students in science education. However, research on using robots in science education literature is limited (Benitti, 2012; Koç & Büyük, 2013). Therefore, to contribute to raising science-literate individuals, this project aims to enable students to learn geology and science subjects using artificial intelligence, mobile applications, robots, and robotic sensors.

For Türkiye to succeed in international exams such as PISA and TIMSS and to increase its economic competitiveness with other countries in the 21st-century world, prioritizing STEM education is seen as a great necessity. Especially after the climate change and rising disasters in the world and Türkiye, studies integrating geology and natural sciences with STEM activities stand out as both a necessity and an exciting area for students.

As a result, the primary purpose of the current study is to evaluate how effective the project training program, which aims to use STEM applications for earthquake survivor-gifted students studying in science and art centers, is for the participants. In line with this general purpose, the following questions were sought to be answered in the research.

1. What do gifted students think about the education they received during the project education program?

2. Is there a significant difference between gifted students' mean pre-test and post-test achievement scores?

3. Is there a significant difference between the reactions of gifted students to the project before and after receiving training?

4. What do gifted students think about the knowledge, skills, attitudes, and ability to apply what they have learned and all aspects of the project program?

2. Method

The research was conducted based on the experimental model. In the study both quantitative and qualitative data collection analysis techniques were used to obtain data. It was designed to reach the results through a single-group pretest-posttest model. In this sense, the research was conducted based on a mixed method. Quantitative and qualitative data were obtained in line with the aims aimed to be achieved through mixed methods. The basic assumption of mixed method research is that using qualitative and quantitative research methods together or blended provides a better understanding of research problems and questions than the separate use of these methods (Cresswell, 2008). According to the classification made by Karasar (2009), the single-group pretest-posttest model was preferred among the three types of designs frequently encountered before the experiment. Pre- and post-test measurements determined the effectiveness of the training in a single group. In such designs, assignments are generally not made unbiasedly, and a single group is used most of the time. Therefore, their scientific value is limited (Metin, 2014).

To determine the opinions of the students in the experimental group about the approach applied, qualitative data collection techniques were used simultaneously with the mixed method used in this research process, and in-depth information was obtained according to quantitative techniques.

The participants were selected according to the criterion sampling method, one of the purposeful sampling methods. In the determination of the participants, firstly, an application form was shared for the students of the Science and Art Centres in Hatay, Kahramanmaraş, Osmaniye, Adana, who are in the 7th grade as of the 2024-2025 academic year, who are in a disadvantaged group due to the disaster, whose houses were destroyed and who were affected by the earthquake in the first degree in the selection criteria. Participants were selected based on the responses of the project participants to the application form and the requirements determined. In line with the determined criteria, 24 students, 12 girls and 12 boys, studying in Science and Art Centres, participated in the project training.

Within the scope of the research, special pre-tests were applied to the students selected to receive training before each training. After the training, post-tests, response evaluation questionnaires, and written opinions about their experiences during the project were collected to evaluate the effectiveness of the training. The data were collected before and after the workshops organized by special education, educational sciences, geology experts, and academicians on 1-4 July 2024.

The experts who provided training in the workshops developed various achievement tests to evaluate the impact of the training. The validity and reliability of these tests were ensured in line with the opinions of field experts and measurement and evaluation experts. The "Reaction Evaluation" questionnaire was previously developed by Yüreğilli Göksu, Yalçın, Gelişli, and

Taşpınar (2020) and was also used in this study after obtaining the necessary permissions. Participants' opinions about their experiences were collected throughout the study.

Qualitative questionnaires and quantitative achievement tests supported the data collection process. "The Kirkpatrick Training Programme Evaluation Model" was used to evaluate the training offered to the participants during the project. This model was developed by Prof. Donald Kirkpatrick from the University of Wisconsin in 1959 and consists of four stages. The first stage evaluates the participants' first impressions of the training. "Measuring First Reaction" measures students' feelings about the training process, instructors, content, materials used, presentation, and training environment. At this stage, the quality of the training is assessed from different perspectives. The second stage, "Measuring Learning," evaluates the cognitive learning of the participants and analyses the changes in knowledge level before and after the training. After the workshops, the changes in the knowledge levels of the participants are analyzed, and the gains targeted by the trainers are measured. At this stage, it is determined which knowledge the participants have acquired through the evaluations made before and after the training. In the third stage, "Measuring Behaviours," the extent to which the participants can apply what they have learned is analyzed. The final stage, "Conclusion," evaluates the project's impact on the relevant institution or organization. This model can be used to evaluate training programs and assess programs carried out by the private sector. This study applied the first two stages of the model to evaluate project training (Kirkpatrick, 2006).

Since the data obtained from the achievement tests applied to the participant students before and after the training met the normality assumption, the dependent samples t-test was used to examine whether there was a significant difference in the mean achievement test scores between the pre and post-training responses of the participants. The responses obtained from the questionnaires were presented using frequencies and percentages. The data obtained with qualitative data collection tools during the project training were analyzed by thematic analysis based on the participants' views.

3. Results

"The Kirkpatrick Training Programme Evaluation Model" was used to evaluate the training. In the first stage, the Reaction Evaluation Questionnaire (Yüreğilli Göksu et al., 2020) was applied to 24 participants. The results of the data analysis related to the participant reactions obtained as a result of the application of the questionnaire are presented in Table 1 as frequency (f) and percentage (%)Provide dates defining the periods of recruitment and follow-up and the primary sources of the potential subjects, where appropriate. If these dates differ by group, provide the values for each group.

Table 1. Frequencies and Percentages of the Items in the Reaction Evaluation Questionnaire

Statements	Strongly Disagree		Disagree		I agree		Strongly Agree	
	f	%	f	%	f	%	f	%
1. The trainings were of a quality to improve my knowledge and skills in my school life.					8	33,3	16	66,6
2. The training provided was related to my field of interest.					10	41,7	14	58,3
3. I will use the knowledge I have gained here in my educational life.					7	29,2	17	70,8
4. The content/subject scope of the training activities was adequate.			1	4,2	9	37,5	14	58,3
5. The training gave me different perspectives on some issues.					4	16,7	20	83,3
6. Time was used efficiently during the training.	1	4,2	2	8,3	7	29,2	14	58,3
7. The training gave me the knowledge and skills to apply new information in my lessons.					9	37,5	15	62,5
8. The duration of the training was sufficient to gain new information in the content.	2	8,3	2	8,3	10	41,7	10	41,7
9. The duration of the training was sufficient to gain new perspectives and insights into its content.	1	4,2	2	8,3	8	33,3	13	54,2
10. The trainers who participated in the training were experts in their fields.					1	4,2	23	95,8
11. The trainers considered the participants' different learning styles.			1	4,2	8	33,3	15	62,5
12. The trainers had sufficient knowledge and skills about innovative educational practices.					2	8,3	22	91,7
13. The trainers explained the topics sufficiently.					3	12,5	21	87,5
14. The trainers gave enough examples about the topics.					5	20,8	19	79,2
15. Trainers made/showed/explained sample activities related to the topics.					4	16,7	20	83,3
16. The trainers ensured our active participation in the process.			1	4,2	5	20,8	18	75
17. During the training, sufficient interaction was provided between the participants.			1	4,2	6	25	17	70,8
18. An effective communication environment was provided.			1	4,2	9	37,5	14	58,3
19. The techniques and methods used by the trainers were adequate in transferring the knowledge to the participants.					4	16,7	20	83,3

20. The auxiliary materials required for the training were sufficient.			7	29,2	17	70,8
21. Training organization was adequate.			6	25	18	75
22. The activity environments where the trainings were held were suitable.			5	20,8	19	79,2
23. The hall where the trainings were conducted was suitable for teaching.	1	4,2	6	25	17	70,8
24. The training generally met my expectations.			5	20,8	19	79,2

As seen in Table 1, the item with the highest agreement rate (95.8%) is item 10 (M10. The trainers who took part in the training were experts in their fields). The rate of "Agree" and "Strongly Agree" responses to all items is 97.2%. Fifteen items (M1: The trainings were of a quality to improve my knowledge and skills in my school life, M2: The trainings were related to my field of interest, M3: I think I will use the knowledge I gained here in my educational life, M5: The trainings gave me different perspectives on some subjects, M7: The trainings provided me with the necessary knowledge and skills to apply the new information in my lessons, M10: The trainers who took part in the trainings were experts in their fields, M12: The trainers had sufficient knowledge and skills about innovative educational practices, M13: Trainers explained the topics sufficiently, M14: Trainers gave enough examples related to the issues, M15: Trainers made/showed/explained sample activities related to the problems, M19: The techniques and methods used by the trainers were sufficient in transferring the knowledge to the participants, M20: The auxiliary materials required for the trainings were sufficient, M21: Training organisation was sufficient, M22: The activity environments where the trainings were held were good, M24: The trainings generally met my expectations. The ratio of "Agree" and "Strongly Agree" responses the participants gave is 100%. In other words, none of the participants disagreed with these items. The findings show that the participants reacted positively to the training and liked the trainer, the content, the materials used, the presentation, and the environment where the training was given.

The participants' learning was assessed to "Measure Learning" in the second stage. The experts performed the normality test for the achievement tests applied before and after the training, and the results are presented in Table 2.

Table 2. Normality Test Results of Pre-Test and Post-Test Achievement Tests

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-Test	.145	24	.200	.931	24	.103
Final Test	.147	24	.191	.966	24	.568

According to the Shapiro-Wilk test, since the significance level of the pre-test and post-test achievement tests was more significant than 0.05, it was determined that the data had a normal distribution.

Since the achievement test data applied by the experts before and after the training met the normality assumption, a dependent/paired samples t-test was applied. Skewness and kurtosis coefficients were checked to evaluate whether the total scores obtained from the achievement tests used in the training met the assumption of normal distribution. The results are presented in Table 3.

Table 3. Examination of Normality Assumption for Achievement Tests

Pre-Test		Final Test	
Skewness	Kurtosis	Skewness	Kurtosis
-.333	-.989	-.366	.347

Skewness measures the disproportionality and asymmetricity of distribution, while kurtosis measures the sharpness of the distribution (Salkind, 2011/2015). The kurtosis and skewness coefficients of a normally distributed data set are 0 (Büyüköztürk et al., 2020). However, this is usually not the practice case. As the skewness coefficients move away from 0, the distribution of the data set moves away from the ordinary and becomes skewed to the right or left (Atılgan, 2017). Therefore, the fact that the skewness coefficient is in the range [-1, +1] indicates that the data does not deviate excessively from normality (Büyüköztürk, 2019). Although this suggests that normality is ensured, it is recommended to evaluate it together with the graphical method (Tabachnick & Fidell, 2019). A negative skewness value may indicate a left-skewed distribution, while a positive skewness value may indicate a right-skewed distribution (Can, 2017). As seen in Table 3, the skewness and kurtosis coefficients are generally within the limits of -1 and +1. The results of the dependent/paired samples t-test analysis to examine whether there is a significant difference between the pre-test and post-test scores are given in Table 4.

Table 4. Dependent/Related Samples t Test Analysis Results

N	X	S	Sd	t	P
24	39,17	3,46	.706	25,085	.000

According to the results obtained in Table 4, this t-test showed that the mean score (39,17) was statistically significantly different from the test value of 21,45. The level of significance ($p = .000$) indicates that this difference is unlikely to be accidental. This suggested that the mean of the tested group was significantly higher. In addition, the 95% confidence interval (between 16.26 and 19.18) of the mean difference is given. This means there is a 95% probability that the actual mean difference lies within this range. The fact that the mean difference (17,717) fell within this range increased the reliability of the results.

In the third stage, the participants' opinions about their experiences during the project were taken in writing. Student opinions were analyzed using the thematic analysis method. Thematic analysis is a method that involves determining the main themes and sub-themes in the data and categorizing these themes. This process includes detailed coding of student opinions, determining sub-themes, elaborating themes, in-depth tabulation, and interpretation of themes. It shows that student opinions are organized around five main themes: Student Satisfaction, Quality of Education, Applied Learning, Course Materials, and Faculty Support. These themes help us understand students' educational experiences. These themes and sample student views are given in Table 5.

Table 5. Tabulation of Themes and Sample Student Views

Main Theme	Sub Theme	Examples of Student Opinion
Student Satisfaction	Overall satisfaction	"I am satisfied with the quality of education."
	Meeting expectations	"I received an education above my expectations."
Quality of Education	Theoretical knowledge	"The theoretical information was very comprehensive and in-depth."
	Practical application	"Practical applications reinforced the theoretical knowledge."
Practical Learning	Laboratory studies	"Laboratory work was handy."
	Project-based learning	"Learning with projects was very effective."
Course Materials	Books and articles	"The books and articles were sufficient and up-to-date."
	Online resources	"Access to online resources was effortless."
Faculty Member Support	Academic counselling	"Faculty members were always helpful."
	Individual attention	"Each student is given individual attention."

As seen in Table 5, student satisfaction was analyzed under the sub-themes of satisfaction with the quality of education and meeting expectations. Students stated that they were generally satisfied with the quality of education and that their expectations were met. This shows that the education program is effective in meeting student needs. A sample student opinion: "I am generally satisfied with the quality of education. The quality of education was evaluated under the sub-themes of theoretical knowledge, practical application, and training methods. Students found the balance between theoretical knowledge and practical applications favorable and appreciated the diversity and effectiveness of the training methods. These findings reveal that the training program is strong both theoretically and practically. A sample student opinion: "The theoretical information was very detailed and comprehensive." Applied learning was analyzed under the sub-themes of laboratory work and project-based learning. Students found laboratory work and project-based learning methods effective and stated that these methods played an important role in developing their practical knowledge and skills. A sample student opinion: "Laboratory work was handy and reinforced my learning." Course

materials were evaluated under the sub-themes of books and articles, online resources, and currency of materials. Students stated that course materials were sufficient and up-to-date, and online resources were easy to access, supporting their learning process. A sample student opinion: "Access to online resources was straightforward, and the materials were up-to-date." Faculty support was analyzed under the sub-themes of academic guidance, individual interest, and accessibility. Students stated that they were satisfied with the academic guidance and individual attention provided by the faculty members and that they were always accessible. These findings show that the support provided by faculty members to students is an important factor in increasing their academic success. A sample student opinion: "Faculty members always provided academic guidance."

These findings show that the project effectively meets student needs and has a solid infrastructure to increase student satisfaction. Continuous updating of education programs and expanding the support provided by faculty members to students play an essential role in improving student satisfaction and academic success.

4. Discussion

The primary purpose of this research is to increase the interest of earthquake survivor students in geology and STEM fields, to enable participants to develop their knowledge and skills in these fields, promote scientific knowledge-based thinking in society, and encourage future scientists. The aim is to evaluate the effectiveness of the student education project program. For this purpose, 24 students studying at Science and Art Centres in Hatay, Kahramanmaraş, Osmaniye, and Adana, selected from across Türkiye and most affected by the earthquake, were trained for five days. Within the scope of the research, pre-tests and post-tests were applied to the students selected for training. In addition, data were collected and analyzed through a response evaluation questionnaire and an interview form regarding the efficiency of all elements of the project and the trainers.

According to the results of the analyses, it was revealed that the participants' reactions to the training process were positive and that they liked the trainers, topics, materials, presentations, and the training environment in the project training process. When the training given by all trainers is evaluated, it can be stated that the training benefited the participants and provided positive changes in measuring the participants' learning. In addition, it was concluded that the training extensively and positively affected the acquisition of knowledge, skills, and attitudes. According to the participants' statements, the gains from the training have provided them with skills that can be transformed into practice in their life-oriented experiences and show that the feasibility level is high.

In this study, considering that the training was carried out to develop activities for the participants and the workshops, the student's belief that they can implement these practices in their fields is high. In the literature, various studies have reached similar conclusions that the

results of such training projects are beneficial to the participants (Dağlıoğlu, 2020; Yüreğilli Göksu et al., 2020).

5. Conclusions

The study results show that stakeholders may continue such training and projects to extend the training presented within the scope of this research to a broader audience and update them in line with the developments in STEM education approaches. In the literature, it is emphasized that training and on-site training opportunities should be developed to increase the qualifications of both students and teachers (Dağlıoğlu, 2020; Yüreğilli Göksu et al., 2020). The education of gifted students and the effectiveness of general education and training activities are directly related to the quality of educators (Karaçalı, 2004). Therefore, it may be recommended that teacher training must be provided in combination with student training. In addition, reaching a broader range of participants may be possible by providing the necessary technological infrastructure for distance education to prevent economic and temporal constraints at national and international levels.

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Declaration of Conflicting Interests and Ethics

“The authors declare no conflict of interest.”

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