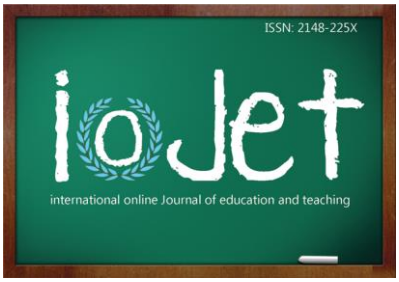

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AN EFFECTIVENESS EVALUATION OF A TUBITAK PROJECT PROGRAMME ABOUT AEROSPACE TECHNOLOGIES TRAINING FOR SCIENCE AND ART CENTRE TEACHERS

Research article

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Abstract

The main purpose of this study is to evaluate the effectiveness of the training of trainers project programme funded by The Scientific and Technological Research Institution of Türkiye (TUBITAK), which aims to provide teachers who teach gifted students with innovative approaches involving aviation and space technologies and these approaches through applied activities. For this purpose, 35 teachers working in Science and Art Centres (BİLSEM) selected from across Turkey were trained for six days. Within the scope of the research, pre-tests and post-tests were administered to the teachers selected for the training. In addition, data were collected and analysed through a response evaluation questionnaire. The research was conducted mainly on the basis of an experimental model and quantitative data collection and analysis techniques were used in the data collection process. According to the results of the analyses, it was revealed that the participants' reactions to the training process were positive and that the participants liked the trainers, topics, materials, presentations and the training environment in the project training process. When the trainings given by all trainers are evaluated, it can be stated that the trainings were beneficial for the participants and provided positive changes in the context of measuring the learning of the participants. In addition, it was concluded that the trainings had a great and positive effect on the acquisition of knowledge, skills and attitudes. According to the answers given by the participants, the gains they have obtained as a result of the trainings they have received have provided them with skills that can be transformed into practice in their teaching life and show that the level of feasibility is high.

Keywords: aerospace, innovative approaches, project, TUBITAK, BİLSEM, training of trainers, education of gifted students

1. Introduction

Aerospace technologies are considered as critical elements that increase the economic, scientific and defense capacity of modern societies. These technologies have significant impacts not only in military and industrial fields but also in the field of education. These effects in education are of great importance especially in terms of teacher education. Equipping teachers with knowledge and skills in aerospace technologies is necessary to increase students' awareness and interest in this field.

Aerospace technologies play critical roles in a wide range of areas, from national security to civil innovation. The development of these technologies enables the acceleration of

scientific research and the emergence of new industries. For example, strategic documents such as the Space Roadmap 2050 state that space technologies will revolutionise sectors such as energy, health and transport in the coming decades (National Aeronautics and Space Administration [NASA], 2020).

The developments in the field of aerospace and space technologies, which started in the 20th century and progressed dazzlingly in the first quarter of the 21st century, are reflected in the space mission documents of NASA and space agencies of other countries, as well as in the TUA 2022-2030 National Space Programme Strategy Document. It cannot be expected that primary and secondary school students, especially gifted students, will remain as spectators to the developments in the world. In this context, in order to ensure that interested individuals are trained in this field, it is expected that teachers should improve themselves and receive training in this field.

Teachers' knowledge of relevant technologies plays a key role in increasing students' interest in this field. The inclusion of modules related to aerospace technologies in teacher education programmes can inspire students to explore the possibilities of pursuing a career in these fields. The integration of such technologies in education is recognised as a critical element to improve the quality of STEM (Science, Technology, Engineering and Mathematics) education.

Aerospace technologies have significant implications not only for scientific discoveries and economic developments, but also for global education systems. The integration of these technologies into the field of education provides students with in-depth knowledge and skills in science, technology, engineering and mathematics (STEM) subjects, as well as improving students' critical thinking and problem-solving abilities. Therefore, aerospace technologies are at the centre of educational innovation and curriculum development efforts worldwide.

Integrating aerospace technologies into education provides students with the opportunity to learn and explore the frontiers of science. These technologies are used in teaching subjects such as space exploration and aeronautical engineering, thus increasing students' interest and curiosity in these fields. NASA's education programmes and organisations such as the European Space Agency (ESA) aim to develop students' scientific thinking skills by developing specific educational materials and projects for teachers and students (European Space Agency [ESA], 2021). Integrating space technologies into education not only provides students with scientific thinking and problem-solving skills, but also encourages them to pursue careers in science and technology" (ESA, 2021).

The integration of aerospace technologies into education not only improves the quality of STEM education, but also contributes to the digital transformation of global education systems. These technologies support the development of distance education and digital learning platforms, ensuring equal opportunities in education. For example, satellite-based internet technologies provide access to quality educational materials even for students in rural and remote areas. Education programmes for aerospace technologies increase the likelihood of students pursuing careers in these fields. A study conducted by NASA shows that students who participate in projects related to space technologies have significantly increased their interest in science and engineering fields (NASA, 2020). This will contribute to an increase in qualified labour force in these fields in the long term.

In Turkey, science and art centres (BİLSEM) institutions, which provide education to gifted students, have students making inventions in the fields of aerospace technology among other fields (Yüreğilli Göksu, 2021). In the global context, it also reveals the importance of the support they will receive from teachers in the inventions and designs of students, who are

the most valuable resources of the future, and in the success they can achieve in TÜBİTAK and other project competitions. In this context, in this study, the programme evaluations of the project titled *"Innovative Aerospace Technologies Education and Applications for BİLSEM Teachers"*, which is themed on aerospace technologies and entitled to receive a grant by TÜBİTAK, have been carried out. The main purpose of the project is to provide the participants with theoretical and practical knowledge and skills in the field of aerospace technologies, and to enable them to transfer their gains to their students using innovative teaching environments, original methods and materials. In addition to theoretical and practical skills in aviation, it is aimed to develop engineering and design skills of the participants. As a result of the current research, in line with the findings obtained from the results, literature-based recommendations were made on behalf of the country and world education.

2. Method

Research Model

The research was conducted mainly on the basis of an experimental model and quantitative data collection and analysis techniques were used in the data collection process. In order to reach the results, it was planned to use a single group pretest-posttest design. According to Karasar's (2009) classification, single group pre-test-post-test model was selected among the three types of designs commonly encountered before the experiment. The effectiveness of the training was determined by pre- and post-test measurements on a single group. In such designs, groups are generally not randomly assigned and mostly a single group is used; therefore, their scientific validity is limited (Metin, 2014).

Working Group

The participants of the study were selected by criterion sampling method, which is one of the purposeful sampling methods. In the process of determining the participants, an online application form was shared in the branch communication groups established by the Ministry of National Education across Turkey. Project participants were selected according to the answers they gave in the application forms and the criteria determined. In line with these criteria, a total of 35 BİLSEM teachers participated in the project trainings.

Data Collection Process and Analysis

Within the scope of the research, special pre-tests were applied to the selected teachers before each training, followed by post-tests and a response evaluation questionnaire to evaluate the effectiveness of the training. Data were collected from participating teachers before and after the workshops conducted by academics between 24-29 June 2024.

The field experts who provided training in the workshops prepared different achievement tests to evaluate the effectiveness of the training, and the validity and reliability of these measurement tools were ensured in line with the opinions of measurement and evaluation experts and field experts. The "Reaction Evaluation" questionnaire was previously developed by Yüreğilli Göksu, Yalçın, Gelişli, and Taşpınar (2020) and used in this study after obtaining the necessary permissions.

During the research process, six days of trainings were given with workshops focusing on how to make applications for gifted students in line with innovative approaches and aerospace technologies. In the data collection process, achievement tests prepared by the trainers were used as quantitative data collection tools.

"Kirkpatrick Training Programme Evaluation Model" was used to evaluate the trainings given to the participants during the project process. This model, developed in 1959 by Prof. Dr. Donald Kirkpatrick, a faculty member at the University of Wisconsin and former president of the American Society for Training and Development (ASTD), consists of four stages. In the first stage, the participants' initial reactions to the training are measured. In the "Measuring Initial Reaction" stage, information is collected on how teachers evaluate the training, the trainer, the content, the materials used, the presentation and the training environment. At this stage, the quality of the training in different aspects is tried to be determined.

In the second stage, "Measuring Learning", the cognitive learning of the participants is assessed. At this stage, the changes in the knowledge levels of the participant teachers before and after the training are analysed. The differences between the knowledge gained before the training and the knowledge gained after the training are analysed and the extent to which the gains targeted by the trainers are realised is determined. These evaluations are carried out through measurements made before and after the training.

In the third stage of the model, "Measuring Behaviours", the extent to which the participants put into practice what they have learned is analysed. In the final stage, "Conclusion", the effects of the training on the relevant institution or organisation are evaluated. This model is used not only in the evaluation of training programmes but also in the evaluation of programmes of private companies. In this research, only the first two stages of the model were applied in the analysis of project trainings (Kirkpatrick, 2006).

Analysing the Data

Since the data obtained from the achievement tests applied to the participant students before and after the training met the normality assumption, the significant difference between the mean scores of the participants before and after the training was analysed by dependent samples t-test. The responses obtained from the questionnaires were reported using frequencies and percentages.

3. Findings

"Kirkpatrick Training Programme Evaluation Model" was used for the evaluation of the trainings. In the first stage, Reaction Evaluation Questionnaire (Yüreğilli Göksu et al., 2020) was applied to 35 participants. The results of the analysis of the data obtained about the reactions of the participants as a result of the application are presented in Table 1 as frequency (f) and percentage (%).

Table 1. *Frequency and Percentages of the Items in the Response Evaluation Questionnaire*

Statements	Strongly Disagree		Disagree		I agree		Strongly Agree	
	f	%	f	%	f	%	f	%
1. The trainings were of a quality to improve my professional knowledge and skills.	1	2,9			7	20	27	77,1
2.The trainings provided were related to my field.					10	28,6	25	71,4
3.I think that I will use the knowledge I have gained here in my professional life.					7	20	28	80
4. The content/subject scope of the training activities was adequate.					13	37,1	22	62,9
5.The trainings gave me different perspectives on some issues.			1	2,9	8	22,9	26	74.3
6. Time was used efficiently during the trainings.					8	22,9	27	77,1
7. The trainings provided me with the knowledge and skills to apply new information in my lessons.					9	25,7	26	74,3
8. The duration of the trainings was sufficient to gain new knowledge in its content.	2	5,7	5	14,3	9	25,7	19	54,3
9.The duration of the trainings was sufficient to gain new perspectives and insights in their content.	2	5,7	3	8,6	9	25,7	21	60
10. The trainers who took part in the trainings were experts in their fields.			1	2,9	7	20	27	77,1
11.The trainers took into account the different learning styles of the participants.			3	8,6	11	31,4	21	60
12.The trainers had sufficient knowledge and skills about innovative educational practices.			2	5,7	8	22,9	25	71,4
13.The trainers explained the topics			1	2,9	12	34,3	22	62,9

sufficiently.								
14.The trainers gave enough examples about the topics.	1	2,9	1	2,9	15	42,9	18	51,4
15. Trainers made/showed/explained sample activities related to the topics.			1	2,9	12	34,3	22	62,9
16.The trainers ensured our active participation in the process.	1	2,9	1	2,9	12	34,3	21	60
17. During the trainings, sufficient interaction between the participants was ensured.			2	5,7	10	28,6	23	65,7
18. An effective communication environment was provided.			1	2,9	10	28,6	24	68,6
19.The techniques and methods used by the trainers were adequate in transferring the knowledge to the participants.			2	5,7	9	25,7	24	68,6
20.The auxiliary materials required for the trainings were sufficient.	1	2,9	4	11,4	13	37,1	17	48,6
21.Training organisation was adequate.	1	2,9	1	2,9	9	25,7	24	68,6
22. The activity environments where the trainings were held were good.			1	2,9	12	34,3	22	62,9
23. The hall where the trainings were conducted was suitable for teaching.			2	5,7	11	31,4	22	62,9
24.The trainings generally met my expectations.			1	2,9	6	17,1	28	80

As seen in Table 1, the items that the participants agreed with the most (80%) were items 3 and 24 (M3: I think that I will use the knowledge I gained here in my professional life, M24: The trainings generally met my expectations). The rate of "Agree" and "Strongly Agree" responses to all items is 95%. The rate of "Agree" and "Strongly Agree" responses to five items (M2: The trainings were related to my field, M3: I think that I will use the knowledge I gained here in my professional life, M4: The content/subject scope of the training activities was sufficient, M6: Time was used efficiently during the trainings, M7: The trainings provided me with the knowledge and skills necessary to apply new information in my lessons) is 100%. In other words, none of the participants disagreed with these items. The

findings can be interpreted that the participants' reaction to the training was positive and that the participants liked the trainer, the content, the materials used, the presentation and the environment in which the training was given.

In the second stage, what the participants learnt was measured in order to "Measure Learning". Normality test was performed for the achievement test data applied by the experts before and after the training. The results are presented in Table 2.

Table 2. *Pre-Test Post-Test Achievement Test Normality Test Results*

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Pre-Test	,144	35	,064	,953	35	,143
Final Test	,142	35	,073	,965	35	,311

According to the Shapiro-Wilk test, since the significance level of the pre-test and post-test achievement tests was greater than 0.05, it was shown to have a normal distribution.

Since the achievement test data applied by the experts before and after the training met the normality assumption, dependent/paired samples t test was performed. The skewness and kurtosis coefficients of the total scores obtained on the achievement test developed by the experts and used in all trainings were checked for the normal distribution assumption. The results are presented in Table 3.

Table 3. *Investigation of Normality Assumption for Achievement Tests*

Pre-Test		**Final Test**	
Skewness	**Kurtosis**	**Skewness**	**Kurtosis**
-0,420	0,398	-0,155	0,778

As seen in Table 3, skewness and kurtosis coefficients are generally within the limits of -1 and +1. The results of the dependent/paired samples t-test analyses conducted to examine whether there was 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
35	607,43	78,303	34	14,463	,000

According to the results obtained in Table 4, this t-test showed that the mean score (607,43) was statistically significantly different from the test value of 416. The level of significance (p = 0.000) indicates that this difference is very unlikely to be accidental. This indicated that the tested group mean was significantly higher. In addition, the 95% confidence interval (between 164.53 and 218.33) of the mean difference was given. This means that there is a 95% probability that the true mean difference lies within this range. The fact that the mean difference (191,429) fell within this range increased the reliability of the results.

4. Conclusions and Recommendations

The main objective of the project, the programme evaluation of which was carried out, is to meet the interest, curiosity, knowledge and educational needs of the final target group of gifted students by providing the teachers of science and art centres with theoretical and practical knowledge and experience in the fields of aerospace technologies, rocket science, parachuting, sportive aviation, astronomy and space sciences. In this context, the proposed project aims to increase the knowledge and skills of teachers in the field of aerospace sciences and to increase their experience through experimental and practical studies such as workshops, laboratories, design and production.

When the trainings given in the related project and the reaction evaluations of the participants were analysed, it was revealed that the participants' reactions to the training were positive and that the participants liked the trainer, the content, the materials used, the presentation and the environment in which the training was given. In addition, when the scores of the participants before and after the project trainings were analysed, it was seen that there was a significant difference between the pre-test scores and the post-test scores. In this context, it was revealed that the project trainings followed a positive direction in terms of the development of the participants.

A review of the literature shows that there are similar results indicating that teacher trainings have positive results. In a similar study evaluating the impact of trainings on participants, Yüreğilli Göksu and Yalçın (2023) found that the majority of participants stated that the trainings improved their professional knowledge and skills. This study showed that the training contents were evaluated positively by the participants and were applicable in professional life. The overall satisfaction rate for the trainings was found to be over 90%.

These findings are consistent with the literature supporting the effectiveness of the Kirkpatrick model in training evaluation and show the positive effects of the training on the participants. In all three studies, the contributions of the trainings on professional development, increase in achievement level and cognitive learning were emphasised.

There are other studies in the literature that give similar results on these issues. As a result, it is recommended that stakeholders should continue such trainings and projects in order to disseminate the trainings presented within the scope of the research and to update them in accordance with technological developments and the needs of the age. In the studies

conducted on this issue in the literature, it is recommended to develop in-service trainings and opportunities for on-site training services in order to increase teacher qualifications (Dağlıoğlu, 2020; Yüreğilli Göksu et al., 2020). The effectiveness and quality of gifted students and all kinds of education and training are directly related to the quality of the teacher (Karaçalı, 2004).

Regarding the trainings provided within the scope of the study, it was found that the trainings were effective Although it is considered, the study also has limitations. For example, in the study the lack of a control group can be accepted as a limitation. Besides this teachers only for the purpose of generating data for this study. as a control group, due to both economic and ethical problems could not be realised. In addition to these limitations, the participant teachers' Project to apply the knowledge they have learnt after their training in their own institutions whether it transfers or not, could not be realised observationally. In Kirkpatrick programme the part of measuring the behaviours in the third stage of the assessment model, for this reason, it could not be realised through direct observation. In addition, in different studies, the Kirkpatrick programme evaluation model has also been used. It was observed that the third and fourth stages were not used (Kaya, Günay and Damgacı, 2015). Kirkpatrick, in his book, which he has presented with examples in his book stages were not used for all programmes (Kirkpatrick, 2006).

As a result, the impact of aerospace technologies on education can indirectly increase students' interest in these fields through teacher education. Therefore, teacher education programmes need to be restructured to increase awareness of these technologies. In addition, providing trainings on the importance of these technologies in the continuous professional development of teachers will improve the quality of education in the long run.

Even if other conditions related to education and training are prepared as well as possible, if the teacher does not have the expected competences, the expected outputs for education and training cannot be achieved (Demirel & Kaya, 2006; Yaşar et al., 2005).

The integration of aerospace technologies into education offers significant advantages such as increasing equality of opportunity in education and encouraging students to pursue careers in STEM fields, as well as providing students with scientific thinking skills. For this reason, education systems around the world are taking important steps towards educating the scientists and engineers of the future by including these technologies in their curricula. In this context, the development of similar projects and training programmes can provide great progress in terms of education in the country and worldwide.

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6. Conflict of interest

The author declares that there is no conflict of interest.

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