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The Effect of Laboratory Practices Supported by Virtual Learning Environments on Educational Technology Self-Efficiencies of Teacher Candidates

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Abstract. It is important that teachers, who are responsible for the qualified integration of technology into the education process, should be equipped with the necessary knowledge and skills. Implementation of technology integration practices with the participation of teacher candidates will contribute to gaining experience. Therefore, in this study, it is aimed to examine the effect of physics laboratory applications supported by virtual learning environments on the self-efficacy of teacher candidates towards educational technologies. The one group pre-test post-test design was used in the study. The study group consisted of 10 male and 18 female physics teacher candidates studying at a state university. The data were obtained by applying the "Education Technology Standards Self-Efficacy (ETSSE) Scale" as the pre-test and post-test. As a result of the analysis, there was no statistically significant difference between the pre-test and post-test self-efficacy scores of the pre-service teachers and similar results were obtained in terms of the sub-factors of the scale. While there was no significant difference according to the pre-test self-efficacy scores of male and female candidates, there was a significant difference in favour of female teacher candidates according to the post-test scores.

Keywords. Educational technologies self-efficacy, teacher candidates, virtual learning environments.

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In the emergency distance education process during the pandemic period, educators and students of all ages and levels used technology, from pre-school to graduate education. Therefore, even though the pandemic process has disappeared, technology applications in education are developing still rapidly. In this case, the point to be considered is the structure of the use of Information and Communication Technologies (ICT) in education process for teaching purposes. “Learning with Information and Communication Technologies” and “Learning through Information and Communication Technologies” define two different technology usage structures (Pelgrum & Law, 2003:23). The first one refers to the use of ICT in order to create an environment that enhances learning in the process by supporting classical methods without making any significant changes in teaching-learning methods and classroom activities. The second one, refers to the integration of the relevant ICT tools into the course and program, and so that teaching and learning of that course/program can no longer be without them. These tools create student centred environment which allows students to be creative/productive and which enables them to make the changes they want. (Maddux & Johnson, 2006; Pelgrum & Law, 2003:23; Tubin, 2006). The first type of applications are simple and easily applicable. However, the second type of applications are applications that require more extensive and planned configuration (Maddux & Johnson, 2006). Therefore, the integration of technology into the education-teaching process and the use of technology in the course do not mean the same thing (Tanel, 2020). Technology integration in education requires an understanding of the pedagogical principles of the technology to be used as well as learning to use certain pieces of hardware and software (Diaz & Bontenbal, 2000). Therefore, the ICT tools to be used should not be added to the teaching process afterwards, and the decisions regarding their use should be taken into consideration during the teaching planning process (Britten & Cassady, 2005; Jimoyiannis & Komis, 2006; Kent & Giles, 2017; Okojie, Olinzock & Okojie-Boluder, 2006). Considering that teachers are responsible for making plans for the annual and daily implementation of curriculum, it can be said that they are one of the important factor in applying ICT integration in schools (Jimoyiannis & Komis, 2006; Ozan & Taşgın, 2017; Özmen, Koçak Usluel & Çelen, 2014; Tanel, 2020).

However, even if the necessary conditions are met, it is seen that teachers and even teacher educators cannot perform qualified technology integration due to their lack of knowledge, skills and experience regarding technology integration (Cuban, Kirkpatrick & Peck, 2001; Demiraslan & Usluel Koçak, 2008; Hernandez-Ramos, 2005; Hew & Brush, 2007; İnan, 2007; Orhan, Kurt, Ozan, Vural & Turkan, 2014; Sutton, 2011; Turan, Küçük & Gündoğdu, 2013; Yıldırım, 2007). For example, while experienced teachers resist including technology applications in their lessons (Su, 2009), young teachers who are new to the profession and can use technology very well in their daily lives do not know how to integrate the technologies they use into the teaching process (Bebell, Russell & O'Dwyer, 2004; Clausen, 2007; Egan, FitzGibbon, Johnston & Oldham, 2019; Kurz & Middleton, 2006; Sadaf, Newby & Ertmer, 2012; Sang, Valcke, Van Braak & Tondeur, 2010).

However, considering today's conditions, it is an important feature and responsibility that all teachers should have to acquire the ability to use technology and to be equipped how to choose appropriate ICT tools that increase student learning and will help to achieve learning outcomes (Birişçi & Kul, 2019; Bozdoğan & Özen, 2014; Ruggiero & Mong, 2015). In addition, this situation has been demonstrated by international and national standards. Within the framework of ICT competencies revealed by UNESCO, the skills that teachers should have are included under the fields of technology literacy, deepening of knowledge and creation of knowledge (UNESCO, 2011). Teacher standards for technology integration in education put forward by International Society for Technology in Education (ISTE) are detailed under seven sub-areas: learner, leader, (digital) citizen, collaborator, designer, facilitator and analyst (ISTE, 2022). There are two competencies ("Planning and organizing teaching processes" and "To have information and communication skills") in both primary (MEB, 2017b) and secondary (MEB, 2017c) education special field teacher competencies. These are based on the competency ("B3.9. He/she uses information and communication technologies effectively in the teaching and learning process.") included in the general teacher competencies (MEB, 2017a) determined by the Ministry of National Education.

The most effective way for teachers to reach these competencies is through the training given in teacher training institutions before starting the profession (Drent & Meelissen, 2008). However, when the literature is examined, it is emphasized that the courses in these programs are generally devoid of teaching process applications and are in a structure to develop skills for the use of basic ICT tools (Ertmer, Conklin & Lewandowski, 2003; Jacobsen, Clifford & Friesen, 2002; Koehler, Mishra & Yahya, 2007; Şimşek & Yazar, 2019). These technology-centred approaches, which are far from the teaching process, do not support effective technology integration (Harris, Mishra & Koehler, 2009) and cause pre-service teachers to be insufficient in how to transfer the technologies they have learned to the classroom environment and teaching process (Egan at al., 2019; Ottenbreit-Leftwich, Glazewski, Newby & Ertmer, 2010). For this reason, teacher training programs should provide young teacher candidates the opportunity to implement teaching practices based on concrete examples regarding the integration of these technologies into the teaching process, as well as providing them the knowledge and skills related to the use of ICT (Chai, Koh, Tsai & Tan, 2011; Groth, Dunlap & Kidd, 2007; Hew & Brush, 2007; Kent & Giles, 2017; Kapici & Akcay, 2020; Sweeney & Drummond, 2013; Tondeur, Pareja Roblin, van Braak, Voogt & Prestridge, 2017).

The fact that the pre-service teachers can experience technology integration and the positive results of integration during pre-service period and they cooperate with their teachers and peers in these practices positively affect their self-efficacy in technology and technology integration (Abbitt, 2011; Al-Awidi & Alghazo, 2012; Chai et al., 2011; Holden & Rada, 2011; Kabakci Yurdakul & Çoklar, 2014; Chai, Koh, Tsai & Tan, 2011; Niederhauser & Perkmen, 2010; Tondeur, Scherer, Siddiq & Baran, 2017; Wang, Ertmer & Newby, 2004). ICT self-efficacy of teachers and pre-service teachers can be expressed as their self-confidence in using ICT tools effectively and integrating them into the teaching process (Peciuliauskiene, Tamoliune & Trepule, 2022; Ropp, 1999; Yıldız Durak, 2019). In the studies, it was emphasized that the pre-service teachers who adopt the use of technology through their self-efficacy increased with pre-service applications for educational technologies, will be able to realize successful technology integration in their classrooms willingly and carefree (Abbitt, 2011; Anderson & Maniger, 2007; Brown, Holcomb & Lima, 2010; Koh & Frick, 2009; Niederhauser & Perkmen, 2010).

Considering all the points mentioned above, it is very important in training of teacher candidates that they gain experience in preparing constructivist learning environments created with the qualified integration of technology that will enable to learn meaningfully.

Based on this requirement, in this study, it is aimed to examine the effects of supporting the laboratory practices attended by pre-service teachers with virtual learning environments on their educational technologies self-efficacies.

Method

Research Model

The one group pre-test post-test design was used in this study. The one group pre-test post-test design is a model in which there is one experimental group and the measurement tools are applied as pre-test before the experimental procedure and the same measurement tools are applied as post-test after the experimental intervention. Thus, effect of the experimental procedure is identified (Özmen & Karamustafaoğlu, 2019).

Study Group

The study group of the research was determined by convenience sampling, which is one of the non-random sampling methods (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2019). The study group consisted of 10 male and 18 female physics teacher candidates studying at education faculty of a state university. These participants are pre-service teachers enrolled in the "Laboratory Practices in Physics Teaching 2" course in the spring semester of the 2021-2022 academic year at the third year of the physics education department.

Data Collection Tools

As a data collection tool in the research, "Education Technology Standards Self-Efficacy (ETSSE) Scale" developed by Şimşek and Yazar (2016) was used with the permission of its developers. ETSSE scale consists of 40 items in five-point likert type with options and scoring in the form of "Strongly Disagree" (1), "Disagreed" (2), "Mildly Agree" (3), "Agree" (4) and "Strongly Agree" (5). ETSSE scale consists of five sub-factors and Cronbach Alpha coefficient of whole scale is 0,95. The sub-factors of the scale were defined as facilitating and inspiring student learning and creativity (factor 1), designing and developing digital age learning experiences and assessments (factor 2), modelling digital age work and learning (factor 3), promoting and modelling digital citizenship and responsibility (factor 4) and engaging in professional growth and leadership (factor 5), respectively. Şimşek and Yazar (2016) reported that Cronbach Alpha coefficient of the first sub-factor with 9 items is 0,83; for the second sub-factor with 10 items is 0,87; for the third sub-factor with 5 items is 0,77; for the fourth sub-factor with 7 items is 0,87 and for the fifth sub-factor with 9 items is 0,85.

Process

The experiments to be handled during the implementation process were selected within the scope of the "Laboratory Applications in Physics Teaching 2" course, so that they can be performed both in laboratory environment and in the virtual environment. Eight experiments were determined on force balancing, springs, simple pendulum, moment of inertia, lenses, refraction, current and voltage dividers and Kirchhoff's Laws. The computer laboratory and the physics laboratory were used as classrooms during the application. Each student was provided with a computer that they can use in the computer laboratory.

Before the application, the students in the study group were informed about the purpose of the research and why it was carried out. In addition, participant consent forms were obtained from them stating whether they would voluntarily participate in the study.

"Education Technology Standards Self-Efficacy (ETSSE) Scale" was administered to the teacher candidates as pre-test before the experimental process started.

After the pre-test application, EDMODO, an educational online social learning platform that teachers and students can use free of charge, was introduced to teacher candidates during two-hour lesson in the first week. In this introducing process, information was given about registering as a teacher, student and parent, opening a class, creating groups under classes, sharing from lesson and group interfaces, creating and assigning homework and exams, use of evaluation statistics and task schedule. Students were wanted to open an account on EDMODO by using the computers in the computer lab and to practice using it. The candidates in the responsible group were appointed as assistant teachers every week. Thus, candidates in all groups in turn experienced how to use this platform as a student and a teacher.

In the second week, information was given about the TINKERCAD web application, which makes it possible to do applications for 3D design, electronics and coding, where electrical experiments will be carried out during a two-hour lesson. At this stage, again, information was given about registering and participating in a lesson as a student and teacher, creating lessons as a teacher and opening activities in the lessons, participating in an activity as a student, checking the circuit designs created by the students, giving feedback, circuit elements, setting up circuits, taking measurements and running the circuit simulation. After the introducing, a circuit design was made in an exemplary activity, feedbacks were given and sample measurements were taken by running the simulations of these circuits. Information was shared with the groups that will carry out the electrical experiments, in which circuit they will work with which values of resistance and voltage. Thus, they were guaranteed to make the same circuits in both virtual and real laboratory environment.

Simulation experiments about springs, simple pendulums, lenses and refraction were selected from PhET, created by University of Colorado, free interactive simulation experiments. Simulation experiments on force balancing and moment of inertia were selected from the experiment simulations at https://www.vascak.cz/physicsanimations.php?l=tr. The selected simulations have features that allow measurement by changing the values of the relevant variables. Each group was informed about where to access the simulation of the experiment they were responsible for.

After the necessary information training given by all researchers, eight groups of 3-4 people were formed from the pre-service teachers, and they were informed about which group was responsible for which experiment.

Each group was asked to first perform the experiment they were responsible for in the real environment, to record the necessary measurements by making a video during the real experiment, and to make the necessary calculations. Then, they were asked to perform the same experiment under the same conditions in the virtual environment, take their measurements and make the necessary calculations. Also, they were asked to compare the results of experiments done in real and virtual environments. In addition to these, they were asked to upload these, measurements, videos, graphics, calculations, pictures and comparisons they obtained, to the course interface in the EDMODO environment and share them with their friends. Each week, two groups presented what they had done in the experiment they were responsible for to their friends using a smart board.

At the end of the lesson, the presenting groups asked 3-4 questions regarding the experiment they introduced to their fellow students by using the quiz property of EDMODO. At this stage, students in the position of assistant teacher in each responsible group created a question. Pre-service teachers who answered these questions, which included simulation application and theoretical knowledge, again sent their answers by using the quiz property of EDMODO. The pre-service teachers in the status of assistant teachers evaluated the answers given to their own questions in the next week. Thus, pre-service teachers were enabled to use the EDMODO platform interactively in their student and teacher status. Two experiment topics were covered with two group presentations each week. For this reason, the application process period of eight experiments was completed in four weeks.

"Education Technology Standards Self-Efficacy (ETSSE) Scale" was administered to the teacher candidates as a post-test at the end of the experimental process.

Data Analysis

In order to decide which analysis can be applied on the data, analyses were made primarily to test the normality of the data. Shapiro-Wilk test is recommended in cases where the number of observations is less than 30 (Can, 2016, p.89). The results are presented in Table 1.

Table 1.

Shapiro-Wilk Test Results of Pre-Test and Post-Test Data

	Pre-test			Post-test		
	Stat.	df	p	Stat.	df	p
Total	.954	28	.25	.927	28	.053
Sub-factor 1 Facilitating and inspiring student learning and creativity	.941	28	.115	.911	28	.021*
Sub-factor 2 Designing and developing digital age learning experiences and assessments	.948	28	.178	.946	28	.155
Sub-factor 3 Modelling digital age work and learning	.926	28	.05	.924	28	.044*
Sub-factor 4 Promoting and modelling digital citizenship and responsibility	.964	28	.431	.854	28	.001*
Sub-factor 5 Engaging in professional growth and leadership	.907	28	.017*	.905	28	.015*

The p value for the pre-test sub-factor 3 data was at the limit for p=0.05 significance level. The skewness z value of the distribution of the sub-factor 3 data (the value obtained by dividing the skewness coefficient by the standard error of the skewness) is -0.45; the kurtosis z value (the value obtained by dividing the kurtosis coefficient by the standard error of kurtosis) is -1.51. If the z values are between -1.96 and +1.96, the distribution can be accepted as normal (Can, 2016, p.85). Thus, it is understood that for the pre-test data, only the data for the sub-factor 5 and for the sub-factors 1, 3, 4 and 5 for the post-test data do not fit the normal distribution. For the analysis of the research, data that met the normality condition were subjected to parametric tests, while non-parametric tests were applied to the data that did not.

Results

The arithmetic mean and standard deviation values of teacher candidates' self-efficacy towards educational technology standards before and after the application are presented in Table 2.

Table 2.

Means and Standard Deviations of Teacher Candidates' Scores from ETSSE Scale

	Pre-test (n=28)		Post-test (n=28)	
	Mean	SD	Mean	SD
Total	4.14	.43	4.34	.42
Sub-factor 1 Facilitating and inspiring student learning and creativity	4.31	.49	4.42	.47
Sub-factor 2 Designing and developing digital age learning experiences and assessments	4.05	.45	4.31	.50
Sub-factor 3 Modelling digital age work and learning	4.17	.57	4.31	.45
Sub-factor 4 Promoting and modelling digital citizenship and responsibility	3.92	.59	4.21	.65
Sub-factor 5 Engaging in professional growth and leadership	4.25	.50	4.41	.51

The classification of self-efficacy scores is as follows; between 1.00-1.80 very low score, between 1.81-2.60 low score, between 2.61-3.40 intermediate score, between 3.41-4.20 high score and between 4.21-5.00 very high score. From Table 2, it is seen that pre-service teachers' self-efficacy for educational technology standards was high before the application and very high after the application. Pre-service teachers also showed very high self-efficacy in the pre-test for the sub-factor of facilitating and inspiring student learning and creativity and the sub-factor of engaging in professional growth and leadership. In both the pre-test and post-test, the lowest average was found in the sub-factor of promoting and modelling digital citizenship and responsibility, and the highest average was in the sub-factor of facilitating and inspiring student learning and creativity.

Paired samples t-test was performed in order to understand whether there is a significant difference between the scores obtained from the ETSSE scale before and after the application.

Table 3.

Comparison of Pre-Service Teachers' Self-Efficacy Scores for Educational Technology Standards Before and After the Application

	n	Mean	SD	df	t	p
Pre-test	28	165.75	17.34	27	-1.494	.147
Post-test	28	173.67	17.14			

As seen in Table 3, there was no statistically significant difference between the total mean scores obtained from the scale, although the post-test scores were higher than the pre-test scores, at the $p=0.05$ significance level ($p=0.147>0.05$).

Results of paired samples t-test applied for sub-factor 2 which satisfies the normality condition for both pre-test and post-test, in order to understand whether there is a significant difference between the scores obtained before and after the application for the sub-factor of the ETSSE scale indicated in Table 4. The Wilcoxon signed-rank test results for the sub-factors 1, 3, 4 and 5 that do not meet the normality condition for pre-test and/or post-test are presented in Table 5.

Table 4.

Paired Samples T-Test Results for Sub-Factor 2

Sub-factor 2 Designing and developing digital age learning experiences and assessments	n	Mean	SD	df	t	p
Pre-test	28	40.46	4.56	27	-1.934	.064
Post-test	28	43.10	5.09			

Table 5.

Wilcoxon Signed-Rank Test Results for the Sub-Factors of 1, 3, 4 and 5

Sub-factors	Post-test – Pre-test	n	Mean Rank	Sum of Ranks	z	p
Sub-factor 1 Facilitating and inspiring student learning and creativity	Positive Ranks	14	15.68	219.50	.734	.463
	Negative Ranks	13	12.19	158.50		
	Ties	1				
Sub-factor 3 Modelling digital age work and learning	Positive Ranks	13	16.42	213.50	.967	.333
	Negative Ranks	13	10.58	137.50		
	Ties	2				
Sub-factor 4 Promoting and modelling digital citizenship and responsibility	Positive Ranks	16	14.63	234.00	1.489	.137
	Negative Ranks	10	11.70	117.00		
	Ties	2				
Sub-factor 5 Engaging in professional growth and leadership	Positive Ranks	15	15.37	230.50	.998	.318
	Negative Ranks	12	12.29	147.50		
	Ties	1				

As can be seen from Tables 4 and 5, there is no statistically significant difference between pre-test and post-test data for any of the sub-factors of ETSSE scale.

In order to compare the data obtained from the ETSSE scale applied before and after the application according to the gender variable, the independent t-test was applied to the pre-test and post-test total scores, because of the normality condition was met (see Table 6).

Table 6.

Comparison of Teacher Candidates' Total Self-Efficacy Scores of Pre-Test and Post-Test According to Gender Variable

	Gender	n	Mean	SD	df	t	p
Pre-test	Female	18	167.61	16.00	26	.756	.457
	Male	10	162.40	19.97			
Post-test	Female	18	181.43	10.50	26	3.204	.004*
	Male	10	163.33	19.15			

As seen in Table 6, student teachers' pre-test total self-efficacy scores of the ETSSE scale did not show a significant difference according to gender.

In the pre-test data obtained from the sub-factors, the independent t-test (see Table 7) was used for the sub-factors satisfying the normality condition. Mann-Whitney U-test (see Table 8) was applied for the sub-factor 5 that did not show normal distribution.

Table 7.

Comparison of Sub-Factor 1, 2, 3 and 4 Self-Efficacy Scores for Pre-Test Data According to Gender Variable

Sub-factors	Gender	n	Mean	SD	df	t	p
Sub-factor 1 Facilitating and inspiring student learning and creativity	Female	18	39.50	3.69	26	1.14	.26
	Male	10	37.50	5.56			
Sub-factor 2 Designing and developing digital age learning experiences and assessments	Female	18	40.44	4.73	26	-.03	.97
	Male	10	40.50	4.50			
Sub-factor 3 Modelling digital age work and learning	Female	18	21.22	2.83	26	.90	.37
	Male	10	20.20	2.93			
Sub-factor 4 Promoting and modelling digital citizenship and responsibility	Female	18	27.77	3.60	26	.58	.56
	Male	10	26.80	5.22			

Table 8.

Comparison of Sub-Factor 5 Self-Efficacy Scores for Pre-Test Data According to Gender Variable

Sub-factor	Gender	n	Mean Rank	Sum of Ranks	U	p
Sub-factor 5 Engaging in professional growth and leadership	Female	18	15.44	278.00	73.00	.41
	Male	10	12.80	128.00		

As can be seen from Tables 7 and 8, the pre-test self-efficacy scores for each sub-factor do not show a statistically significant difference according to gender.

The total self-efficacy scores of the pre-service teachers in the post-test differ significantly in favor of women according to gender (see Table 6). Results of the Mann Whitney U test applied for the sub-factors 1, 3, 4 and 5 that do not meet the normality condition, in order to understand from which sub-factors the difference arises, are presented in Table 9. The results of the independent t-test for sub-factor 2, which meets the normality condition, are presented in Table 10.

Table 9.

Comparison of Sub-Factor 1, 3, 4 and 5 Self-Efficacy Scores for Post-Test Data According to Gender Variable

Sub-factors	Gender	n	Mean Rank	Sum of Ranks	U	p
Sub-factor 1 Facilitating and inspiring student learning and creativity	Female	18	16.41	262.50	65.5	.154
	Male	10	11.96	143.50		
Sub-factor 3 Modelling digital age work and learning	Female	18	16.09	257.50	70.5	.229
	Male	10	12.38	148.50		
Sub-factor 4 Promoting and modelling digital citizenship and responsibility	Female	18	18.12	290.00	38.00	.007*
	Male	10	9.67	116.00		
Sub-factor 5 Engaging in professional growth and leadership	Female	18	17.44	279.00	49.00	.028*
	Male	10	10.58	127.00		

Table 10.

Comparison of Sub-Factor 2 Self-Efficacy Scores for Post-Test Data According to Gender Variable

	n	Mean	SD	df	t	p
Female	18	45.18	3.95	26	2.791	0.01*
Male	10	40.33	5.26			

As can be seen from Tables 9 and 10, the post-test data on sub-factor 2, 4 and 5 show statistically significant differences according to gender in the favor of the women.

Discussion and Conclusion

In the light of the findings, the following conclusions were reached:

The pre-service teachers' self-efficacy towards educational technology standards were found to be high before the application and very high after the application. In the related literature, it has been stated that the technology self-efficacy of the teacher candidates is high in the results of the studies conducted on teacher candidates (Birişçi & Kul, 2019; Bozdoğan & Özen, 2014; Caner & Aydın, 2021; Kent & Giles, 2017; Ozan & Taşgın, 2017). At this point, the findings of the study support these findings. Explanations in the literature indicate, that teachers in the field of science think that their field is more prone to the use of technology (John & Baggot la Velle, 2004 cited in Şimşek & Yazar, 2019), that they find this field more suitable for technology integration (Kula & Deryakulu, 2017 cited in Şimşek & Yazar, 2019), and that the pre-service teachers in this field have high self-efficacy (Balçın & Ergün, 2018). These explanations can be considered as a reason for the high pretest self-efficacy scores of physics teacher candidates in the sample group of the present study. On the other hand, it is another important point emphasized in the literature that teacher candidates' mastery experiences and indirect experiences positively affect their self-efficacy (Al-Awidi & Alghazo, 2012) and that senior teacher candidates from the upper grades have higher self-efficacy (Caner & Aydın 2021). Considering that the pre-service teachers constituting the study group of the research are third grade students, it also reveals the idea that their high self-efficacy may be due to their being in the upper class.

In terms of sub-factors of ETSSE scale, pre-service teachers' self-efficacy for the factors of facilitating and inspiring student learning and creativity, and engaging in professional growth and leadership were found to be very high before application. The lowest average before and after the application appeared in the sub-factor of promoting and modelling digital citizenship and responsibility, and the highest average in the sub-factor of facilitating and inspiring student learning and creativity. Fu (2013) stated that experiences in the teaching process will facilitate technology integration. For example; Birişçi and Kul (2019) emphasized that the applications in the content of the Instructional Technologies and Material Development course taken by the pre-service teachers can contribute to the development of the pre-service teachers due to their feature of combining technology and course content. Physics teacher candidates have taken courses that include educational technologies and field-specific teaching methods until they reach the third year. It is thought that the knowledge about the constructivist learning environments they learned in the courses they took and the technologies used in these environments may be a source of very high self-efficacy, especially in these sub-factors. In contrast to the previous situation, the lack of experience due to the fact that their internship experience has not started and they have not yet entered the classroom environment can be seen as the source of low self-efficacy in the sub-factor of digital citizenship. Caner and Aydın (2021) also concluded in their study that pre-service teachers' self-efficacy in enabling others to use computer technologies is low. In addition, in the studies of Ozan and Taşgın (2017), it was emphasized that pre-service teachers who consider themselves competent in terms of productivity and professional practices do not in same thinking on social, ethical, legal and humanitarian issues. Accordingly, it can be said that the above-mentioned results for the sub-factors are compatible with these studies.

The pre-service teachers' self-efficacy towards educational technology standards did not show a statistically significant difference compared to the pre-application after the application. However, the self-efficacy score averages after the application are higher than before the application. In terms of sub-factors, there is no significant difference between pre-service teachers' self-efficacy before and after the application. In this case, it can be stated that the high readiness of the candidates does not make the size of the change meaningful.

The total self-efficacy scores of the pre-service teachers before the application did not show a significant difference according to gender. In terms of sub-factors, there was no difference in pre-application self-efficacy scores according to gender. These results of the research produced the same result as the studies of Caner and Aydın (2021), Kavak (2021), Birişçi and Kul (2019), Doğru, Şeren, and Koçulu, (2017), Seferoğlu and Akbıyık (2005). There was a significant difference in favor of women in self-efficacy scores after the application. After application; scores of sub-factors of the scale that designing and developing digital age learning experiences and assessments, that promoting and modelling digital citizenship and responsibility, and that engaging in professional growth and leadership differs in favor of women according to gender. Although there is no significant difference in the pre-test scores, when we look at the studies conducted around the world in the related literature, it is seen that this situation generally shows a favorable for men between men and women (Huffman, Whetten & Huffman, 2013). In studies aimed at balancing the differences at this point, it has been concluded that women increase technology integration when they receive interactive training for technology, since they can learn technology when interacting with others (Zhou & Xu, 2007). It can be interpreted that the interactive training process carried out in the study contributes more to female candidates than self-confident male candidates at this point. This result is considered to be important in terms of efforts to eliminate the gender gap in technology integration.

Recommendations

Practitioners who will carry out studies similar to this study are recommended to create an application plan by keeping the application time longer and by designing activities that will contribute to the experiences of the candidates in the specified sub-dimensions.

In addition, it is recommended to conduct studies with candidate groups with low technology self-efficacy levels determined in the relevant literature. In this case, it can be predicted that the results regarding the effects of the applications may vary.

However, it is thought that carrying out the study group at different grade levels will contribute to the diversity of the results.

In addition, receiving the opinions of the participants on the practices can also contribute to determining the effect of these practices.

About Authors

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