

Oktay Kizkapan
Education faculty of Nevşehir Hacı Bektaş Veli University
Türkiye

Original scientific paper
UDC: 37.018.43
DOI: 10.5937/IstrPed2401090K

BOOSTING PRE-SERVICE SCIENCE TEACHERS' SELF-EFFICACY IN CONSTRUCTIVISM AND DISTANCE EDUCATION^{1,2}

Abstract: In this study, the impact of training supported by the TUBITAK 2237-A Grant Program for Scientific Training on the self-efficacy of pre-service science teachers (PSSTs) in implementing the constructivist approach and delivering distance education (DE) was investigated. The research employed a single-group pretest-posttest experimental design, a quantitative research design. The study's population comprised PSSTs enrolled in science teaching programs across 27 universities in Türkiye, with a sample of 32 pre-service teachers selected through criterion sampling. Data were collected using the distance education competence scale and self-efficacy scales for applying the constructivist approach. The analysis involved both descriptive and statistical methods. The results revealed a significant enhancement in the self-efficacy of PSSTs in both distance education delivery and the application of the constructivist approach through the online education. This improvement was attributed to the direct experiences and mentor support gained during the training program, as discussed in the study.

Keywords: Science education, Teacher Training, Constructivism, Distance Education

Introduction

In accordance with the constructivist approach, individuals assimilate newly acquired information by connecting it to their existing knowledge (Fosnot, 2007). Thus, in science courses designed based on this approach, incorporating problem-based, project-based, and collaborative learning is crucial. Hence, innovative teaching methods such as argumentation, creative drama, STEM, flipped learning, and the integration of digital transformation applications are deemed important in science education (MEB, 2018).

Despite the longstanding adoption of the constructivist approach in Turkey, research indicates that teachers do not consistently apply methods or strategies aligned with this approach. This discrepancy is attributed to factors such as teachers lacking the necessary pedagogical field knowledge, feeling incompetent in creating constructivist-friendly learning environments, limited familiarity with alternative assessment methods, and a lack of peer support. Additionally, challenges include ineffective mentor support and difficulties in developing lesson plans grounded in constructivism (Eser, 2010; Gomleksiz, 2007; Ozenc & Cakir, 2015).

¹ This article is a revised and expanded version of a paper entitled "Boosting Pre-Service Science Teachers' Self-Efficacy in Applying Constructivist Approach in Online Environments and Conducting Distance Education" presented at "International Education Congress (EDUCongress), held in Ankara University on September 20-23, 2023.

² The data for this study was gathered from PSSTs taking part in the project named "Pre-Service Science Teachers Construct Distance Education through Interactive Applications." This education project is supported by TÜBİTAK 2237-A Grant Program for Scientific Training.

Beyond these challenges, the necessity to adapt DE and constructivist learning approaches to the ongoing DE process, initiated during the pandemic and later reintroduced after the earthquake in Turkey on February 6, 2023, has become apparent. While methods and techniques from traditional classrooms can be applied to DE, there is a need to leverage various learning strategies and methods to ensure student interaction (Simonson, Zvacek, & Smaldino, 2019). Paradoxically, research indicates a preference for traditional teaching methods over those grounded in the constructivist approach during the DE process (Bakioglu & Cevik, 2020; Tasci, 2021). The pandemic presented a challenging situation for educators, who suddenly had to transition to mandatory DE, prompting a reevaluation of existing educational paradigms (Blumenstyk, 2020). Consequently, the swift and mandatory shift to DE provided an opportunity to explore the potential advantages it offers and how effectively educators can harness those (Harrison & Laco, 2022).

A potential reason for the preference of traditional teaching methods in the DE process may stem from a lack of sufficient knowledge on how to implement methods and strategies based on the constructivist approach in DE (Canpolat & Yildirim, 2021). Another contributing factor could be preconceptions that methods and strategies grounded in the constructivist approach are not suitable for application in DE. Some studies indirectly support this perspective, suggesting that certain skills cannot be acquired through DE (Karakus et al., 2021). However, it is worth noting that constructivism is a valuable and effective learning approach that can be successfully applied in DE (Jahanara et al., 2021). According to Jha (2017), the constructivist learning approach provides a solid foundation for designing distance learning environments. Similarly, Jahanara et al. (2021) argue that through the effective integration of the constructivist approach into DE, students acquire essential skills and motivation for the information age, such as decision-making, innovation, creative and critical thinking, self-control, and self-regulation, enabling them to generate new ideas actively. They posit that productive learners can be cultivated through this approach.

Given this information, it appears both necessary and feasible to apply constructivist learning approaches in science courses delivered through DE. To achieve success in this regard, both in-service and pre-service training should focus on imparting the know-how of utilizing methods and strategies based on the constructivist approach in DE. However, it is observed that the training provided to teachers and teacher candidates on this subject is not deemed sufficient (Bakioglu & Cevik, 2020). Therefore, there is a discernible need for training on incorporating constructivist methods and strategies into DE for science teacher candidates who will soon enter the teaching profession. These trainings can equip teacher candidates with greater experience and awareness of DE, which has become the new norm. Research outcomes on this matter reveal that one of the critical factors influencing teacher candidates' competencies in online learning-teaching environments is their self-efficacy perceptions regarding online education (Woodcock, Sisco, & A. ve Eady, 2015).

Self-efficacy, a task-specific emotional attribute that enhances human functioning, is defined as teachers' confidence in their ability to effectively navigate new situations (Bandura, 1986). This belief system plays a pivotal role in shaping significant academic outcomes such as students' success and motivation (Barni, Danioni, & Benevene, 2019). According to Renner and Pratt (2017), self-efficacy beliefs play a crucial role in influencing teachers' effectiveness, overall job satisfaction, and comfort in carrying out their responsibilities. Educators possessing strong self-efficacy more inclined to engage with students and experiment with creative teaching strategies (Ma et al., 2021). Studies have identified a connection between the utilization and incorporation of technology in the classroom and teachers' self-efficacy. (Corry & Stella, 2018). Hence, it is imperative for teachers and teacher candidates to cultivate self-efficacy when employing the constructivist approaches in the context of DE. However, without opportunities to develop technological competencies and incorporate them into teaching practices during teacher education courses, teachers and teacher candidates may struggle to acquire and apply these skills (Dogru, 2020). Supporting this perspective, studies have found that teachers with prior online teaching experience are more motivated to engage in online teaching (Horvitz et al., 2015). Therefore, practice-based training tailored to meet teachers' learning needs in the online environment

is crucial for professional development (Hall & Trespalacios, 2019). Intervention programs that provide such training can positively impact the enhancement of both in-service teachers and teacher candidates' perception of technological pedagogical content knowledge, particularly regarding their self-efficacy in integrating technology into teaching (Dolighan & Owen, 2021).

Building on these considerations, a week-long training initiative was implemented for science teacher candidates under the project titled "PSSTs construct DE through interactive applications." This training aimed to equip future teachers with insights and knowledge on integrating student-centered learning approaches, including argumentation, project-based learning, problem-based learning, STEM education, creative drama, scientific creativity practices, flipped learning, and nature of science teaching, into DE environments. The primary goal was to provide hands-on experience in utilizing these methodologies. Consequently, the focus of this research is to assess the impact of the training program on the competencies of science teacher candidates in applying the constructivist approach in DE and delivering science education within DE environments. To address this objective, the following research questions were formulated as;

1. What is the effect of "PSSTs construct DE through interactive applications" project on the PSSTs' self-efficacy to apply the constructivist approach in DE?
2. What is the effect of "PSSTs construct DE through interactive applications" project on the PSSTs' self-efficacy to conduct science education in DE environments?

Method

Research Design

The study employed a single-group pretest-posttest experimental design within the framework of quantitative research methodology. This design involves measuring a single group both before and after exposure to an intervention program with a focus on specific characteristics (Fraenkel & Wallen, 2006). The rationale for choosing a single-group pretest-posttest experimental design in this study lies in its aim to investigate the impact of online education, centered on teaching student-centered learning approaches in science education, on the competencies of PSSTs regarding the application of the constructivist approach in DE and the delivery of science education in DE environments.

Population and Sample

The study focused on PSSTs enrolled in the third and fourth years of science education departments of education faculties across Turkey. Data for the research were collected online from PSSTs who took part in the education project "PSSTs construct DE through interactive applications" supported by TUBITAK 2237-A Grant Program for Scientific Training, with the author serving as the coordinator of the project. The event accepted applications from third and fourth-year PSSTs for training. A total of 115 pre-service science teaches, representing 27 different state universities in Turkey, applied to participate. Consequently, the study's population comprised PSSTs studying at these 27 universities.

The sample selection was conducted through criterion sampling, a method where individuals from the population who meet specific criteria are included (Fraenkel & Wallen, 2006). In this context, PSSTs who applied were contacted based on their general achievement scores, starting from the highest, and 32 PSSTs who expressed willingness to participate were included in the study. It is noteworthy that all the participants in the study are female, and their weighted grade point averages range from 2.89 to 3.77.

Data Collection Tools

In the study, PSSTs' self-efficacy in DE applications were assessed using the DE competency scale, initially developed by Sagin, Yucekaya, & Gullu (2021) for physical education teachers. For the current research, the scale items were adapted and employed specifically for science lessons. The scale comprises two dimensions and a total of 18 items: "planning and technology use" (Cronbach's Alpha: 0.635) and "implementation and evaluation" (Cronbach's Alpha: 0.945). Sample items from the scale: I can use measurement tools (Rubriks, tally scales, etc.) that can evaluate students from psychological dimensions in DE. I can interact with students in an online classroom environment in DE.

To gauge PSSTs' self-efficacy in applying the constructivist approach in DE, the self-efficacy perception scale for applying the constructivist approach was utilized. This scale was originally developed by Evrekli, Oren, & Inel (2010) and adapted by Eskici and Ozen (2013). The scale encompasses four dimensions and a total of 29 items: guiding (Cronbach's Alpha: 0.940), activating the student (Cronbach's Alpha: 0.932), encouraging thinking (Cronbach's Alpha: 0.938), and alternative evaluation (Cronbach's Alpha: 0.864). Permission to use these scales was obtained from the respective researchers. Sample items from the scale: I can use content such as videos, slides and pictures while teaching in the science course conducted through DE. I can design activities with materials available at home in the science course conducted through DE.

Intervention

The findings of this research are derived from data collected from PSSTs who took part in the education supported by the TUBITAK 2237-A Grant Program for Scientific Training. As part of this project, aspiring teachers underwent a five-day online training program. During this training, 25 experts from various fields, representing 15 different universities and institutions, delivered sessions to PSSTs. The primary objective of the training was to educate future science teachers on integrating student-centered learning approaches, such as argumentation, project-based learning, problem-based learning, STEM education, creative drama, scientific creativity practices, flipped learning, and nature of science teaching, into DE environments. The aim was to enhance their competence in establishing learning environments conducive to the constructivist approach in DE by providing them with knowledge, experience, and awareness.

Within the scope of the training, PSSTs developed lesson plans suitable for DE using various methods and strategies. The science curriculum advocates the use of methods and strategies that foster student-centered learning environments in science courses. Consequently, the activity involved the preparation of lesson plans aligned with the student-centered and constructivist philosophy. These lesson plans were crafted based on methods and strategies such as argumentation, project-based learning, problem-based learning, STEM education (utilizing digital transformation applications), creative drama, flipped learning, nature of science teaching, and scientific creativity applications.

The training unfolded in four stages. In the first stage, pre-tests were administered, followed by expert instructors providing theoretical information to PSSTs about the constructivist learning methods and strategies mentioned earlier.

Moving on to the second stage, instructors illustrated how science courses delivered through DE could be meticulously planned, from the introduction phase to assessment and evaluation, in line with the constructivist approach. This planning aimed to create a more student-centered approach and enhance students' high-level cognitive skills. The prepared lesson plans demonstrated how tools and materials such as web 2.0 tools, learning scenarios, puzzles, simulations, online measurement tools, posters, stories, digital boards, concept maps, concept networks, and infographics could be utilized to facilitate teacher-student, student-student, and student-material interaction in DE. This integration was elucidated through practical examples.

In the third stage of the training, PSSTs were organized into four groups, each comprising eight participants. Group 1 and Group 2 collaborated to create lesson plans based on one teaching method, while Group 3 and Group 4 simultaneously developed lesson plans aligned with the objectives of the current science course curriculum but using a different teaching method. Consequently, at the conclusion of the third stage, two distinct sets of lesson plans emerged for each teaching method or strategy. Throughout the preparation of lesson plans, groups that attended the same session were separated into study groups and distinct study environments, utilizing the Breakout Rooms feature of the Zoom program. Group 1 and Group 2 crafted lesson plans centered around the same learning methods but with different objectives. Similarly, pre-service teachers in Group 3 and Group 4 devised lesson plans based on the same learning methods but with different subjects and objective. Specifically, Group 1 and Group 2 focused on teaching argumentation, project-based learning, creative drama, and nature of science, whereas pre-service science teacher in Group 3 and Group 4 concentrated on preparing lesson plans related to flipped learning, STEM education, problem-based learning, and scientific creativity practices. Experts overseeing the session actively participated in the Breakout Rooms, offering mentorship to the PSSTs. The lesson plans, shaped by the PSSTs based on the identified objectives, were enriched with teaching tools and materials designed to cater to students with diverse learning styles.

In the fourth and final stage, PSSTs presented the lesson plans they had developed to both field experts and fellow participants. Field experts thoroughly assessed the lesson plans using an analytical rubric specifically crafted for evaluating lesson plans within the framework of the activity. They provided valuable feedback and suggestions for improvement. Additionally, posttests were administered at the conclusion of this stage to gauge the impact of the training.

Data Analysis

The research data underwent analysis utilizing both descriptive and inferential statistics. Initially, descriptive statistics were computed, including measures such as mean, mode, median, kurtosis, and skewness values, to assess the central tendency and distribution characteristics of the data. The normal distribution of the data was then examined.

Following the descriptive analysis, inferential statistical techniques, specifically the dependent samples t-test, were employed to compare participants' pre- and post-training measurements. This statistical test helps determine whether there are significant differences between two related groups, in this case, the measurements taken before and after the training. The dependent samples t-test is particularly useful for assessing the impact or effectiveness of an intervention by comparing related measures from the same individuals.

Results

The research data were analyzed descriptively beforehand to decide on the inferential statistical analyzes to be used to answer the research questions. First of all, the descriptive statistical findings of the constructivist approach application self-efficacy scores obtained in the research are given in Table 1.

Table 1. Descriptive Findings Regarding Self-Efficacy Scores for Applying the Constructivist Approach

		Pre Test	Post Test
N	Valid	32	32
	Missing	0	0
Mean		113.88	137.31
Median		116.00	142.00
Mode		112	145
Skewness		-.682	-1.322

Std. Error of Skewness	.414	.414
Kurtosis	.194	.408
Std. Error of Kurtosis	.809	.809
Sum	3644	4394

The analysis of PSSTs' self-efficacy scores for applying constructivist approach, as depicted in Table 1, reveals that the mean, median, and mode values are close to each other. Furthermore, both pretest and posttest scores exhibit kurtosis and skewness values within the range of +/-1.5, as recommended by George and Mallery (2001). These indicators suggest that PSSTs' self-efficacy scores for applying the constructivist approach in DE demonstrate a normal distribution. Therefore, the use of the paired sample t-test, a parametric test, is deemed appropriate for comparing the post-test and pre-test scores.

Following the examination of constructivist approach application self-efficacy scores, descriptive statistics concerning PSSTs' DE application self-efficacy perceptions were calculated, and the findings are presented in Table 2.

Table 2. Descriptive Findings Regarding DE Application Self-Efficacy Scores

		Pre Test	Post test
N	Valid	32	32
	Missing	0	0
Mean		70.00	81.19
Median		71.50	83.50
Mode		68 ^a	84 ^a
Skewness		-1.223	-1.294
Std. Error of Skewness		.414	.414
Kurtosis		2.694	.492
Std. Error of Kurtosis		.809	.809
Sum		2240	2598

a. Multiple modes exist. The smallest value is shown

In Table 2, it is evident that the mean, median, and mode values of both the pre-test and post-test scores for PSSTs' DE application self-efficacy are close to each other. Additionally, the kurtosis and skewness values fall within the acceptable range, with the exception of the kurtosis value for the pretest scores, which is slightly outside the typical reference range. However, given that this deviation was considered unlikely to pose a significant problem in the context of the research, the paired samples t-test, a more powerful statistical test, was employed instead of non-parametric tests to compare the pre- and post-test scores.

Following the descriptive statistics, the decision was made to use the paired samples t-test for comparing the pre-test and post-test scores in the research. The outcomes obtained from the comparison of pre-test and post-test scores, measuring pre-service teachers' self-efficacy in applying the constructivist approach before and after the training, are provided in Table 3.

Table 3. Comparison of Pre- and Post-Test Scores for Self-Efficacy in Applying the Constructivist Approach

	Paired Differences			t	df	Sig. (2-tailed)	Effect Size
	Mean	Std. Deviation	Std. Error Mean				
Pre-Post Tests	-23.438	19.652	3.474	-6.747	31	.000	1.19

According to Table 3, a statistically significant difference in favor of the post-test is observed between the pre-test and post-test scores of the self-efficacy of applying the constructivist approach in DE for the PSSTs who participated in the training project ($t(31) = -6.747; p < .000$). In simpler terms, the training had a positive and significant impact on PSSTs' self-efficacy beliefs toward applying the constructivist approach in DE. The effect size (d) value calculated from the test results was found to be 1.19. This indicates that the training had a high level of impact on the self-efficacy of pre-service science teachers in applying the constructivist approach in DE (Green & Salkind, 2003).

Following the examination of the training's effect on the constructivist approach application self-efficacy, the impact on DE application self-efficacy was investigated. The outcomes from the paired sample t-test conducted within the scope of this study are presented in Table 4.

Table 4. Comparison of DE Application Self-Efficacy Pre- and Post-Test Scores

	Paired Differences			t	df	Sig. (2-tailed)	Effect Size
	Mean	Std. Deviation	Std. Error Mean				
Pre-Post Tests	-11.188	10.633	1.880	-5.952	31	.000	1.05

Table 4 indicates a significant difference in favor of the post-test scores compared to the pre-test scores for the DE application self-efficacy of pre-service science teachers who participated in the training ($t(31) = -5.952; p < .000$). In simpler terms, the training positively influenced the self-efficacy beliefs of PSSTs regarding DE application. The effect size (d) value calculated from the test results was found to be 1.05. This value means that the training had a substantial impact on the self-efficacy of PSSTs in applying the constructivist approach (Green & Salkind, 2003).

Discussion

In this study, the effectiveness of an online training project aimed at providing PSSTs with experience in applying constructivist learning methods in DE was tested. The analysis revealed a significant difference between the PSSTs' post-test (137.31) and pre-test (113.18) self-efficacy scores in applying the constructivist approach, as well as their post-test (81.19) and pre-test (70.00) scores in DE application self-efficacy. Based on these results, it can be concluded that the training activity positively impacted the constructivist approach application self-efficacy and DE application self-efficacy of the PSSTs.

The notable improvement in PSSTs' self-efficacy in applying the constructivist approach and DE can likely be attributed to their mastery experience in creating constructivist learning environments during the activity. Throughout the process, PSSTs, guided by field experts, formed lesson plans on a subject of their choice within the science curriculum, incorporating recommended teaching methods for science education. The preparation of these lesson plans involved online sessions with the presence of field experts, providing PSSTs with an example of how to guide students in an educational process. Additionally, as the entire training was conducted online, PSSTs gained practical experience in the implementation of DE. These direct experiences played a crucial role in enhancing PSSTs' perceptions of their competence in applying the constructivist approach and DE. The findings align with existing literature indicating that teachers with previous online teaching experience are more inclined to have the drive to instruct online (Horvitz et al., 2015). This underscores the significance of gaining expertise through personal experience in the formation of self-efficacy, particularly in the context of DE.

The literature highlights the significant role of psychological characteristics in the academic achievement of university students (Rohde & Thompson, 2007). Among these psychological factors, students' self-efficacy stands out as a crucial element in shaping learning approaches (van Dinther, Dochy, & Segers, 2011). Teachers with high beliefs in self-efficacy tend to demonstrate improved

performance, contributing to enhanced student success (Saracaloglu & Yenice, 2009; Schwarzer & Hallum, 2008). Schools with teachers holding strong self-efficacy beliefs often witness the development of students' questioning, discovery, skills in resolving problems, and positive perspectives on science (Shahzad & Naureen, 2017). Conversely, educators with low self-efficacy beliefs may resist adopting new teaching methods, leading to less effective teaching practices (Berg & Smith, 2016; Karabatak & Turhan, 2017).

Self-efficacy serves as a moderating variable among various determinants of individual development. According to Bandura, self-efficacy refers to perceived abilities to successfully perform a particular task at a specified level (Bandura, 1997). This belief in one's own capability facilitates human functioning and is specific to the domain and task at hand (Bandura, 1986). The confidence that teachers have in their capacity to adeptly navigate novel situations is pivotal in shaping significant academic outcomes, including students' motivation and success (Barni et al., 2019). As per Renner and Pratt (2017), self-efficacy have a substantial influence on the effectiveness of teachers, their overall job satisfaction, and their comfort in performing their roles. The difficulties stemming from the abrupt shift to online learning amid the pandemic have become apparent that teachers may experience low self-efficacy in using advanced technologies in their lessons (Baroudi & Shaya, 2022). They often encounter difficulties in developing engaging lessons suitable for online environments and offering significant educational opportunities to every student (Merrill, 2020). Therefore, the positive result indicating that the training activity implemented within the scope of the research improved the self-efficacy of PSSTs in conducting DE is noteworthy. This enhancement in self-efficacy is likely to contribute to teachers' success in online courses, strengthen their learning motivation (Rahim, 2022; Zimmerman & Kulikowich, 2016), make them more receptive to using new teaching methods in DE (Pressley, Roehrig, & Turner, 2018), and encourage their participation in online training in the future. Overall, it increases the likelihood of them adopting a positive perspective on the subject (Lim, 2001).

According to Hung (2016), self-efficacy is a crucial determinant of teachers' readiness for online teaching. Teachers' beliefs about their proficiency in using online learning and teaching environments can significantly influence their utilization of these platforms. Numerous studies in the literature highlight the relationship between belief and technology use (Can, 2020; Woodcock et al., 2015). Can (2020) suggests that instructors' perceptions and expectations towards DE can be a variable influencing their level of engagement with the DE system. Woodcock et al. (2015) highlight that a pivotal factor influencing the online teaching competencies of PSSTs is their self-efficacy perceptions related to online learning environments. However, a significant portion of teachers does not feel competent in teaching in online environments (He, 2014), with one reason being that learners unfamiliar with computers and the web often lack confidence in their skills to use them (Nahm & Resnick, 2008).

The literature on self-efficacy emphasizes the importance of mastery experiences in its development. As per Bandura (1986), the development of self-efficacy is grounded in mastery experiences, alongside vicarious learning, verbal persuasion, and physiological-emotional states. Hence, the experiential opportunities provided to pre-service teachers during their pre-service training directly impact their self-efficacy (Kizkapan, Karaca, & Eroglu, 2023). In line with the current research findings, Tas et al. (2021) determined that educators who underwent online education training during their college coursework showed higher levels of self-efficacy than those who did not. Additionally, teachers who had previous experience about DE exhibited higher self-efficacy than their counterparts without such training. The existing literature also indicates that engaging in direct experiences (McKim & Velez, 2017) through professional development programs have been linked to an enhancement in teachers' self-efficacy. However, some studies have shown that the self-efficacy of providing DE was initially low during the pandemic period due to practitioners' lack of experience (Ma et al., 2021).

In the study, another potential reason for the enhancement in the self-efficacy of pre-service teachers in applying the constructivist approach and providing DE after the training may be the mentor support

they received during the training (Kizkapan, Onal, & Kirmizigul, 2023). On the third and fourth days of the training activity, PSSTs prepared lesson plans based on constructivist learning approaches used in science education under the mentorship of field experts. Consequently, when encountering challenges in the process, they sought support from mentors and leveraged their knowledge and experience. By the end of the process, they crafted lesson plans suitable for the constructivist approach and applicable in DE. It is plausible that all these processes contributed to improving the self-efficacy of PSSTs in both applying the constructivist approach and providing DE. Supporting this possibility, the literature suggests a connection between beginner teachers' perceptions of the effectiveness of the education they attended and their self-efficacy beliefs (Henry, 2016). Various studies have indicated that self-efficacy increases through prior work experiences, mentoring support from colleagues, and professional development, including mentorship from experts. For instance, Dolighan and Owen (2021) found that professional collaboration among teachers is linked to the use of technology in teaching. Consequently, fostering mentoring relationships and colleague support among teachers, especially novice ones, is likely to enhance their self-efficacy (Tschannen-Moran & Woolfolk Hoy, 2007).

Conclusion

In conclusion, the research reveals that TUBITAK 2237-A Grant-supported training substantially boosts the PSSTs' self-efficacy of in utilizing the constructivist approach and delivering distance education. Engaging in organized online sessions and receiving guidance from experts in the field enabled participants to enhance their self-efficacy in effectively applying innovative teaching methods. This enhanced self-efficacy aids educators not only in adapting to online learning settings but also in promoting ongoing professional growth. Moving forward, focused training programs and mentoring efforts are essential to empower educators and enhance educational achievements across different teaching environments.

Limitations

Like any academic research, this study has specific limitations. The first limitation pertains to the duration of the intervention. The research focused on PSSTs participating in a TUBITAK-supported educational event, where support is provided for a maximum of seven days. Consequently, the training duration was restricted to five days. The second limitation concerns the number of participants, with data obtained from 32 PSSTs. The selection of participants was influenced by the support framework of the project, limiting the participant number to 32. Additionally, the chosen PSSTs had high academic grade point averages, leading to a lack of heterogeneity in terms of academic achievement among the participants.

Suggestions

Based on the research findings and limitations, several suggestions can be offered. Firstly, since the training activity significantly improved the self-efficacy of PSSTs in applying the constructivist approach and conducting DE, it is recommended to integrate similar opportunities into both pre-service and in-service teacher training programs to enhance the self-efficacy perceptions of teachers. Furthermore, when planning future training activities similar to the one in this research, it might be beneficial to organize sessions with more participants over an extended period, considering the limitations of the current study, to thoroughly assess the effectiveness of the training. Finally, the post-test data in this study were obtained immediately after the training. To assess the lasting impact of future training events, measures can be implemented to evaluate the persistence of the observed improvements over time.

Acknowledgment

I gratefully acknowledge the generous support of TUBITAK 2237-A Grant Program for Scientific Training, without which this research would not have been possible.

References:

- Bakioglu, B. & Cevik, M. (2020). Science teachers' views on distance education in the COVID-19 pandemic process. *Turkish Studies*, 15(4), 109-129. <https://dx.doi.org/10.7827/TurkishStudies.43502>
- Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology*, 4(3), 359-373. <https://psycnet.apa.org/doi/10.1521/jscp.1986.4.3.359>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman and Company.
- Barni, D., Danioni, F., & Benevene, P. (2019). Teachers' self-efficacy: The role of personal values and motivations for teaching. *Frontiers in Psychology*, 10, 1645. <https://doi.org/10.3389/fpsyg.2019.01645>
- Baroudi, S., & Shaya, N. (2022). Exploring predictors of teachers' self-efficacy for online teaching in the Arab world amid COVID-19. *Education and Information Technologies*, 27(6), 8093-8110. <http://dx.doi.org/10.1007/s10639-022-10946-4>
- Berg, D. A. G., & Smith, L. F. (2016). Preservice teacher self-efficacy beliefs: An opportunity to generate "good research" in the Asia-Pacific region. In: S. Garvis, & D. Pendergast (Eds.), *Asia-Pacific perspectives on teacher self-efficacy* (1-17). Sense Publishers.
- Blumenstyk, G. (2020). Why coronavirus looks like a 'black swan' moment for higher. Ed. *The Chronicle of Higher Education*. Available at: <https://www.chronicle.com/newsletter/the-edge/2020-03-11> (accessed on 11.01.2024).
- Can, E. (2020). Coronavirus (Covid-19) pandemic and its pedagogical reflections: Open and distance education practices in Turkey. *Journal of Open Education Applications and Research*, 6(2), 11-53.
- Canpolat, U. & Yildirim, Y. (2021). Examining the distance education experiences of secondary school teachers in the COVID-19 outbreak process. *Journal of Open Education Applications and Research*, 7(1), 74-109. DOI: [10.33407/itlt.v8i5.4466](https://doi.org/10.33407/itlt.v8i5.4466)
- Corry, M., & Stella, J. (2018). Teacher self-efficacy in online education: a review of the literature. *Research in Learning Technology*, 26, 1-13. <https://doi.org/10.25304/rlt.v26.2047>
- Dogru, O. (2020). An investigation of pre-service visual arts teachers' perceptions of computer self-efficacy and attitudes towards web-based instruction. *International Journal of Research in Education and Science (IJRES)*, 6(4), 629-637. <https://doi.org/10.46328/ijres.v6i4.1454>
- Dolighan, T., & Owen, M. (2021). Teacher efficacy for online teaching during the COVID-19 pandemic. *Brock Education Journal*, 30(1), 95-95. <https://doi.org/10.26522/brocked.v30i1.851>
- Eser, S. (2010). *Interrelation among job satisfaction, colleague relationships and managerial support in early childhood teachers (The case of Tekirdag)*. [Unpublished Master Thesis, Canakkale Onsekiz Mart University], National Dissertation Center.
- Eskici, M., & Ozen, R. (2013). Adaptation of "self efficacy perceptions of teachers about the implementation of the constructivist approach scale". *Adnan Menderes University Faculty of Education Journal of Educational Sciences*, 4(2), 19-29.
- Evrekli, E., Oren, F. S. & Inel, D. (2010). Examining the self-efficacy of teacher candidates for applying the constructivist approach in terms of gender, department and grade level variables. Paper presented at *International Conference on New Trends in Education and Their Implications* (11-13 November, Antalya).
- Fosnot, C. T. (2007). *Constructivism: Theory, Perspectives and Practice* (Trans. Ed. S. Durmus). Ankara: Nobel Yayin Dagitim.

- Fraenkel, J. R., & Wallen, N. E. (2006). *How to design and evaluate research in education*. New York: Mac Graw Hill.
- George, D., & Mallery, P. (2001). *SPSS for Windows*. Needham Heights, MA: A Pearson Education.
- Gomleksiz, M. N. (2007). An evaluation of teachers' perceptions of the new primary school curriculum in terms of some variables. *Eurasian Journal of Educational Research*, 27, 69–82. <https://doi.org/10.1016/j.sbspro.2011.04.198>
- Green, S. B., & Salkind, N. J. (2003). *Using SPSS for Windows and Macintosh: Analyzing and understanding data*. Prentice Hall Press.
- Hall, A. B., & Trespalacios, J. (2019). Personalized professional learning and teacher self-efficacy for integrating technology in K–12 classrooms. *Journal of Digital Learning in Teacher Education*, 35(4), 221–235. DOI:[10.1080/21532974.2019.1647579](https://doi.org/10.1080/21532974.2019.1647579)
- Harrison, T., & Laco, D. (2022). Where's the character education in online higher education? Constructivism, virtue ethics and roles of online educators. *E-Learning and Digital Media*, 19(6), 555-573. <https://doi.org/10.1177/20427530221104885>
- He, Y. (2014). Universal design for learning in an online teacher education course: enhancing learners' confidence to teach online. *MERLOT Journal of Online Learning and Teaching*, 10(2), 283–297.
- Henry, S. (2016). *An evaluation of mentoring, self- efficacy, and teacher retention in an induction program*. Walden University and Doctoral Studies. <https://scholarworks.waldenu.edu/cgi/viewcontent>.
- Horvitz, B. S., Beach, A. L., Anderson, M. L., & Xia, J. (2015). Examination of faculty self-efficacy related to online teaching. *Innovative Higher Education*, 40(4), 305–316. <https://doi.org/10.1007/s10755-014-9316-1>
- Hung, M. (2016). Teacher readiness for online learning: Scale development and teacher perceptions. *Computers & Education*, 9(4), 120–133. <https://doi.org/10.1016/j.compedu.2015.11.012>
- Jahanara, A., Sarmadi, M. R., Esmaili, Z., & Zarabian, F. (2021). Determining the Effectiveness of Distance Teaching Model Based on the Constructivism approach on Learning Performance, Satisfaction and Attitude of Payam-e-Noor University Students. *Iranian Journal of Learning and Memory*, 3(12), 19-30. <https://doi.org/10.22034/iepa.2021.251590.1215>
- Jha, A. (2017). ICT pedagogy in higher education: A constructivist approach. *Journal of Training and Development*, 3(1), 65-70. DOI:[10.3126/jtd.v3i0.18232](https://doi.org/10.3126/jtd.v3i0.18232)
- Karabatak, S., & Turhan, M. (2017). Effect of web-based problem learning on school administrators' self-efficacy beliefs and attitudes towards principalship profession. *Education and Science*, 42(191), 1–29. DOI:[10.15390/EB.2017.7105](https://doi.org/10.15390/EB.2017.7105)
- Karakus, N., Ucuşsatar, N., Karacaoglu, M. O., Esendemir, N., & Bayraktar, D. (2020). Turkish teacher candidates' views on distance education. *RumeliDE Journal of Language and Literature Studies*, (19), 220-241. DOI:[10.5539/ies.v14n10p53](https://doi.org/10.5539/ies.v14n10p53)
- Kizkapan, O., Karaca, M., & Eroglu, S. (2023). Pre-service science teachers' experiences of an expert-guided online education project. *Participatory Educational Research*, 10(6), 192-207. <http://dx.doi.org/10.17275/per.23.96.10.6>
- Kizkapan, O., Onal, N. T., & Kirmizigul, A. S. (2023). Laboratory use self-efficacy of Turkish pre-service science teachers trained in different teacher education programmes. *Center for Educational Policy Studies Journal*.1-19. <https://doi.org/10.26529/cepsj.1571>
- Lim, C. K. (2001). Computer self-efficacy, academic self-concept, and other predictors of satisfaction and future participation of adult distance learners. *American Journal of Distance Education*, 15(2), 41–51. <https://doi.org/10.1080/08923640109527083>
- Ma, K., Chutiya, M., Zhang, Y., & Nicoll, S. (2021). Online teaching self-efficacy during COVID-19: Changes, its associated factors and moderators. *Education and information technologies*, 26(6), 6675-6697. <https://doi.org/10.1007/s10639-021-10486-3>
- McKim, A. J., & Velez, J. J. (2017). Developing self-efficacy: Exploring preservice coursework, student teaching, and professional development experiences. *Journal of Agricultural Education*, 58(1), 172–185. <https://doi.org/10.5032/jae.2017.01172>
- MEB, (2018). *Science course draft curriculum (primary and secondary school 3rd, 4th, 5th, 6th, 7th, 8th grades)*. Ankara: General Directorate of Basic Education.

- Merrill, S. (2020). Teaching through a pandemic: A mindset for this moment. *Edutopia*. <https://www.edutopia.org/article/teaching-through-pandemic-mindset-moment>
- Nahm, E. S., & Resnick, B. (2008). Development and testing of the web-based learning self-efficacy scale (WBLSES) for older adults. *Ageing International*, 32(1), 3-14. DOI:10.1007/s12126-008-9003-6
- Ozenc, M., & Cakir, M. (2015). Exploring Primary School Teachers' Competencies of Alternative Assessment and Evaluation. *Elementary Education Online*, 14(3), 914-933. DOI:10.17051/ieo.2015.22900
- Pressley, T., Roehrig, A. D., & Turner, J. E. (2018). Elementary teachers' perceptions of a reformed teacher-evaluation system. *The Teacher Educator*, 53(1), 21-43. <https://doi.org/10.1080/08878730.2017.1391362>
- Rahim, N. B. (2022). The interaction between teaching competencies and self-efficacy in fostering engagement amongst distance learners: A path analysis approach. *Malaysian Journal of Learning and Instruction*, 19(1), 31-57. DOI:10.32890/mjli2022.19.1.2
- Renner, S., & Pratt, K. (2017). Exploring primary teachers' self-efficacy beliefs for teaching dance education. *Issues in Educational Research*, 27(1), 115-133. <https://doi.org/10.3316/ielapa.788359457694377>.
- Rohde, T. E., & Thompson, L. A. (2007). Predicting academic achievement with cognitive ability. *Intelligence*, 35(1), 83-92. <https://psycnet.apa.org/doi/10.1016/j.intell.2006.05.004>
- Sagin, A. E., Yucekaya, M. A., & Gullu, M. (2021). The scale of distance education competences of physical education teachers: A scale development study. *Ondokuz Mayıs University Journal of Sports and Performance Researches*, 12(2), 200-211.
- Saracaloglu, A. S., & Yenice, N. (2009). Investigating the self-efficacy beliefs of science and elementary teachers with respect to some variables. *Journal of Theory and Practice in Education*, 5(2), 244-260.
- Schwarzer, R., & Hallum, S. (2008). Perceived teacher self-efficacy as a predictor of job stress and burnout: Mediation analyses. *Applied Psychology*, 57(1), 152-171. DOI:10.1111/j.1464-0597.2008.00359.x
- Shahzad, K., & Naureen, S. (2017). Impact of teacher self-efficacy on secondary school students' academic achievement. *Journal of Education and Educational Development*, 4(1), 48-72. DOI:10.22555/joeed.v4i1.1050
- Simonson, M., Zvacek, S. M., & Smaldino, S. (2019). *Teaching and learning at a distance: Foundations of distance education* (7th ed.). IAP Publishing.
- Tas, Y., Eminoglu, S., Atila, G., Yildiz, Y., & Bozkurt, U. (2021). Teachers' self-efficacy beliefs and opinions about distance education during the COVID-19 pandemic. *Turkish Online Journal of Distance Education*, 22(4), 229-253. <https://doi.org/10.17718/tojde.1002868>
- Tasci, S. (2021). Evaluation of emergency distance language education: Perspectives of ELT students. *Nevsehir Haci Bektas Veli University Journal of ISS*, 11(1), 286-300.
- Tschannen-Moran, M., & Woolfolk Hoy, A. (2007). The differential antecedents of self-efficacy beliefs of novice and experienced teachers. *Teaching and Teacher Education*, 23(6), 944-956. <https://doi.org/10.1016/j.tate.2006.05.003>
- van Dinther, M., Dochy, F., & Segers, M. (2011). Factors affecting students' self-efficacy in higher education. *Educational Research Review*, 6(2), 95-108. <https://doi.org/10.1016/j.edurev.2010.10.003>
- Woodcock, S., Sisco, A. ve Eady, M. (2015). The learning experience: Training teachers using online synchronous environments. *Journal of Educational Research and Practice*, 5(1), 21-34. DOI:10.5590/JERAP.2015.05.1.02
- Zimmerman, W. A., & Kulikowich, J. M. (2016). Online learning self-efficacy in students with and without online learning experience. *American Journal of Distance Education*, 30(3), 180-191. <https://doi.org/10.1080/08923647.2016.1193801>

Biographical note:

Oktay Kizkapan is an associate professor in the science education department at the education faculty of Nevsehir Haci Bektas Veli University, Turkiye. The researcher has articles published in national and international journals on science education and teacher education as well as gifted education.