Examining the Pre-service Teachers' Components of Self-Efficacy Beliefs in Science Teaching (SEBST)*

Dilber POLAT**   Gülşah ULUAY***

Uğur BAŞARMAK****

Abstract. This study was designed as a qualitative–quantitative triangulation research, one of the mixed method designs in which the data are collected concurrently, with the purpose of examining the pre-service teachers' components of self-efficacy beliefs in science teaching. The study was carried out with the participation of 189 pre-service science teachers. Data of the study was collected using a "Personal Information Form", the "Self-Efficacy Scale for Science Teaching", and an "Unstructured Questionnaire" consisting of four open-ended questions. Since the quantitative data obtained from the research fulfilled the assumptions of parametric test, the descriptive statistics were analyzed using independent samples t-Test and one-way analysis of variance (ANOVA). The qualitative data was analyzed using content analysis. Based on the analysis results obtained from the quantitative data, it was found that whereas the pre-service teachers' mean scores for the Self Efficacy Scale for Science Teaching did not differ significantly in terms of gender, they differed significantly in terms of level of grade, whether selected the department willfully and career plan. The results obtained from the qualitative data was evaluated under four themes: Verbal persuasion, direct experiences, indirect experiences and emotional state.

Keywords: Self-efficacy, pre-service science teachers, self-efficacy components

1. INTRODUCTION

Every step an individual takes and every work an individual starts aim at success. It cannot be ignored that self-efficacy belief, an individual's belief in whether she/he will be able to succeed or not, affects the task undertaken or the results of the action being carried out. The first researches on self-efficacy started in the United States in the late 1970s with Albert Bandura's therapy studies that were carried out with the participation of individuals with a phobia of being bitten by various animals such as snakes and dogs (Sakız, 2013).

According to Bandura (1997), self-efficacy is "one's belief in own personal competencies and potential." In another definition, self-efficacy is defined as an individual's self-confidence in accomplishing or fulfilling the task or tasks undertaken (Kinzie, Delcourt, & Powers, 1994). Teachers' beliefs towards teaching and learning processes affect their way of using the pedagogical knowledge (Roehrig & Luft, 2004). Similarly, teachers' self-efficacy has a positive effect on their beliefs about teaching behaviors (Cho and Shim, 2013). Teachers' self-efficacy also affects their choice of teaching methods and techniques to be used in the classroom and their students' success level (Ross, 1994) Recepoğlu and Recepoğlu (2020) emphasized that improving the quality of teaching profession and enhancing the quality of education could be possible through increasing the motivation and self-efficacy of teachers, especially the prospective ones who are at the beginning of the road.

Bandura (1995) asserted that the factors (components) affecting self-efficacy are verbal persuasion, direct experiences, indirect experiences, and emotional state. The factor "verbal persuasion" refers to the effect of the encouragement and advices the individual receives about whether she/he will succeed or not on her/his self-efficacy perception. As for the individual's direct experiences, it is stated that positive experiences support the individual in forming self-efficacy belief in oneself for similar situations in the future. The factor "indirect experiences" refers to an individual's ability to develop belief in oneself in a situation where she/he observes the skills of other people, similar to oneself, to cope with difficult situations. The component "emotional state" emphasizes that an individual's level of happiness, stress, or anxiety while carrying out an action affects her/his self-efficacy perception (Aksu, 2019; Arseven, 2016; Yaz & Çetin, 2020).

Self-Efficacy Belief in Science Teaching

Self-efficacy beliefs of today's teachers and pre-service teachers, who make the greatest contribution to raising well-equipped new generations, are critical and important (Henson, Bennet, Sienty & Chambers, 2000). Based on this perspective, it can be asserted that pre-service science teachers' self-efficacy beliefs in science teaching have an effect on science teaching processes. So, examining the factors affecting the self-efficacy in science teaching is an important key to understand how to motivate teachers to overcome obstacles encountered in science teaching processes (Ramey-Gassert, Shroyer & Staver, 1996). Self-efficacy belief in science teaching is defined as a teacher's belief or confidence in her/his ability to teach science effectively (Ramey-Gassert & Shroyer,

1992). Levitt (2002) emphasizes the importance of teachers' self-efficacy beliefs to succeed in reforms for science education. Based on the related literature, it can be stated that the level of self-efficacy in science varies depending on various variables. In this regard, the effect of experiences on self-efficacy beliefs in science teaching is emphasized in the literature. Teachers with high self-efficacy report that they have had successful experiences in science in the past. On the other hand, it was reported that teachers with low self-efficacy associated their lack of confidence and interest in science with their previous negative experiences in science (Avery & Meyer, 2012).

Purpose of the Study

The purpose of this study was to examine the pre-service science teachers' components of self-efficacy belief in science teaching. To this end, answers to the following research questions were sought:

1. Is there a significant difference between the pre-service teachers' scores for self-efficacy in science teaching in terms of the variables such as gender, department preference, career plan, grade, academic achievement, and experiment anxiety?

2. What are the components of the pre-service teachers' self-efficacy beliefs in science teaching?

3. How do the pre-service teachers behave in situations that require self-efficacy in teaching?

2. METHOD

This section includes explanations about the research design, study group, data collection tools, data collection and its analysis.

Research Design

Creswell (2003) classified the design types as "sequential exploratory, sequential explanatory, sequential transformative, concurrent triangulation, concurrent nested, and concurrent transformative." Since the quantitative and quantitative data was collected concurrently, this study was designed in line with "concurrent triangulation." The reason why this design was preferred was to determine the accuracy, similarity, and relationship of the results using different methods. In the literature these designs were also generally classified as "triangulation, exploratory, nested, and explanatory" (Creswell & Plano Clark, 2007; Creswell, 2008).

Study Group

The sample of the study was selected using criterion sampling, which is one of the sub-types of purposeful sampling which is a type of non-random sampling. Patton (2014) defined the criterion sampling as a sampling involving the cases that meet some predetermined criteria of importance. In this study, the sampling criteria were as follows: being a student at the department of science education and having successfully completed the laboratory course at her/his grade level. The data collection process was

carried out on a voluntary basis with the participation of 189 pre-service science teachers who met these criteria.

Participants were coded as TF1-TM2. T refers to the participant pre-service teacher, F to female, and M to male. The code numbers are unique to each participant. 112 female and 77 male pre-service teachers participated in the study. 56 of the participants were freshmen, 32 were sophomores, 47 were juniors, and 54 were seniors.

Data Collection Tools

The following data collection tools were used in the study: a "personal information form" developed by the researchers, the "Self-Efficacy Scale for Science Teaching" developed by Kaya, Polat, and Karamüftüoğlu (2014), and an "unstructured questionnaire" consisting of four open-ended questions. In order to question some situations that were thought to affect the self-efficacy in teaching, the personal information form contained the following information: gender, grade, whether selected the department willfully, satisfaction with academic achievement in science, teaching preferences, experiment anxiety, and career plans. The "Self-Efficacy Scale for Science Teaching" (Kaya et al., 2014) is a 5-point Likert-type scale with 3 dimensions and 14 items. The Cronbach Alpha (α), the internal reliability coefficient of the scale, was given in Table 1 together with the coefficient calculated in this study.

Table 1

Internal Reliability Coefficients of the Self-Efficacy Scale for Science Teaching

Sub-dimensions	Cronbach Alpha(α) of the scale	Cronbach Alpha(α) calculated in this study
1. Sub-dimension: *Self-Efficacy in subject matter knowledge*	,80	,82
2. Sub-dimension: *Self-efficacy in realizing in-class activities (performance)*	,57	,79
3. Sub-dimension: *Self-efficacy in laboratory knowledge*	,87	,83
Internal reliability coefficient for overall scale	,83	,86

The reason why we used an unstructured questionnaire consisting of open-ended questions was to verify the data obtained from the scale and have a deeper insight through the answers given to open-ended questions. Unstructured questionnaires have some advantages over the structured ones. Baş (2010; p. 49) asserts that some information impossible to be obtained by closed-ended questions can be obtained using open-ended questions, and answers are not limited to the thoughts of the researcher. The content and face validity of the questionnaire questions were reviewed by two

experts, and the language validity was reviewed by a linguist. They were asked to score each question in the draft questionnaire consisting of six questions, and the Kappa coefficient of agreement between the reviewers was calculated and found to be .92. According to Landis and Koch (1977), the Kappa Coefficients equal to or above ,81 refer to a "very good fit" between the reviewers and are the proof of the reliability of the measurement tool. The following four questions were included in the final version of the questionnaire:

1. If your self-efficacy in science teaching is a success, what do you owe your success to?

2. How would you react when a student asks you an unexpected science-related question in the future? (How would you respond/react to your students who ask science-related questions when you are unprepared?)

3. What is your first choice when teaching a science-related subject? Please explain. (Would you prefer theory or experiment to make the students grasp the subject?)

4. What do you feel while experimenting? Does experimenting make you anxious? If so, what is the level of the anxiety? Why?

Data Collection

The ethics committee approval for this study was obtained from the Ethics Committee of the Rectorate of Kırşehir Ahi Evran University, dated 27/08/2020 and numbered 2020/03. Qualitative and quantitative data was collected concurrently at one time. It took 10-15 minutes for the pre-service teachers to complete the measurement tool under the supervision of the researcher.

Data Analysis

Since the research data was collected by concurrent triangulation, they were analyzed separately by quantitative and qualitative analysis methods. Assumptions of parametric test are reported to be as follows: "distribution of the measurements in the population is normal", "variances for the populations of samples are equal", "size of samples is at least 30 for each subgroup to be compared", and "subjects are independent from each other" (Büyüköztürk, Çokluk, and Köklü, 2017; p. 141). In this research, the number of participants in each subgroup was more than 30 [$n_{(freshmen)}$=56; $n_{(sophomores)}$=32; $n_{(juniors)=}$47; $n_{(seniors)}$=54] and they are independent from each other. As for the other test assumptions, normality and homogeneity test results are shown in the Tables 2 and 3 below.

Table 2

Normality Test results for the research data

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Grade	KS	df	p	S-W	df	p
Self-Efficacy Score	Freshmen	,106	56	,178	,969	56	,164
	Sophomores	,145	32	,086	,962	32	,309
	Juniors	,070	47	,200*	,979	47	,568
	Seniors	,067	54	,200*	,983	54	,633

The subgroups had n <50, so Kolmogorov Smirnov (KS) test results were taken into account. Since the significance level was greater than 0,5 (p>,05) [(KS$_{(56)}$=,106; p>,05), (KS$_{(32)}$=,145; p>,05), (KS$_{(47)}$=,070; p>,05), (KS$_{(54)}$=,067; p>,05)], the data was found to be normally distributed (Büyüköztürk et al., 2017). Homogeneity test results of the variances are shown below in Table 3.

Table 3

Homogeneity Test Results for the Variances of the Research Data

Self-Efficacy Total Score			
Levene Statistic	df1	df2	Sig.
1,892	3	185	,132

The Levene statistics results in the Table 3 show that the variances for the populations of the samples are equal (LS$_{(3,185)}$=1.892; p>,05). As a result, since the quantitative data obtained from the research fulfilled the assumptions of parametric test, the descriptive statistics were analyzed using independent samples t-Test and one-way analysis of variance (ANOVA), and the qualitative data was analyzed using content analysis. Content analysis is a method where similar data are grouped under certain concepts and themes and interpreted in a way that the reader can understand (Yıldırım & Şimşek, 2011; p. 227). In the content analysis phase, the pre-service teachers' responses to the open-ended questions were examined, and after the codes were divided into categories, common themes were identified. The self-efficacy components identified by Bandura ("Verbal persuasion", "Direct experiences", "Indirect experiences", and "Emotional state") in 1995 were accepted as themes in the content analysis, and the codes were grouped under these themes. The research data was analyzed and interpreted as qualitative and quantitative data separately, and finally, the overlapping situations were revealed by correlating the results in line with the requirement of concurrent triangulation design.

3. FINDINGS

In this section, the results obtained from the study were presented in tables individually by sub-problems.

The first sub-problem

Is there a significant difference between the pre-service teachers' mean scores for SEBST in terms of the variables such as gender, department preference, career plan, grade, academic achievement, and experiment anxiety? The independent samples t-test results were given in the Table 4 by the pre-service teachers' gender, department preference, and career plan.

Table 4

Independent samples t-Test results of the SEBST scores by gender, department, and career preference

Gender		N	X̄	S	t	sd	p	d
	Female	112	77,57	10,73	1,276	187	,181	-
	Male	77	79,44	8,12				
Did you select the department willfully?		N	x̄	S	t	sd	p	d
	Yes, I willfully selected	134	79,49	9,23	2,607	187	,010*	0,493
	No, I had to	55	75,47	10,55				
Are you thinking of teaching in the future?		N	x̄	S	t	sd	p	d
	Yes	174	78,68	9,84	1,711	187	,039*	0,474
	No	15	74,20	8,13				

*p<,05

When the Table 4 is examined, it is seen that the male pre-service teachers' mean score for SEBST ($\bar{x}$ =79,44) was higher than that of the females ($\bar{x}$ =77,57), however, this difference was not statistically significant ($t_{(187)}$=1,276;p >,05). The pre-service teachers who willfully chose the department ($\bar{x}$=79,49) had a significantly higher mean score for SEBST than those who had to choose the department ($\bar{x}$=75,47) ($t_{(187)}$=2,607; p<,05). In other words, choosing the profession willfully and consciously made a positive contribution to the self-efficacy beliefs. The effect size also confirmed this result, and

Cohen's standardized (d) effect size value was calculated as 0.493. So, the variable "whether willfully selected the department" had a considerable effect on the self-efficacy (Büyüköztürk, 2018; 44). The pre-service teachers who were planning to teach in the future ($\bar{x}$=78,68) had a significantly higher mean self-efficacy score than those who were not ($\bar{x}$=74,20) ($t_{(187)}$=1,711; p>,05). When the effect size is examined (Cohen d = 0,474), it can be said that the variable "whether planning to teach after graduation" had a considerable effect on SEBST.

Table 5 shows the descriptive analysis results of the distribution of the pre-service teachers' SEBST scores by their grade level, level of satisfaction with academic achievement, and level of anxiety while experimenting.

Table 5

Descriptive analysis results of the SEBST scores by levels of grade, academic achievement, and experiment anxiety

Variable	Level	SEBST scores		
		N	$\bar{x}$	S
Grade	Freshmen	56	75,64	11,33
	Sophomores	32	74,88	10,05
	Juniors	47	81,09	7,26
	Seniors	54	80,74	8,57
Academic achievement	Not satisfied (1)	22	73,41	12,09
	Not bad (2)	56	77,39	10,12
	Good (3)	89	78,78	8,89
	Very good, I am proud of myself (4)	22	83,77	7,10
Experiment anxiety	No (N)	21	78,87	7,19
	Low (L)	34	77,94	11,93
	Medium (M)	31	77,57	9,07
	High (H)	103	77,42	9,75

When the Table 5 is examined, it is seen that the pre-service teachers' SEBST scores are ranked as follows: juniors>seniors>freshmen>sophomores. It is thought-provoking that the freshmen ($\bar{x}$=75,64) had a higher SEBST mean score than the sophomores ($\bar{x}$=74,88), and the seniors ($\bar{x}$=80,74) had a lower SEBST mean score than the juniors ($\bar{x}$=81,09).

When the pre-service teachers' SEBST scores were examined by the degree of satisfaction with academic achievement, it was seen that as their level of satisfaction with their academic achievement increased, their SEBST scores also increased.

When the SEBST scores were examined by the levels of experiment anxiety, it was observed that there was an inverse relationship between anxiety and self-efficacy belief in teaching (N = 78,87; L = 77,94; M = 77,57; H = 77,42). In other words, the lower the pre-service teachers' anxiety while experimenting, the higher their self-efficacy belief in teaching science.

Table 6 shows the results of the one-way analysis of variance (ANOVA) test carried out to find whether there was a significant difference between the scores, and the results of the Scheffe analysis carried out, in case of a difference, to identify between which groups the difference was.

Table 6

ANOVA test results for self-efficacy scores

Variable	Source of the variance	KT	sd	KO	F	p	Scheffe	η^2
Grade	Between groups	1456,925	3	485,642	5,442	,001*	3-1; 3-2; 4-2;	0,591
	Within group	16508,387	185	89,235				
	Total	17965,312	188					
Academic achievement	Between groups	1251,268	3	417,089	4,617	,004*	4-1	,483
	Within group	16714,045	185	90,346				
	Total	17965,312	188					
Experiment anxiety	Between groups	173,379	3	124,460	1,253	,059	-	-
	Within group	17891.933	185	96.713				
	Total	17965.312	188					

*p<.05

The analysis results in the Table 6 show that there was a significant difference between the pre-service teachers' SEBST scores in terms of their grade [$F_{(3,185)}$ =5.442; p<.05]. Since the variances were homogeneous, Scheffe test was applied in the further analysis conducted to identify between which grades the difference existed. According to the results of the analysis, it was found that the juniors' SEBST scores ($\bar{x}$ = 81.09) were significantly higher than those of the freshmen ($\bar{x}$=75.64) and the sophomores

($\bar{x}$=74.88); and the seniors' SEBST scores ($\bar{x}$=80.74) were significantly higher than those of the sophomores ($\bar{x}$=74.88).

Eta-squared value (η^2=0.591) calculated in order to determine the effect of the independent variable "grade" on the dependent variable showed that the grade level had a high effect on the dependent variable (Büyüköztürk, 2018; 44). In other words, the analysis results showed that the grade level explained 59.1% of the total variance of SEBST.

Moreover, it was found that there was a significant difference between the pre-service teachers' SEBST scores in terms of their satisfaction with their academic achievement [$F_{(3,185)}$=4.617;p<.05]. As a result of the Scheffe test carried out to identify between which groups this difference existed, it was found that the pre-service teachers who were proud of their academic achievement ($\bar{x}$ = 83.77) had a significantly higher SEBST score than those who were not satisfied with their academic success at all ($\bar{x}$ = 73.41). In addition, the eta-squared value (η^2=0.483) showed that the level of satisfaction with academic achievement had a high effect on the SEBST scores (Büyüköztürk, 2018; 44). In other words, the analysis results showed that the level of satisfaction with academic achievement explained 48.3% of the total variance of SEBST.

According to another result in the Table 6, although there were mathematical differences between the pre-service teachers' SEBST scores in terms of the level of anxiety they experienced while experimenting, this difference was not statistically significant [$F_{(3,185)}$ =1.253; p>.05]. In other words, although the pre-service teachers' SEBST scores decreased as their experiment anxiety increased (N=78.87> L=77.94> M=77.57> Y=77.42), there was no statistically significant difference between the scores.

The second sub-problem

What are the components of the pre-service teachers' self-efficacy beliefs in science teaching? (To what do you owe your self-efficacy in science teaching?)

It was examined on what the pre-service teachers' self-efficacy depended, and the themes and codes for their opinions on this subject were given in Table 7.

Table 7

Pre-service *teachers' opinion on the components of SEBST*

Themes and Codes	n
Verbal persuasion	
My opinion being valued	112
Expressing myself in a democratic environment	88
My communication with my family	84

My teachers' behaviors towards me	72
What my friends say	53
Approvals in social media	53
Likes/compliments I receive	30
Direct experiences	
Self-confidence	129
Background (knowledge on subject matter)	90
My previous achievements	64
Not losing heart in the face of challenges/struggling until succeeding	31
My personality structure	64
Whether the task is hard or not	25
Working systematically and determinedly	20
Willingness to learn	17
Updating myself	17
My skill to cope with my fears	13
Indirect experiences	
Observing the experiences of others	95
Researching	90
Having a reading habit	87
Listening to others' success stories	64
Environment in which I was raised	40
People whose example I follow	24
Emotional state	
Being happy with the work I do	53
The mood I am in at that moment	15
My morale	13
My motivation	12
Controlling my excitement	5

It was found that the pre-service teachers were affected by the following components of SEBST in order of high to low: verbal persuasion (n=492), direct experiences (n=470), indirect experiences (n=400), and emotional state (n=98). They stated that the following components and the related factors affected their SEBST: their opinions being valued (n=112), communication with the family (n=84) under the component "verbal persuasion"; their previous achievements (n=64), their struggle against challenges (n=31) under the component "direct experiences"; observing the experiences of others (n=95) under the component "indirect experiences"; and being happy with the work being done (n=53), morale (n=13), motivation (n=12), and excitement (n=5) under the component "emotional state."

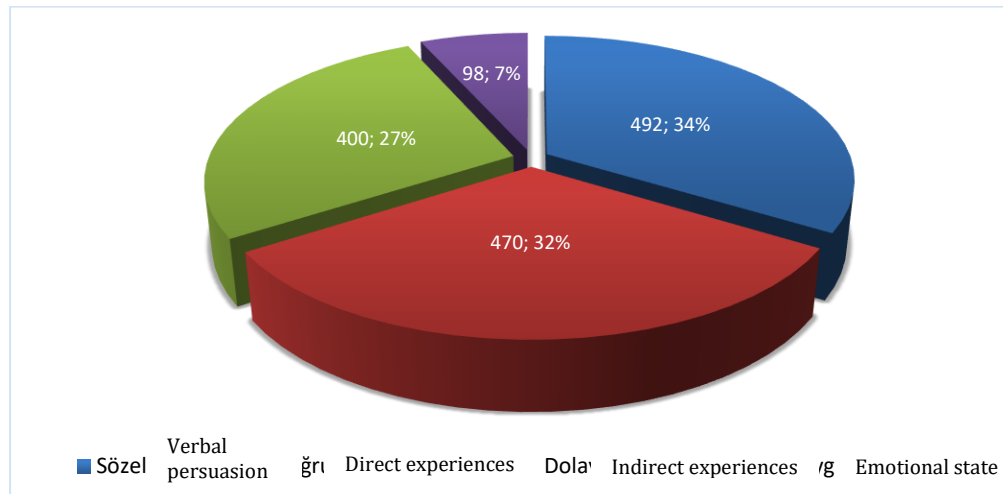A graph (Figure 1) was created in order to explain the ratios given in the Table 5 more clearly.

Figure 1. The graph for the ratios of the components of the pre-service teachers' self-efficacy beliefs in science teaching

It was found that the pre-service teachers' beliefs in their ability to teach science successfully were affected the most by, in order of most to least, what they hear from those around them, the past experiences, the experiences of other people that they have the opportunity to observe, and their own emotional state.

Below are some examples of pre-service teachers' statements regarding the codes associated with the components.

TM62; "If my instructor encourages me, especially in the experiments, I get more confident. I do a better job."

TM226; "Honestly, if I am in a good mood at that moment, I can do everything"

TF197; "The success of my teachers, whom I take as an example in the faculty, makes me love science and I believe more in my ability to do."

The third sub-problem

How do the pre-service teachers behave in situations that require self-efficacy in teaching?

Table 8 gives the analysis results for the behaviors related to self-efficacy in science teaching.

Table 8

Behaviors related to self-efficacy in science teaching

Themes and Codes		Themes and Codes	
How do you feel when you are asked a science-related question and you are unprepared?	n	**When teaching science, do you prefer theory or experiment?**	n
Positive behaviors (High SEBST)		I prefer experiment to teach science	110
I feel happy to be asked a question and answer	71	I feel safer when I teach theoretically	70
I try to understand	16	I believe that I can teach using both theory and experiment	9
I give a more detailed answer when convenient	16		
Negative behaviors (Low SEBST)	n	**What are you anxious about while experimenting?**	n
I give homework to the student who asks the question	117	Giving false information	116
I turn a deaf ear	20	Safety measures (causing an accident)	80
I fudge the issue	20	Harming students	24
I feel uneasy	15	My own health	17
I get angry	15	**Total**	**237**
I get bored	15		
I escape	11		

When the Table 8 is examined, it is seen that most of the pre-service teachers stated that they would assign the question to the student as a homework (n = 117), 71 of them stated that they would be happy to be asked a science question, 20 of them stated that they would turn a deaf ear, 16 stated that they would try to understand, search, and give

a more detailed answer when convenient, and 15 of them stated that they would feel uneasy, angry, and bored, and show an escape behavior. When these results were evaluated in terms of those who respond the question positively (n=119) or negatively (n=213), it was found that the majority of the pre-service teachers preferred avoiding a science question when unprepared.

When the pre-service teachers' answers to the question regarding their way of teaching science were examined, it was found that a great majority of the participants (n=110) stated that they would prefer experiments, a group of them (n=70) stated that they would prefer theoretical teaching rather than experiments, and a very few of them (n=9) stated that they would prefer both theoretical and experimental teaching.

The analysis results for the pre-service teachers' anxieties during experimenting showed that a great majority of pre-service teachers (n=116) stated that they were anxious about giving false information, some of them (n=80) stated that they were anxious about causing an accident, and others stated that they were anxious about harming students' health (n=24) or their own health (n=17).

In the concurrent triangulation design, data obtained using different methods are associated with the purpose of revealing whether quantitative and qualitative data overlap. In order to show the relationships between quantitative and qualitative data, the pre-service teachers' level of agreement with the items in the SEBST scale and the content analysis results obtained from their answers to the open-ended questions were examined, and some examples of the overlapping responses were given in Table 9. The qualitative and quantitative data was associated and interpreted in the Table 9.

Table 9

Association of qualitative and quantitative data

Measurement	Quantitative data	Qualitative data	Harmony between quantitative and qualitative data
I have the skills to use a laboratory.	$\bar{x}$=4.21 Most of the time (4)	I prefer experiment to teach science (n=110) My self-confidence increases while teaching science by experiment (n=129)	The qualitative data support the quantitative data
When the science and technology textbook gives false information, I can spot it.	$\bar{x}$=4.46 Most of the time (4)	Reading (n=90) Research (n=87)	The qualitative data support the quantitative data

Teachers' success during lesson increases the students' success.	$\bar{x}$=4.59 Always (5)	I feel anxious about giving false information to the student (n=116) I update myself (n=17)	The qualitative data support the quantitative data
I can adapt new practices/activities applied in different fields to the science and technology course.	$\bar{x}$=3.70 Most of the time (4)	I am curious about learning new things in science (n= 83) I like to adapt practices from other fields to science (n=27) I adapt the theoretical knowledge to the experiment (n=32)	The qualitative data support the quantitative data
I can scientifically explain the things students are curious about in daily life.	$\bar{x}$=3.83 Most of the time (4)	I feel happy to be asked a question and answer (n=71) I do a research about the questions asked by the student (n=16) and then give detailed answers (n=16)	The qualitative data support the quantitative data

When the Table 9 is examined, it is seen that the pre-service teachers' responses to the items in the SEBST scale and the data obtained from the content analysis of the answers to the open-ended questions overlap. These items are as follows: I have the skills to use a laboratory ($\bar{x}$=4.21), when the science and technology textbook gives false information, I can spot it ($\bar{x}$=4.46), teachers' success during lesson increases the students' success ($\bar{x}$=4.59), I can adapt new practices applied in different fields to the science and technology course ($\bar{x}$=3.70) , and I can scientifically explain the things students are curious about in daily life ($\bar{x}$=3.83). Here, the highest rate of agreement was found to be in the item "Teachers' success during lesson increases the students' success."

4. RESULTS, DISCUSSIONS AND SUGGESTIONS

According to the results of the research, it was found that there was no significant difference between male and female pre-service teachers' self-efficacy in science teaching. In the relevant literature, while there are some studies (Palavan & Açar, 2016; Yaman, Cansüngü Koray & Altunçekiç, 2004) reporting that self-efficacy beliefs did not differ depending on gender, likewise the case in this study; some other studies reported that the female pre-service teachers had higher self-efficacy perceptions than the males in terms of academic development and creating a positive classroom environment (Deniz & Tican, 2017; Yeşilyurt, 2013).

The pre-service teachers who willfully chose the department had a significantly higher mean score for SEBST than those who had to choose the department. In other words, choosing the profession willfully and consciously made a positive contribution to the self-efficacy beliefs in science teaching. This result is supported by the results in the relevant literature asserting that it is very important to do the teaching profession with love and willfully in order to be successful in this profession that requires patience, dedication, and effort; and only with teachers who love their profession, are sufficiently motivated, have high spirits, and are willing to work, it is possible to increase the quality of the teaching profession and have productive teachers (Recepoğlu & Recepoğlu, 2020).

The pre-service teachers who were planning to teach in the future were found to have a significantly higher mean self-efficacy score than those who were not. Similarly, Danişman (2015) stated that it is important to reveal and identify the teachers' and pre-service teachers' beliefs in their teaching ability or their readiness to teach.

The pre-service teachers' SEBST mean scores were as follows, by grade level: juniors>seniors>freshmen>sophomores. It is remarkable that the freshmen had a higher SEBST mean score than the sophomores, and the seniors had a lower SEBST mean score than the juniors. It was found that the juniors' SEBST scores were significantly higher than those of the freshmen and the sophomores; and the seniors' SEBST scores were significantly higher than those of the sophomores. On the contrary, Kurbanoğlu and Takunyacı (2012) and Zimmerman and Martinez-Pons (1990) found that as the pre-service teachers' grade level increased, so did their self-efficacy level. The reason why the teachers' self-efficacy did not show a linear progress with the grade level in this study may be due the fact that the second-grade lessons in the science department are harder than the first-grade lessons, and the pre-service teachers in the fourth grade have a realistic approach thanks to their teaching experience in real classroom environments within the scope of the course "school experience and teaching practice."

It was found that as the level of satisfaction with their academic achievements increased, so did their SEBST scores. When the pre-service teachers' SEBST scores were examined according to their satisfaction with their academic achievement, it was found that the pre-service teachers who were proud of their academic achievement had a significantly higher SEBST mean score than those who were not satisfied with their academic success at all. There are some studies in the relevant literature showing that general self-efficacy and teaching self-efficacy are in parallel. Mutlu, Öztürk and Aktekin (2019) reported that, in the cognitive dimension, a pre-service teacher's one of the most important beliefs is the perception of "Belief in Being Ready to Teach." It is important to reveal and identify the teachers' and pre-service teachers' beliefs in their teaching ability or their readiness to teach (Danişman, 2015).

When the SEBST scores were examined by the level of experiment anxiety, it was observed that there was an inverse relationship between anxiety and self-efficacy belief in teaching (N=78,87; L=77,94; M=77,57; H=77,42). In other words, the lower the pre-service teachers' anxiety while experimenting, the higher their self-efficacy belief in

teaching science. Although the pre-service teachers' SEBST scores decreased as their experiment anxiety increased (N=78,87> L=77,94> M=77,57> Y=77,42), the difference was not statistically significant.

The pre-service teachers stated that they were affected by the following components of SEBST, in order of high to low: verbal persuasion, direct experiences, indirect experiences, and emotional state. In other words, the pre-service teachers stated that their beliefs in their ability to teach science successfully were affected the most by, in order of most to least, what they hear from those around them, the past experiences, the experiences of other people that they have the opportunity to observe, and their own emotional state.

 The pre-service teachers stated that their SEBSTs were affected by the following factors under the theme "verbal persuasion": their opinions being valued, communication with the family, what their instructors and friends say, likes received on social media, and compliments of the people around. It was reported in the relevant literature that individuals who are verbally persuaded and have the skills to do the job in full try harder to solve a problem and tend to continue this effort, rather than having doubts and personal inadequacies (Yaman, Cansüngü Koray & Altunçiçek, 2004). In a similar study, it was reported that teacher feedback was a control tool for students to fulfill the task on time (Kushner, 1993).

The pre-service teachers stated that their SEBSTs were affected by the following factors under the theme "direct experiences": their previous achievements, their struggle against challenges, self-confidence, whether the task is hard or not, work systematically and determinedly, willingness to learn, updating oneself, their skills to cope with their fears. So, it can be asserted that when students have successful experiences in the past, they feel confident that they can get the same result again in the same or similar activities in future. On the other hand, having unsuccessful experiences in the past can damage their self-efficacy beliefs. A similar result was reported by Güneri and Arslan (2018) as follows: "Whereas the students' successful experiences enable them to have positive self-efficacy beliefs, their unsuccessful experiences cause them to have negative self-efficacy beliefs."

In the theme "indirect experiences", the following aspects created a source for SEBST: observing the experiences of others, examining what is happening around, reading, researching, listening to other teachers' success stories, environment where raised, success stories of exemplary characters, and having a teacher in the family.

In the theme "emotional state", the pre-service teachers stated that the mood at that moment, being happy with the work being done, morale, motivation, and excitement affected their SEBSTs. Bıkmaz (2002, p.199) states that individuals' "psychological and emotional states" also play a partial role in judging their own abilities.

Most of the pre-service teachers stated that they would assign the question to the student as a homework, some of them stated that they would be happy to be asked a science question, some others stated that they would turn a deaf ear, still some others

stated that they would try to understand, search, and give a more detailed answer when convenient, and a minority of them stated that they would feel uneasy, angry, and bored, and show an escape behavior. Although some of the pre-service teachers stated that they would welcome questions, the results showed that the majority of them avoided encountering a science question when unprepared. The cause of this result can be associated with the research result reported by Ritter, Boone and Rubba (2001) where they asserted that people with low self-efficacy would behave timidly in difficult tasks and perceive these tasks as personal threats. They also asserted that when these individuals are faced with a difficult task, they dwell on their own personal shortcomings, the obstacles and bad consequences they will experience, rather than concentrating on how they can achieve. Ultimately, the researchers stated that individuals in this situation minimize their efforts when they encounter difficulties and give up very quickly. Unlike these individuals, those who have strong beliefs in their self-efficacy tend to make a top effort, can struggle even in the face of negative situations, are aware of their self-efficacy, and improve their own competence levels, and all these factors make them work more and more effectively even under very bad conditions (Roberts, Henson, Tharp & Moreno, 2001).

When the pre-service teachers were asked the question regarding their way of teaching science were examined, a great majority of them stated that they would prefer experimenting, a group of them stated that they would prefer theoretical teaching rather than experimenting, and a very few of them stated that they would prefer both theoretical and experimental teaching.

According to the analysis results regarding the pre-service teachers' anxiety during experiments, a great majority of them stated that they were anxious about giving false information, some of them stated that they were anxious about causing an accident, and others stated that they were anxious about experiencing a situation where the students' health (n=24) or their own health (n=17) is harmed. It was reported that there was a moderately significant positive correlation between the pre-service elementary school mathematics teachers' mathematics anxiety and their anxiety about teaching mathematics, and their mathematics anxiety predicted their mathematics teaching anxiety. Similarly, in their study on pre-service elementary school teachers, secondary and primary school mathematics teachers, Peker and Ertekin (2011) reported that there was a positively significant relationship between their mathematics anxiety and mathematics teaching anxiety. On the other hand, Ünlü, Ertekin, and Dilmaç (2017) found that one of the most important factors affecting the pre-service mathematics teachers' mathematics teaching anxiety was their mathematics anxiety. Moreover, there are some studies reporting that the relationship between mathematics anxiety and mathematics teaching anxiety is not always the same for all pre-service teachers (Çenberci, 2019) and that pre-service teachers who have a high mathematics anxiety may have a low mathematics teaching anxiety (Yaz & Çetin, 2020).

In the present study, the pre-service teachers stated that teachers' success during lesson would increase the students' success; when the science and technology textbook gives

false information, they could spot it; they had the skills to use a laboratory; they could scientifically explain the things students are curious about in daily life; and they could adapt new practices applied in different fields to the science and technology course. Teachers should develop the above-mentioned competencies and skills during their education. Only with a qualified education, it is possible for pre-service teachers to have these competencies at the desired level. However, the quality of the education provided to pre-service teachers alone is not sufficient for developing their teaching skills (Yaz & Çetin, 2020). Therefore, consultancy and education programs that can help students develop positive beliefs should be offered, especially in higher education institutions (Nasir & Iqbal, 2019). The results of the study showed that the most effective component of the pre-service teachers' self-efficacy beliefs in science teaching was verbal persuasion, followed by their own experiences, others' experiences, and their emotional states. Moreover, the study revealed that the pre-service teachers exhibited various avoidance behaviors instead of answering when a science question is asked and they were unprepared, they were anxious about being asked questions, and they hesitated about using laboratory tools; all these results prove that, in undergraduate education, pre-service science teachers need more activities where they can practice teaching.

Recommendations

Based on the results of this study, it is recommended that;

- Instructors who provide education to science teachers design activities and experiments that will increase pre-service teachers' self-efficacy in science teaching,

- Pre-service teachers carry out studies that will help them overcome possible psychological barriers associated with laboratory works,

- Researchers carry out more comprehensive long-term studies on self-efficacy in science teaching with larger samples.

References

Akbaş, A., & Çelikkaleli, Ö. (2006). Science teaching self-efficacy of class teacher candidates ınvestigation of beliefs by gender, type of education and universities, *Mersin University Journal of the Facult Education, 2*(1), 98–110.

Aksu, Z. (2019). The relationship among self-efficacy, anxiety and beliefs about teaching mathematics of middle school pre-service teachers. *Türk Psikolojik Danışma ve Rehberlik Dergisi, 9*(54), 841-856.

Alkan, V., Şimşek, S., & Armağan Erbil, B. (2019). Mixed Methods design: a narrative literature review. *Journal of Qualitative Research in Education, 7*(2), 559-582. http://doi: 10.14689/issn.2148-2624.1.7c.2s.5m

Arseven A. (2016). Self-efficacy: a concept analysıs. *Turkish Studies, 11*(19), 63–80.

Avery, L. M., & Meyer, D. Z. (2012). Teaching science as science is practiced: Opportunities and limits for enhancing preservice elementary teachers' self-efficacy for science and science teaching. *School Science and Mathematics, 112*(7), 395-409.

Baş, T. (2010). *Anket [Survey]. (6. Baskı).* Seçkin Yayıncılık.

Bandura, A. (Ed.). (1995). *Self-efficacy in changing societies.* Cambridge University Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Bıkmaz, F. H. (2002). Self-efficacy belief instrument in science teaching, *Educational Sciences and Practice, 1*(2), 197-210.

Büyüköztürk, Ş., Çokluk, Ö., & Köklü, N. (2017). *Sosyal bilimler için istatistik [Statistics for social sciences] (19. Baskı.).* Pegem A Yayıncılık.

Büyüköztürk, Ş. (2018). *Sosyal bilimler için veri analizi el kitabı [Manual of data analysis for social sciences] (24. Baskı).* Pegem Akademi Yayıncılık.

Cho, Y., & Shim, S. S. (2013). Predicting teachers' achievement goals for teaching: The role of perceived school goal structure and teachers' sense of efficacy. *Teaching and teacher education, 32*, 12-21.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches (2nd Edition).* Thousand Oaks, CA: Sage.

Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research (1th edition).* London: Sage Publications Ltd.

Creswell, J. W. (2008). *Educational research: planning, conducting, and evaluating quantitative and qualitative research (3rd edition).* USA: Pearson Education Inc.

Çenberci, S. (2019). The examination of prospective mathematics teachers' mathematics teaching anxiety levels. *Journal of Theoretical Educational Science, 12*(4), 1193 – 1208.

Deniz, S., & Tican, C. (2017). An investigation of pre-servıce teachers' teacher self-effıcacy beliefs and opinions for their professional anxieties *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi, 17*(4), 1838-1859.

Danişman, Ş. (2015). *The interaction of classroom teachers' beliefs related to the mathematics and teaching and the impact of these beliefs on students' mathematics achievement.* (Unpublished Doctoral Dissertation) Osmangazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Eskişehir.

Güneri, B., & Arslan, A. (2018). The adaptation of the scale of determining the sources of selfefficacy for secondary school students. *Karaelmas Journal of Educational Sciences, 6*(2), 256-268.

Henson, R. K., Bennett, D. T., Sienty, S. F., & Chambers, S. M. (2000). *The relationship between means-end task analysis and context-specific and global self-efficacy in emergency certification teachers: exploring a new model of teacher efficacy*. Task Analysis, The University of Southern Mississippi. 1-44. Retrieved from https://files.eric.ed.gov/fulltext/ED440974.pdf

Kaya, V. H., Polat, D., & Karamüftüoğlu, İ.O. (2014). Development of self-efficacy scale for scıence educatıon *the Journal of Academic Social Science Studies, 28*(2), 581-591.

Kinzie, M. B., Delcourt, M. A., & Powers, S. M. (1994). Computer technologies: Attitudes and self-efficacy across undergraduate disciplines. *Research in higher education, 35*(6), 745-768.

Kurbanoğlu, N. İ., & Takunyacı, M. (2012). An investigation of the attitudes, anxieties and self-efficacy beliefs towards mathematics lessons high school students' in terms of gender, types of school, and students' grades *Uluslararası İnsan Bilimleri Dergisi, 9*(1),110-130.

Kushner, S. N. (1993). Teacher efficacy and pre-service teachers: a construct validation, Paper *Presented at the Annual Meeting of the Eastern Educational Research Association in Clearwater*, February 17-22, Clearwater Beach, FL, USA.

Landis J.R., & Koch G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*, 159–174.

Levitt, K. E. (2002). An analysis of elementary teachers' beliefs regarding the teaching and learning of science. *Science Education, 86*(1), 1-22.

Mutlu, N., Öztürk, M., & Aktekin, S. (2019). Development of self-efficacy scale of dıfferentıated ınstructıon. Trakya Üniversitesi *Sosyal Bilimler Dergisi, 21*(1), 185-202. http://doi: 10.26468/trakyasobed.466734.

Nasir, M., & Iqbal, S. (2019). Academic SELF EFFİCACY as a predictor of academic achievement of students in pre service teacher training programs. *Bulletin of Education and Research, 41*(1), 33-42.

Palavan, Ö., & Açar, D. (2015). Investigation of academic self-efficacy of university students in terms of various variables *Trakya Üniversitesi Eğitim Fakültesi Dergisi, 6*(1), 14-27.

Patton, M. Q. (2014). *Qualitative research and evaluation methods (M. Bütün ve S. B. Demir, çev.)*. Pegem Akademi.

Peker, M., & Ertekin, E. (2011). The relationship between mathematics teaching anxiety and mathematics anxiety. *The New Educational Review, 23*(1), 213-226.

Ramey-Gassert, L., & Shroyer, M. G. (1992). Enhancing science teaching self-efficacy in preservice elementary teachers. *Journal of Elementary Science Education, 4*(1), 26-34.

Ramey-Gassert, L., Shroyer, M. G., & Staver, J. R. (1996). A qualitative study of factors influencing science teaching self-efficacy of elementary level teachers. *Science Education, 80*(3), 283-315.

Recepoğlu, S., & Recepoğlu, E. (2020). Relationship between prospective teachers' motivation for teaching profession and sense of efficacy. *Hacettepe University Journal of Education, 35*(4), 799-814.

Ritter, J., Boone, W., & Rubba, P. (2001). Development of an instrument to assess prospective elementary teacher selfefficacy beliefs about equitable science teaching and learning (SEBEST), *Journal of Science Teacher Education, 12*(3), 175-198.

Roberts, J. K., Henson, R. K., Tharp, B. Z., & Moreno, N. (2001). An examination of change in teacher self-efficacy beliefs in science education based on the duration of in-service activities, *Journal of Science Teacher Education, 12*(3), 199-213

Roehrig, G. H., & Luft, J. A. (2004). Constraints experienced by beginning secondary science teachers in implementing scientific inquiry lessons. *International Journal of Science Education, 26*(1), 3-24.

Ross, J. A. (1994). Beliefs that make a difference: the origins and ımpacts of teacher efficacy. *Paper presented at the annual meeting of the canadian association for curriculum studies*, 1-45.

Sakız, G. (2013). Key word in success: self-efficacy. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 26*(1), 185-210.

Ünlü, M., Ertekin, E., & Dilmaç, B. (2017). Predicting relationships between mathematics anxiety, mathematics teaching anxiety, self-efficacy beliefs towards mathematics and mathematics teaching. *International Journal of Research in Education and Science (IJRES), 3*(2), 636-645.

Yaman, S., Cansüngü Koray, Ö., & Altunçekiç, A. (2004). A research on the investigation of the self-sufficiency belief levels of the science education teacher candidates. *Türk Eğitim Bilimleri Dergisi, 2*(3), 355-366.

Yazlık, D. Ö., & Çetin, İ. (2020). Examining the relationship between mathematics anxiety and mathematics teaching anxiety of prospective mathematics teachers. *Turkish Journal of Computer and Mathematics Education. Advanced publication*. 1-11.

Yeşilyurt, Etem. (2013). Teacher self-efficacy perceptıons of teacher candıdates. *Elektronik Sosyal Bilimler Dergisi. 12*. 88-104.

Yıldırım, A., & Şimşek, H. (2011). *Qualitative research methods in social sciences (8th Edition).* Seçkin Yayınevi.

Zimmerman, B. J., & Martinez-Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex, and giftedness to self-efficacy and strategy use. *Journal of Educational Psychology, 82*(1), 51–59.

The ethics committee approval for this study was obtained from the Ethics Committee of the Rectorate of Kırşehir Ahi Evran University, dated 27/08/2020 and numbered 2020/03.