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THE IMPACT OF THE FLIPPED CLASSROOM MODEL (FCM) IN IN-SERVICE TRAINING ON TEACHERS' SELF-EFFICACY IN PROJECT COMPETITIONS MENTORING

(Research article)

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Abstract

Trainings are indispensable for teachers to meet the requirements of changing educational technologies, pedagogical approaches, and curricula. In-service training is a crucial step towards enhancing the professional development of teachers and improving the quality of education. This study aims to reveal the impact of the Flipped Classroom Model (FCM) in in-service training on teachers' self-efficacy levels in project mentoring. The study group consists of Biology and Science teachers who voluntarily participated in project mentoring training during the 2021-2022 academic year. Three groups were formed among the participating teachers: FCM group, face-to-face training group, and distance education group. The face-to-face training was designed according to the project-based learning approach. In the research, a quasi-experimental design from quantitative methods and a case study from qualitative methods were used together. Data were collected using the "Project Competitions Mentoring Self-Efficacy Scale" before and after the application. In the analysis of the data, descriptive statistics, the Kruskal-Wallis test, the Wilcoxon Signed Ranks test, and the Tamhane's post-hoc analysis for pairwise comparisons were used. The results indicated that the self-efficacy levels of the groups receiving project mentoring training through FCM, face-to-face, and distance education were significantly higher after the application compared to before the application. However, no statistically significant difference was found between the groups. The post-test scores in the responsibility sub-dimension were significantly higher in the face-to-face training group. In conclusion, it can be said that the FCM has similar effects on teachers' overall self-efficacy perception compared to other methods, and that face-to-face education increases teachers' sense of responsibility in project competitions mentoring.

Keywords: Flipped classroom model, Biology and Science teachers, in-service training, self-efficacy, project mentoring.

1. Introduction

In-service training provides significant opportunities for teachers to develop their professional skills and acquire up-to-date knowledge and techniques. Through in-service training, teachers can update their knowledge and skills to better meet students' diverse needs and assist them in learning more effectively (Aslan, 2011; Avalos, 2011; Doğan, 2013; Üstüner, Ersoy, & Sancar, 2000; Reese, 2010). This process is essential for enhancing teachers' qualifications and enabling them to fully utilize their potential (Harris, 1989; Seferoğlu, 2004; Sylvester, 1997).

In-service training can be conducted face-to-face or online in the form of courses and seminars For example, in Turkey, before 2014, only 2% of in-service training activities were conducted through distance education, while this rate increased to 85% by 2018. During the pandemic, the Teacher Informatics Network (ÖBA), established in 2020, carried out in-service training programs entirely through distance education (MEB, 2019; 2020).

There are various studies with both positive and negative views on distance in-service training (Amadi, 2013; Erdinç, 2023; Kelsey & Mincemoyer, 2001; Moonen, 2001; Okçu, Karakoç, & Okçu, 2023; Parlak, Sakarya, & Durukan Tok, 2023; Sarı & Nayır, 2020). Teachers mention advantages such as time and place flexibility, the presence of subject matter experts, cost-effectiveness, and various educational options in distance in-service training. However, they also point out limitations such as lack of interaction on the platform, monotonous presentations, and the limited scope of branch-specific training (Erdinç, 2023). It is found that while distance education is ideal for information transfer via presentations, it is limited for skill and practice-based training (Okçu et al., 2023).

Face-to-face in-service training is known to be costly, requiring significant time and effort for teachers to attend centrally organized in-service training. As an innovative approach, blended/hybrid education structures have emerged as a solution. During the pandemic period, it has been demonstrated that models such as distance and blended learning are effective alternatives in situations where traditional education methods are forcibly interrupted (Okçu et al., 2023; Sarı and Nayır, 2020; Watson, 2008).

Blended learning is defined as the combined use of multiple educational methods to enhance teaching quality (Rossett, 2002). Blended learning supports the learning process by providing customized, flexible, and interactive education, catering to different learning styles and needs, thereby enabling students to learn more effectively (Bonk & Graham, 2012; Garrison & Vaughan, 2008).

The Flipped Classroom Model (FCM) is one of the models that best blends the advantages of face-to-face instruction with technology-enhanced enriched online learning environments (Hayırsever & Orhan, 2018). In FCM, students watch lessons outside the classroom and find more interaction and hands-on learning opportunities in class (Bergmann & Sams, 2012). In other words, what is traditionally done in the classroom is done at home, and what is done at home is done in the classroom (Lage, Platt, & Treglia, 2000). Since FCM offers student-centered and actively engaging activities, it enables more effective teaching compared to traditional methods (Talbert, 2012). This model aims to support learning and transform the teaching process by adopting a student-centered approach.

Research involving the scientific investigation of a topic or problem, the evaluation of findings, and the presentation of these findings in a report is defined as a project (Çubukçu, 2014, p. 528). A project approach can encompass many methods and strategies. Many countries organize scientific activities such as regional, national, or international science fairs, research projects, and competitions to promote scientific culture (TÜBİTAK, 2013; 2024). Large-scale events include the Intel ISEF, ISEF Science and Engineering Fair, Google Science Fair, Young Scientist and Technology Research Competition, Microsoft Innovation Summit, Regeneron Science Competition, Young Reporters For The Environment, and the Stockholm Junior Water Prize (MEB, 2019; Odtügvo, 2024; TÜBİTAK, 2021).

During interschool student project competitions, teachers are expected to mentor and coach students in areas where they may face challenges and require assistance (Klein et al., 2009; Kurtuluş, 2019). Teachers guide students in every phase of project work, including report writing and data analysis (Çepni, 2018). However, the literature review reveals that teachers lack competencies in project development and require training in project-based learning (Artvinli, Çetintaş, & Terzi, 2020; Aydın & Çepni, 2011; Deveci & Daşçı, 2020; Guo & Yang, 2012; Han, Yalvac, Capraro, & Capraro, 2015; Kaplan & Coşkun, 2012; Kurtuluş, 2019; Özel & Akyol, 2016; Mirici & Uzel, 2019; Timur & Çetin, 2017).

Collaborative research projects with students and colleagues contribute to teachers' continuous learning process and support the acquisition of new knowledge and skills (Çetintaş, 2019; Mbowane, de Villiers, & Braun, 2017). Consequently, receiving up-to-date training in relevant subjects to better guide students is believed to enhance teachers' project competition mentoring self-efficacy. Self-efficacy perception, simply put, is the belief in one's ability to complete the tasks required to achieve a particular performance level. According to social cognitive theory, self-efficacy perception is an influential factor in individuals' motivation (Zimmerman, 2000). Therefore, in-service training enables teachers to develop personally, improving their self-esteem and confidence (McLeod & Cropley, 1989; Levent, 2014, p. 94).

1.1. Research Objective

The objective of this research is to examine the impact of the FCM in in-service training on the project mentoring self-efficacy of Biology and Science teachers.

1.2. Problem Statement

This research is built on the problem statement: "What is the impact of the Flipped Classroom Model in in-service training on the project mentoring self-efficacy of Biology and Science teachers?"

1.3. Related Researches

Examining the studies on in-service training reveals topics such as professional competencies, in-service training needs, and the advantages and disadvantages of distance education in in-service training (Amadi, 2013; Balaman & Tiryaki, 2021; Çetin Talan & Demir, 2024; Erdinç, 2023; Kelsey & Mincemoyer, 2001; Moonen, 2001; Okçu et al., 2023; Parlak, Sakarya, & Durukan Tok, 2023; Sarı & Nayır, 2020; Tekin, 2020; Timur & Çetin, 2017). It has been reported that distance in-service training is weak in skill teaching and fails to meet needs due to its lack of practical application (Köktaş and Ağalday, 2023). Balaman and Tiryaki (2021) stated that teachers do not find distance education as effective as face-to-face education. They pointed out that it can be blended with face-to-face education, thereby making it possible to benefit from the advantages of both distance and face-to-face education.

The FCM is applied across various disciplines. Different dimensions such as academic achievement (Erkan, 2023; Moravec et al., 2010; Özaras Öz, 2019; Yavuz and Karaman, 2021), attitude, motivation (Dixon and Wendt, 2021; Urfa, 2017), class participation (Ağırman, 2023; Gilboy, Heinerichs & Pazzaglia, 2015), computational thinking skills (Yaman and Çakır, 2018), retention, self-confidence, self-regulation skills (Sırakaya, 2015), self-efficacy (Talan and Gülseçen, 2018), and teacher and student opinions (Akbulut, 2019; Akçor, 2018; Akı, 2021; Erbil and Kocabaş, 2019; Pearson, 2012) are examined in these scientific studies. Research indicates that flipping the classroom supports the development of 21st-century skills such as critical thinking, creativity, metacognition, problem-solving, collaboration, motivation, self-efficacy, conscientiousness, courage, and perseverance (Mitsiou, 2019).

The literature review revealed that the FCM is used in educational programs and specific field education (Han, Røkenes, and Krumsvik, 2024; Yohannes and Chen, 2024). However, limited data was found regarding its use in in-service training for teachers (El-Din and Attia, 2016; El Samaty, 2024; Razak, Kaur, Halili, and Ramlan, 2016; Schmid, Borokhovski, Bernard, Pickup, and Abrami, 2023; Shyu and Jiang, 2016). With the advancement of technology, Razak et al. (2016) emphasized that teachers need to align with educational reform developments internationally. El-Din and Attia (2016) highlighted the lack of professional training for teachers in Egypt. El Samaty (2024), by examining the perspectives of pre-service and in-service teachers on FCM in the United Arab Emirates, compared the FCM with traditional teaching methods, addressing perceptions of the model, its benefits, class materials, class activities, and encountered challenges. Shyu and Jiang (2016) found that while the implementation of FCM in in-service training did not affect test scores, it did result in high learning motivation.

Studies examining the impact of the FCM on self-efficacy have also been reviewed. Namazyandost and Çakmak (2020) found that female learners showed more improvement in self-efficacy than their male counterparts when using the FCM. Talan and Gülseçen (2018) concluded that there was no significant difference in students' self-regulation skills and computer self-efficacy perceptions between the flipped classroom model, blended learning, and traditional methods. Doo and Bonk (2020) found that the use of the FCM indirectly affected students' learning engagement through self-efficacy. Latorre-Cosculluela et al. (2022) emphasized that the FCM can enhance university students' sense of self-efficacy and significantly contribute to the creation of interactive learning environments. González-Gómez, Jeong, and Cañada-Cañada (2022) indicated that the methodology followed in the classroom significantly increased positive attitudes towards science and scientific content, leading to teacher candidates being more willing to enjoy science. They observed significant differences in students' self-efficacy after completing the course. Han, Røkenes, and Krumsvik (2024) investigated teacher candidates' perceptions of the FCM. Participants reported that they used class time more effectively, attended classes more prepared, and improved their learning performance. Additionally, they noted that more time was dedicated to in-depth learning. However, challenges included the lack of opportunity to ask questions during video lessons, insufficient information about students' preparation levels, and an increased workload. Yohannes and Chen (2024) revealed that flipped mathematics education significantly increased students' mathematical self-efficacy. Interviews showed that students perceived the FCM as an effective learning strategy that provides personalized learning based on collaboration and interaction and encourages problem-solving skills. When reviewing the relevant literature, studies on self-efficacy and the FCM highlighted positive attitudes due to the satisfaction derived from meeting fundamental cognitive needs such as competence, autonomy, and social interaction (Ha, O'Reilly, Ng, and Zhang, 2019).

Limited data were found on the use of the FCM in in-service training for teachers worldwide and in Turkey. Studies mostly focused on secondary school students, with fewer studies involving teachers and parents (Solak & Çoştu, 2023). Thus, it is believed that the results of this study on the implementation of the FCM in in-service training for teachers will contribute to the literature.

2. Method

2.1. Research Design

This research was designed according to a quasi-experimental design with pre-test and post-test control groups. In this design, participants are randomly assigned to groups. A pre-test is applied at the beginning of the process. The experimental procedure is implemented, and post-test data are collected using data collection tools at the end of the process (Büyüköztürk, 2016).

2.2. Study group

The study group of the research consists of Biology and Science teachers who voluntarily participated in project consultancy training during the 2021-2022 academic year. For sample selection in the study, criterion sampling, one of the purposive non-probability sampling methods, was employed. Criterion sampling involves an in-depth study of cases that meet a predefined set of criteria. The criteria used can be developed by the researcher or based on a pre-existing list (Marshall & Rossman, 2014). The criteria forming the basis of the relevant sampling technique for this research were that the teachers had the necessary infrastructure and technological equipment required for the study, had not previously received project consultancy training, and were mandated to continue the training. This was to ensure that the necessary conditions for the successful implementation of the flipped classroom model were met.

The experimental phase of the research involved 44 teacher participants: 12 in the Flipped Classroom Model group, 8 in the face-to-face education group, and 24 in the distance education model group. Due to pandemic conditions, the number of participants in face-to-face and FCM groups was limited since these involved in-class applications. This arrangement aimed to ensure the research proceeded safely and healthily. The demographic information of the participant teachers in different groups is presented below:

Table 1. *Group Distribution of Teachers*

Groups	**n**	**%**
Distance Education	24	54.5
Flipped Classroom Model	12	27.3
Face-to-Face Education	8	18.2

The distribution of teachers by groups is as follows: 54.5% (n=24) in the distance education group, 27.3% (n=12) in the FCM group, and 18.2% (n=8) in the face-to-face education group (Table 1).

Table 2. *Gender, Education Levels, and Project Experience Distribution of Teachers*

Data	**Type**	**n**	**%**
Gender	Male	4	9.1
	Female	40	90.9
Education Level	Doctorate	6	13.6
	Master's	19	43.2
	Bachelor's	19	43.2
Project Experience	Yes	28	63.6
	No	16	36.4

Teachers included in the study comprised 9.1% (n=4) male and 90.9% (n=40) female participants (Table 2). Among the teachers, 13.6% (n=6) hold a doctoral degree, 43.2% (n=19) have a master's degree, and another 43.2% (n=19) have a bachelor's degree (Table 2). It was reported that 63.6% (n=28) of the teachers had previous project experience, while 36.4% (n=16) did not (Table 2).

Table 3. *Distribution of School Types Where Teachers Work*

School Type	n	%
Not Working	4	9.1
Middle School	9	20.5
Priva heyte Middle School	6	13.6
Anatolian High School	5	11.4
Science High School	2	4.5
Private High School	13	29.5
Vocational High School	1	0.2
University	1	0.2
Others	3	0.7
Total	44	100

9.1% (n=4) of the teachers do not work. Among the working teachers, 20.5% (n=9) work in middle schools, 13.6% (n=6) in private middle schools, 11.4% (n=5) in Anatolian high schools, 4.5% (n=2) in Science high schools, 29.5% (n=13) in private high schools, 0.2% (n=1) in vocational high schools, 0.2% (n=1) at universities, and 0.7% (n=3) in other institutions (such as non-school learning environments, government institutions, and tutoring centers) (Table 3).

2.3. Data Collection Tool

A scale developed by Tortop (2014) was used to determine teachers' self-efficacy levels in project competitions mentoring. The scale consists of 16 items and is four-dimensional, with a 5-point Likert scale. These dimensions are: mentoring and guidance competency (items 1, 2, 3, 4, 5), academic competency (items 6, 7, 8, 9, 10), persuasive ability to participate in competitions (items 11, 12, 13), and responsibility dimension (items 14, 15, 16). The reliability coefficient (Cronbach Alpha) for item statistical analysis results is 0.86 for the first dimension, 0.78 for the second dimension, 0.77 for the third dimension, and 0.77 for the fourth dimension, with an overall reliability of 0.88. These findings indicate high reliability and internal consistency of the scale.

2.4. Data Analysis

In data analysis, percentage, frequency, and mean statistics were utilized. Descriptive statistics of the identified variables included minimum, maximum, mean, and standard deviation values. The representation of variables such as gender, educational level, groups of teachers involved in the study, and schools where they worked included both count and percentage values.

For comparing educational groups based on scores obtained from pre- and post-project competition mentoring self-efficacy scales and their sub-dimensions, the Kruskal-Wallis test was employed. In cases where significant differences were found among groups, pairwise comparisons were conducted using the Tamhane method. The Wilcoxon Signed-Rank test was used to compare scale scores obtained before and after the intervention for each group.

IBM SPSS Statistics 27.0 and Microsoft Excel Office 365 were used for statistical analysis and calculations. A statistical significance level of $p < 0.05$ was considered.

3. Results

3.1. Descriptive Statistics

The Wilcoxon Signed Ranks test results for the project competition mentoring self-efficacy scale and its subscale data for teachers in the FCM group are presented in Table 4.

Table 4. *Descriptive Statistics Regarding the Project Competitions Mentoring Self-Efficacy Scale of Teachers in the FCM Group and the Sub-Factors of the Scale*

Sub factors	**Pre-Test Min**	**Pre-Test Max**	**Pre-Test Mean (X̄)**	**Pre-Test Std. Dev. (Sx)**	**Post-Test Min**	**Post-Test Max**	**Post-Test Mean (X̄)**	**Post-Test Std. Dev. (Sx)**
Mentoring and Guidance Competency	14	25	19.92	3.37	19	25	22.00	2.04
Academic Competency	10	20	15.67	3.31	17	25	20.92	2.68
Persuasive Ability to Participate in Competitions	9	15	12.25	1.91	11	15	13.08	1.56
Responsibility Dimension	7	15	11.00	2.45	7	13	11.17	1.85

Examining the results, the lowest pre-test score for the self-efficacy scale in the FCM group was 7 in the responsibility sub-dimension, while the highest pre-test score was 25 in the mentoring and guidance competency sub-dimension. Similarly, in the post-test self-efficacy scale, the lowest score was 7 in the responsibility sub-dimension, while the highest scores were 25 in the mentoring and guidance competency and academic competency sub-dimensions.

The mean pre-test scores of the sub-dimensions of the self-efficacy scale for the FCM group teachers were 19.92±3.37 for mentoring and guidance competency, 15.67±3.31 for academic competency, 12.25±1.91 for persuasive ability to participate in competitions, and 11.00±2.45 for the responsibility dimension. The mean post-test scores of the sub-dimensions of the self-efficacy scale for the FCM group teachers were 22.00±2.04 for mentoring and guidance competency, 20.92±2.68 for academic competency, 13.08±1.56 for persuasive ability to participate in competitions, and 11.17±1.85 for the responsibility dimension (Table 4).

The mean post-test scores of the self-efficacy scale for the FCM group teachers were higher than the mean pre-test scores (Table 4).

The Wilcoxon Signed Ranks test results of the project competitions mentoring self-efficacy scale and its sub-factors for the face-to-face training group are presented in Table 5.

Table 5. *Descriptive Statistics Regarding the Mentoring Self-Efficacy Scale and Sub-Factors of the Project Competitions of Teachers in the Face-to-Face Education Group*

Sub factors	**Pre-Test Min**	**Pre-Test Max**	**Pre-Test Mean (X̄)**	**Pre-Test Std. Dev. (Sx)**	**Post-Test Min**	**Post-Test Max**	**Post-Test Mean (X̄)**	**Post-Test Std. Dev. (Sx)**
Mentoring and Guidance Competency	8	25	17.88	6.33	19	25	21.75	2.25
Academic Competency	5	25	14.00	5.76	17	25	19.50	3.02
Persuasive Ability to Participate in Competitions	3	15	11.75	3.77	12	15	13.13	1.55
Responsibility Dimension	3	15	10.38	4.93	12	15	13.38	1.19

Examining the results, the lowest pre-test scores for the self-efficacy scale in the face-to-face training group were 3 in the persuasive ability to participate in competitions and responsibility sub-dimensions, while the highest pre-test scores were 25 in the mentoring and guidance competency and academic competency sub-dimensions. In the post-test self-efficacy scale, the lowest scores were 12 in the persuasive ability to participate in competitions and responsibility sub-dimensions, while the highest scores were 25 in the mentoring and guidance competency and academic competency sub-dimensions (Table 5).

The mean pre-test scores of the sub-dimensions of the self-efficacy scale for the face-to-face training group teachers were 17.88±6.33 for mentoring and guidance competency, 14.00±5.76 for academic competency, 11.75±3.77 for persuasive ability to participate in competitions, and 10.38±4.93 for the responsibility dimension. The mean post-test scores of the sub-dimensions of the self-efficacy scale for the face-to-face training group teachers were 21.75±2.25 for mentoring and guidance competency, 19.50±3.02 for academic competency, 13.13±1.55 for persuasive ability to participate in competitions, and 13.38±1.19 for the responsibility dimension.

The mean post-test scores of the self-efficacy scale for the face-to-face training group teachers were higher than the mean pre-test scores (Table 5).

The Wilcoxon Signed Ranks test results of the project competitions mentoring self-efficacy scale and its sub-factors for the distance education group are presented in Table 6.

Table 6. *Descriptive Statistics Regarding the Project Competitions Mentoring Self-Efficacy Scale of Teachers in the Distance Education Group and the Sub-Factors of the Scale*

Sub factors	**Pre-Test Min**	**Pre-Test Max**	**Pre-Test Mean ($\bar{X}$)**	**Pre-Test Std. Dev. (Sx)**	**Post-Test Min**	**Post-Test Max**	**Post-Test Mean ($\bar{X}$)**	**Post-Test Std. Dev. (Sx)**
Mentoring and Guidance Competency	15	25	19.51	2.81	8	25	21.46	3.79
Academic Competency	9	21	14.58	3.16	10	25	19.75	3.61
Persuasive Ability to Participate in Competitions	8	15	12.17	2.57	3	15	12.46	2.69
Responsibility Dimension	6	15	10.92	2.57	5	14	11.00	2.27

Examining the results, the lowest pre-test score for the self-efficacy scale in the distance education group was 6 in the responsibility sub-dimension, while the highest pre-test score was 25 in the mentoring and guidance competency sub-dimension. In the post-test self-efficacy scale, the lowest score was 3 in the persuasive ability to participate in competitions sub-dimension, while the highest scores were 25 in the mentoring and guidance competency and academic competency sub-dimensions (Table 6).

The mean pre-test scores of the sub-dimensions of the self-efficacy scale for the distance education group teachers were 19.51±2.81 for mentoring and guidance competency, 14.58±3.16 for academic competency, 12.17±2.57 for persuasive ability to participate in competitions, and 10.92±2.57 for the responsibility dimension. The mean post-test scores of the sub-dimensions of the self-efficacy scale for the distance education group teachers were 21.46±3.79 for mentoring and guidance competency, 19.75±3.61 for academic competency, 12.46±2.69 for persuasive ability to participate in competitions, and 11.00±2.27 for the responsibility dimension.

The mean post-test scores of the self-efficacy scale for the distance education group teachers were higher than the mean pre-test scores (Table 6).

3.1.1. Comparison of Pre-Test Scores Between Groups

The Kruskal-Wallis test results for pre-test scores obtained from the project competitions mentoring self-efficacy scale and its sub-factors in the FCM, face-to-face training, and distance education groups are presented in Table 7.

Table 7. *Kruskall Wallis Test Results of the Project Competitions Mentoring Self-Efficacy Scale and Sub-Factor Pretest Scores of Teachers in Different Groups Before Implementation*

Sub factors	**Teaching Method**	**n**	**Mean Rank**	**χ2**	**p**
Mentoring and Guidance Competency	FCM	12	24.13	0.268	0.874
	Face-to-Face	8	21.75		
	Distance Education	24	21.94		
Academic Competency	FCM	12	26.79	2.071	0.355
	Face-to-Face	8	19.13		
	Distance Education	24	21.48		
Persuasive Ability to Participate in Competitions	FCM	12	26.50	1.877	0.391
	Face-to-Face	8	19.50		
	Distance Education	24	20.65		
Responsibility Dimension	FCM	12	22.00	0.556	0.757
	Face-to-Face	8	20.38		
	Distance Education	24	22.81		
Total	FCM	12	25.17	0.744	0.689
	Face-to-Face	8	20.88		
	Distance Education	24	21.67		

The Kruskal-Wallis test results for pre-test scores obtained from the project competitions mentoring self-efficacy scale and its sub-factors show that there was no statistically significant difference between the groups in the pre-test scores of mentoring and guidance competency, academic competency, persuasive ability to participate in competitions, and responsibility sub-dimensions ($\chi2=0.268$; $p=0.874$) ($p>0.05$). Additionally, there was no statistically significant difference in total pre-test scores between the groups ($\chi2=0.744$; $p=0.689$). The groups showed similarities in terms of pre-test levels of project mentoring self-efficacy and its sub-factors (Table 7).

3.1.2. Within-Group Comparisons

The Wilcoxon test results for pre-test and post-test scores of the project competitions mentoring self-efficacy scale and its sub-dimensions for the FCM group are presented in Table 8.

Table 8. *Willcoxon Test Result Regarding the Project Competitions Mentoring Self-Efficacy Scale and the Sub-Factor Pretest and Posttest Scores of the Teachers in the FCM Group.*

Sub factors	Ranks	N	Mean Rank	Sum of Ranks	z	p
Mentoring and Guidance Competency	Negative	4	3.25	13.00	2.047	**0.041**
	Positive	8	8.13	65.00		
	Equal	0				
Academic Competency	Negative	1	2.00	2.00	2.909	**0.004**
	Positive	11	6.91	76.00		
	Equal	0				
Persuasive Ability to Participate in Competitions	Negative	2	5.50	11.00	1.373	0.170
	Positive	7	4.86	34.00		
	Equal	3				
Responsibility Dimension	Negative	4	5.13	20.50	0.240	0.810
	Positive	5	4.90	24.50		
	Equal	3				
Total	Negative	2	3.25	6.50	2.358	**0.018**
	Positive	9	6.61	59.50		
	Equal	1				

The Wilcoxon test results for pre-test and post-test scores of the project competitions mentoring self-efficacy scale and its sub-dimensions for the FCM group indicate that the post-test scores for the mentoring and guidance competency and academic competency sub-dimensions were significantly higher than the pre-test scores (z=2.040 p=0.041; z=2.909 p=0.004). Similarly, the total post-test scores were significantly higher than the pre-test scores (z=2.358 p=0.018).

The Wilcoxon test results for pre-test and post-test scores of the project competitions mentoring self-efficacy scale and its sub-dimensions for the face-to-face training group are presented in Table 9.

Table 9. *Willcoxon Test Result Regarding the Project Competitions Mentoring Self-Efficacy Scale of Teachers in the Face-to-Face Education Group and the Sub-Factor Pretest and Posttest Scores of the Scale.*

Sub factors	Ranks	N	Mean Rank	Sum of Ranks	z	p
Mentoring and Guidance Competency	Negative	1	1.00	1.00	1.753	0.080
	Positive	4	3.50	14.00		
	Equal	3				
Academic Competency	Negative	0	0.00	0.00	2.379	**0.017**
	Positive	7	4.00	28.00		
	Equal	1				
Persuasive Ability to Participate in Competitions	Negative	2	2.00	4.00	0.962	0.336
	Positive	3	3.67	11.00		
	Equal	3				
Responsibility Dimension	Negative	1	1.00	1.00	1.461	0.144
	Positive	3	3.00	9.00		
	Equal	4				
Total	Negative	0	0.00	0.00	2.366	**0.018**
	Positive	7	4.00	28.00		
	Equal	1				

The final test scores derived from the academic competence subscale of the project competition mentoring self-efficacy scale for teachers in the face-to-face education group are higher than their pre-test scores, and the difference between them is statistically significant (z = 2.379, p = 0.017). Similarly, the total final test scores on the self-efficacy scale for teachers in this group are significantly higher than their pre-test scores (z = 2.366, p = 0.018) (Table 9).

The Wilcoxon test results for pre-test and post-test scores of the project competitions mentoring self-efficacy scale and its sub-dimensions for the distance education group are presented in Table 10

Table 10. *Willcoxon Test Result Regarding the Project Competitions Mentoring Self-Efficacy Scale of Teachers in the Distance Education Group and the Sub-Factor Pretest and Posttest Scores of the Scale.*

Sub factors	Ranks	N	Mean Rank	Sum of Ranks	z	p
Mentoring and Guidance Competency	Negative	3	11.17	33.50	2.865	**0.004**
	Positive	18	10.97	197.50		
	Equal	3				
Academic Competency	Negative	2	4.00	8.00	3.962	**0.000**
	Positive	21	12.76	268.00		
	Equal	1				
Persuasive Ability to Participate in Competitions	Negative	5	7.60	38.00	0.917	0.359
	Positive	9	7.44	67.00		
	Equal	10				
Responsibility Dimension	Negative	7	9.57	67.00	0.456	0.649
	Positive	10	8.60	86.00		
	Equal	7	-	-		
Total	Negative	4	8.25	33.00	3.196	**0.001**
	Positive	19	12.79	243.00		
	Equal	1				

The final test scores derived from the mentoring self-efficacy scale for project competition in the remote education group are higher than their pre-test scores for both the guidance and mentoring competence and academic competence subscales, and the differences between them are statistically significant (z = 2.865, p = 0.004; z = 3.962, p = 0.000). Similarly, the total final test scores on the self-efficacy scale for teachers in this group are significantly higher than their pre-test scores (z = 3.196, p = 0.001) (Table 10)

The post-test self-efficacy scores in all groups (FCM, face-to-face, and distance education) were significantly higher than the pre-test scores. Therefore, it can be stated that the in-service project mentoring training provided through all methods (FCM, face-to-face, and distance education) has an enhancing effect on project mentoring self-efficacy.

3.1.3. Comparison of Final Tests Between Groups

The Kruskal-Wallis test results for post-test scores obtained from the project competitions mentoring self-efficacy scale and its sub-factors in the FCM, face-to-face training, and distance education groups are presented in Table 11.

Table 11. *Kruskal-Wallis Test Results for Post-Implementation Project Competition Mentoring Self-Efficacy Scale and Scale Subfactor Final Test Scores Among Different Groups*

Sub factors	**Teaching Method**	**n**	**Mean Rank**	**χ2**	**p**
Mentoring and Guidance Competency	FCM	12	26.50	1.367	0.504
	Face-to-Face	8	23.00		
	Distance Education	24	22.31		
Academic Competency	FCM	12	24.50	0.439	0.803
	Face-to-Face	8	23.00		
	Distance Education	24	22.71		
Persuasive Ability to Participate in Competitions	FCM	12	22.50	0.317	0.854
	Face-to-Face	8	23.13		
	Distance Education	24	23.25		
Responsibility Dimension	FCM	12	19.67	0.551	0.759
	Face-to-Face	8	24.00		
	Distance Education	24	23.17		
Total	FCM	12	24.25	0.435	0.805
	Face-to-Face	8	22.88		
	Distance Education	24	22.79		

The Kruskal-Wallis test results calculated from the Project Competition Mentoring Self-Efficacy Scale for teachers in different groups indicate that there was no statistically significant difference ($p>0.05$) in the final test scores they obtained across the dimensions of mentoring and guidance competence, academic competence, and persuasion skills for participating in competitions, among the FCM, face-to-face education, and distance education groups. There is no significant difference in terms of final test scores among the FCM, face-to-face education, and distance education groups ($\chi^2=0.355$, $p=0.846$) ($p>0.05$). It has been determined that there is a significant difference in the responsibility dimension final test scores among teachers in the FCM, face-to-face education, and distance education groups ($\chi^2=9.121$, $p=0.010$) (Table 11).

Table 12. *Pairwise comparisons (post-hoc) results for the responsibility sub-factor*

Groups	**p**
Distance Education - FCM	>0.999
Distance Education - Face-to-Face	**0.003**
FCM - Face-to-Face	**0.013**

To determine between which groups this difference exists, pairwise comparisons using the post-hoc method indicated that the responsibility dimension final test scores of teachers in the face-to-face education group are significantly higher than those of teachers in the distance education and FCM groups (respectively; $p=0.003$, $p=0.013$) ($p<0.017$) (Table 12).

4. Conclusion, Discussion and Recommendations

The findings obtained from the project competitions mentoring self-efficacy scale and its sub-factors were presented by relating them to each other.

The pre-test scores of teachers in the FCM, face-to-face education, and distance education groups on the project consultancy self-efficacy scale and its subscales have been compared. In all groups, the highest scores were observed in the consultancy and guidance competence subscale, while the lowest scores were found in the responsibility dimension. This indicates that teachers' levels of self-efficacy in responsibility are areas for potential improvement.

Statistically, there is no significant difference among the FCM, face-to-face education, and distance education groups in terms of pre-test scores on the project competition mentoring self-efficacy scale and all its subscales. This finding suggests that before the intervention, all groups had similar levels of project consultancy self-efficacy.

When the pre-test and post-test scores of the project competitions mentoring self-efficacy scale and its sub-dimensions were evaluated in the FCM, face-to-face training, and distance education groups, it was found that the post-test scores of the mentoring and guidance competency and academic competency sub-dimensions in the FCM and distance education groups were significantly higher than the pre-test scores. This suggests that the project mentoring training provided through the FCM and distance education methods positively impacted teachers' perceptions of mentoring and guidance competency and academic competency. The difference between the final test scores and pre-test scores of teachers in the face-to-face education group on the academic competence subscale of the self-efficacy scale is statistically significant. Based on this finding, it can be stated that face-to-face education positively changed teachers' perceptions of academic competence.

There was no statistically significant difference between the post-test total scores of the self-efficacy levels in the FCM, face-to-face training, and distance education groups. There was no statistically significant difference between the groups in the post-test scores of mentoring and guidance competency, academic competency, and persuasive ability to participate in competitions. However, the post-test scores of the responsibility sub-dimension were significantly higher in the face-to-face training group compared to the distance education and FCM groups. This finding suggests that face-to-face training is more effective on the responsibility self-efficacy levels of teachers.

Overall, it has been observed that the FCM is equally effective compared to other methods in influencing teachers' overall self-efficacy perception. Upon reviewing the literature, there are studies examining the impact of the FCM on students' self-efficacy perceptions. (Doo & Bonk, 2020; Enfield, 2013; Files, 2016; González-Gómez et al., 2022; Han et al., 2024; Latorre-Cosculluela et al., 2022; Namazandost & Çakmak, 2020; Schmid et al., 2023; Talan & Gülseçen, 2018). In the study conducted by Talan and Gülseçen (2018), the effect of the transformed class model, blended learning, and traditional method on students' self-regulation skills and computer self-efficacy perceptions in "Computer-I" course in higher education was examined. They concluded that there was no significant difference in the computer self-efficacy perceptions of students in three different groups. However, they found a significant increase in the scores of all groups, highlighting that this is an expected outcome and emphasizing that the FCM positively impacts individuals' computer self-efficacy perceptions due to the use of computers and technological tools. Files (2016) compared the teaching methods of the FCM, online learning, and face-to-face instruction in mathematics and found no significant difference in students' self-efficacy levels. These results are similar to the findings of this study.

Studies showing that the FCM positively affects students' self-efficacy beliefs towards the course are also present. For example, González-Gómez, Jeong, and Cañada-Cañada (2022) emphasized that the FCM contributed to the self-efficacy of pre-service teachers regarding science content and science teaching. Similarly, Enfield (2013) found that the FCM allowed students to practice more in the classroom, facilitated independent learning, and thus enhanced their self-efficacy perceptions. Özyurt and Özyurt (2018) highlighted that using the FCM increased the programming self-efficacy perceptions of students taking a programming course for the first time. Schmid et al. (2023) found that blended learning/FCM significantly increased self-efficacy in 22 studies involving pre-service and in-service teachers.

The FCM, face-to-face, and distance education groups showed that teachers' self-efficacy levels increased significantly during the project mentoring training process, regardless of the method used. According to Bandura (1997), it can be argued that teachers' experience of in-service project mentoring training has shaped high self-efficacy scores across all groups, as direct experiences have the greatest impact on self-efficacy perceptions and beliefs. It can be considered that the FCM provides teachers with active learning experiences and opportunities to take on responsibilities, thereby enhancing their self-efficacy.

Recommendations

Based on the findings of this study, the following recommendations have been developed:

1. **Expansion of the FCM in In-Service Trainings:** Schools and educational institutions can utilize the FCM more widely in teachers' in-service trainings. This model can enhance teachers' digital skills and make learning environments more effective.

2. **Enhancement of Teachers' Responsibility-Taking Abilities:** Active learning methods such as the FCM and project-based activities can be specifically designed to enhance teachers' ability to take on responsibilities. This approach can increase teachers' self-efficacy perceptions and effectiveness.

3. **Comparison of Different Educational Models:** Future research could more comprehensively compare the effects of new educational approaches like the FCM on different groups of teachers. This could help us better understand the effectiveness of teaching methods and their contributions to teachers' professional development.

In conclusion, this research demonstrates that the FCM can contribute to teachers' professional development and strengthen their self-efficacy perceptions. By offering a perspective different from traditional teaching approaches, this model introduces an innovative outlook in in-service education. It is important to further apply and evaluate this model on a broader scale and in different educational contexts in the future. This study is expected to provide valuable insights to education policymakers, school administrators, teachers, and researchers alike.

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