A Quantitative Investigation of Final Year Preservice Science Teachers' Sources of Self-Efficacy Beliefs

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To cite this article:

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Abstract

The purpose of this study was to reveal final year pre-service science teachers' sources of science teaching self-efficacy beliefs. Research on the sources of pre-service teachers' self-efficacy beliefs is a promising field of research. However, the number of studies examining the sources of pre-service teachers' teaching self-efficacy in a special teaching domain is limited. Two hundred thirty-eight final-year pre-service science teachers constituted the sample of the current quantitative study. Data were gathered through two measures assessing final year pre-service science teachers' science teaching self-efficacy beliefs in classroom management, student engagement, and instructional strategies, and sources of these beliefs. Data were analyzed by using descriptive and inferential statistics. Means, standard deviations, and bivariate correlations were performed for descriptive statistics, and regression analyses were performed for inferential statistics. Regression analyses showed that mastery experiences were the primary source of self-efficacy for classroom management (β=.41), student engagement (β=.47), and instructional strategies (β=47), followed by verbal persuasions. While emotional states were the only negative predictor of prospective science teachers' self-efficacy beliefs related to classroom management (β=-.11), student engagement (β=-.14), and instructional strategies (β=-.14), vicarious experiences were not found to be a significant predictor of any dimension of self-efficacy beliefs. Teacher preparation programs are advised to pay more attention to teaching practice and micro-teaching courses and provide experienced mentor teacher models to pre-service science teachers. Findings are discussed.

Keywords: Preservice science teachers, Sources of self-efficacy, Teaching self-efficacy, Mastery experiences.

Introduction

Self-efficacy in social cognitive theory has been the focus of numerous research including finance (Farrell, Fry & Risse, 2016; Sizoo, Jozkowskia, Malhotra, & Shapero, 2008), sports (Lirgg, Feltz, & Merrie, 2016; Moritz, Feltz, Fahrbach, & Mack, 2000), nursing (Lee & Ko 2010; Peek & Park, 2013), engineering (Fantz, Siller & Demiranda, 2011; Ponton, Edmister, Ukeiley, & Seiner, 2001), educational psychology and education in general (Klassen & Usher, 2010; Schunk, 1995; Schunk & Pajares, 2009; Zimmerman, 1995). Self-efficacy takes place under the umbrella of social cognitive theory and is defined as one's beliefs in possessed capabilities to coordinate required actions to reach the desired end (Bandura, 1997). Self-efficacy studies in the area of education have concentrated mostly on students and their achievement-related outcomes. However, another crucial component of education is teachers, and self-efficacy research has extended its research region to teachers in a short while (Morris, Usher, & Chen, 2017). Teacher self-efficacy was defined as teachers' beliefs in their capabilities to make students learn the taught material (Tschannen-Moran & Woolfolk Hoy, 2001). Teacher self-efficacy stretches from student-related factors such as maintaining student motivation and teaching hard-to-learn concepts to keep an eye on student behavior and learning subject matter knowledge (Clark & Newberry, 2019). Research on teacher self-efficacy has revealed that teachers with high self-efficacy are more eager to use newly introduced teaching strategies, more sensitive to humanitarian classroom management, and have positive feelings toward the teaching profession (Woolfolk Hoy & Davis, 2006; Zee & Koomen 2016). Moreover, teacher self-efficacy influences the classroom learning atmosphere, student motivation, and academic achievement (Ross, 1992). In a comprehensive review of literature on teacher self-efficacy, Klassen, Tze, Betts, and Gordon (2011) have documented that research on sources of teachers' self-efficacy has been ignored while the number of teaching self-efficacy research

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has increased. Recent research has begun to question whether teacher self-efficacy was gained through teacher training programs and what sources contributed to pre-service teachers' self-efficacy. This study aimed to uncover the sources of teaching self-efficacy beliefs of final year pre-service science teachers in student engagement, instructional strategies, and classroom management dimensions.

Sources of Teaching Self-Efficacy for Pre-service Teachers

Bandura (1997) asserted that people develop self-efficacy beliefs by four main sources which are mastery experiences (personal or past accomplishments), vicarious experiences, verbal (social) persuasions, and emotional or physiological states (arousals). These four sources also work for pre-service teachers in constructing their teaching self-efficacy beliefs. Mastery experiences or past accomplishments refer to the activities completed successfully in the past. In teacher preparation programs, final year pre-service teachers have teaching practice courses in which they can teach in micro-teaching sessions and real classroom settings. Moreover, in teaching methods courses pre-service teachers develop lesson plans tapping to related teaching methods and perform teaching mini-sessions (as microteaching) as if they were teachers in a real classroom setting. In most studies conducted with pre-service teachers, mastery experiences have been the most powerful source of self-efficacy beliefs (e.g. Cantrell, Young, & Moore, 2003; Knoblauch & Woolfolk Hoy, 2008). A remarkable finding was reported by Bautista and Boone (2015) that performing a teaching practice had increased teaching efficacy beliefs of pre-service teachers even in a virtual classroom environment.

Vicarious experiences are the conclusions of observations derived by the observer from a model. In teacher preparation programs, pre-service teachers have various opportunities to observe teaching skills being modelled. Professors from the faculty of education, mentor teachers in the schools they visit during practicum courses, and their peers participating in teaching methods and other courses could all serve as role models to observe and inspire. Research on the effectiveness of vicarious experiences on pre-service teachers' self-efficacy beliefs is limited in number. However, these studies indicated that vicarious experiences are the second strongest predictor of pre-service teachers' self-efficacy beliefs (Bautista, 2011; Johnson, 2010; Palmer, 2006).

Verbal (social) persuasions are comments and praises received from others in a close environment. Verbal persuasions help pre-service teachers to enhance their self-efficacy beliefs when received as social support, encouragement, instructive mentoring, and constructive feedback (Clark & Newberry, 2019). In recent research, Arsal (2014) examined micro-teaching practices' contribution to pre-service teachers' self-efficacy by conducting an experimental study. Arsal (2014) concluded that constructive feedback provided to pre-service teachers just after watching their teaching performances could be counted as verbal persuasions, which may help improve their teaching self-efficacy. Another research by Moulding, Stewart, and Dunmeyer (2014) examined the association between perceived support from significant others (mentor teachers and university supervisors) during student teaching and pre-service teachers' self-efficacy. They found a significant correlation between perceived support (as verbal persuasion) and pre-service teachers' self-efficacy beliefs on a moderate level.

Lastly, emotional or physiological states (arousals) are bodily reactions (e.g. mood, stress, anxiety, stomachache, etc.) to the situation to which a person is exposed. Bandura (1997) asserted that these bodily reactions need to be processed since they may not be the determinants of self-efficacy alone. Additionally, people react differently to the signals emerging from emotions and received from their bodies (O'Neill & Stephenson & 2012). According to d'Alessio (2018), pre-service teachers generally feel nervous during their initial teaching practices in a real classroom environment. O'Neill and Stephenson (2012) reported that emotional states negatively predicted pre-service final year primary teachers' self-efficacy beliefs.

Previous researches have demonstrated that these four major sources influence pre-service teachers' self-efficacy as mastery experiences taking the leader role (Can, 2015; Clark & Newberry, 2019; O'Neill & Stephenson, 2012; Seung, Park, & Lee, 2019; Wang et al., 2017). However, slight differences were reported by studies conducted in different countries. For example, in an earlier research Poulou (2007) investigated one hundred ninety-eight fourth and last year pre-service primary teachers' teaching self-efficacy sources in three dimensions of the Teacher Sense of Efficacy Scale (TSES) in Greece. A commonly used scale to measure pre-service and in-service teachers' self-efficacy, the TSES, is able to assess sense of efficacy related to student engagement, instructional strategies, and classroom management with either a long (twenty-four items) or short (twelve items) version. Poulou (2007) developed a Teaching Efficacy Sources Inventory covering seven dimensions, including four main sources of self-efficacy beliefs. A series of multiple regression analyses showed that prospective elementary teachers' self-efficacy beliefs for student engagement, instructional strategies, and classroom management were positively predicted by mastery experiences combined with social (verbal) persuasions. Similar findings were reported by Oh (2011) who used the same instruments with fifty-seven prospective elementary teachers in the United States.

The research findings indicated that efficacy for classroom management was negatively predicted by mastery experiences combined with social (verbal) persuasions and emotional arousal, while efficacy for instructional strategies and student engagement were not predicted by any of the four sources.

Bandura asserted that the predictive capability of self-efficacy sources might vary as levels of self-efficacy in special domains of interest. Concerning science teaching, a limited number of studies yielded similar results. In very recent research, van Rooij, Fokkens-Bruinsma, and Goedhart (2019) investigated the sources of science teaching self-efficacy beliefs of sixty-nine science undergraduates. The researchers decided to measure emotional states with items measuring both positive and negative emotional states. Emotional states items are generally developed with negative meaning words and reversed when entering the data. Negative emotions might be "a more logical focus" compared to positive emotions because the consequences of negative emotions can end with leaving the teaching profession. However, Morris et al. (2017) pointed out that the lack of balance between negative and positive emotions is a general problem in measuring self-efficacy sources. However, there are recent efforts to include positive emotions as a source of teaching self-efficacy (see Lent, Ireland, Penn, Morris, & Sappington, 2017). van Rooij et al. (2019) created a new "positive emotional states" dimension in addition to negative "emotional states" items. Examples of positive states items are "Feeling enthusiastic during teaching". "Feeling cheerful from contact with students". Multiple regression analyses revealed that positive emotional states and mastery experiences were the two positive predictors of science undergraduates' science teaching self-efficacy, which explains more than half of the variance.

In Turkey, several studies have investigated how the four main sources of self-efficacy predicted pre-service teachers' self-efficacy beliefs (e.g. Aydın & Boz, 2010; Can, 2015; Çapa-Aydın, Uzuntiryaki-Kondakçı, Temli, & Tarkın, 2013; Uzuntiryaki, 2008). The samples in these studies ranged from prospective chemistry teachers (see Uzuntiryaki, 2008) to elementary science and mathematics teachers (see Aydın & Boz, 2010; Can, 2015; Gün, Acar-Şeşen, Akbulut, Çetin-Dindar, & Molu, 2021), computer education and information technology teachers, and elementary school teachers (Arslan & Çolakoğlu, 2019; Çapa-Aydın et al., 2013). Although educational psychology studies mainly were conducted using quantitative methods, Turkish researchers have shown examples of the mixed methods (see Aydın & Boz, 2010) and qualitative studies (see Can, 2015). These types of methodologies, known as flexible designs, can reveal additional self-efficacy sources related to the research area in question. In one of these recent studies, Can (2015) studied with five final year pre-service science teachers and examined their science teaching self-efficacy sources. The study was designed on qualitative methodology and data were gathered by semi-structured interviews. She found that all four main sources contributed to final year pre-service science teachers' teaching self-efficacy and science content knowledge, personality traits, and resource provision. Aydın and Boz (2010) examined whether grade level created a difference in pre-service science teachers' science teaching self-efficacy and sources. The famous STEBI (Science Teaching Efficacy Beliefs Instrument) was used as the quantitative measurement tool and semi structured-interviews provided qualitative data. The qualitative part of the study revealed the sources of pre-service science teachers' sources of science teaching self-efficacy. Results showed that pre-service science teachers mentioned mastery experiences, verbal persuasions, and vicarious experiences. While mastery and vicarious experiences were leading sources, pre-service science teachers had not mentioned emotional states as sources of their science teaching self-efficacy.

Previous studies have examined pre-service science teacher self-efficacy either with self-efficacy and outcome expectancy dimensions (mostly using STEBI) or by ignoring grade-level differences. Studies on the self-efficacy sources of pre-service teachers' addressing a single domain of teaching (science, math, social studies, etc.) are also limited in number. Moreover, final year pre-service teachers are the most experienced group at the end of their formal teacher education period. That group of pre-service teachers has almost completed basic mandatory courses to be able to graduate. Thus, the data obtained from such a group of pre-service teachers was considered the most suitable data for the study.

Morris et al. (2017) stated that although STEBI (Enochs & Riggs, 1990) is a content-specific measure concerning science teaching, it falls short to measure teaching self-efficacy from multiple perspectives. To the best of our knowledge, sources of pre-service science teachers' teaching self-efficacy have not been assessed from student engagement, instructional strategies, and classroom management perspectives with final year pre-service science teachers in Turkey. While the literature contains qualitative studies examining the sources of self-efficacy of pre-service science teachers in their final year of schooling with a small group of pre-service teachers, it lacks a quantitative study examining four sources of self-efficacy of pre-service teachers with a large sample. According to Morris et al. (2017), a single model covering all four sources could present a comprehensive notion to researchers regarding sources and their influences. Bandura (1977) proposed that self-efficacy is easily shapeable at the early stages of teacher preparation and these shaped beliefs may exert influence on pre-service teachers'

self-efficacy beliefs in their teaching careers. Teacher educators may benefit from the findings of the current research as it has the potential to reveal latent sources of self-efficacy beliefs in three critical dimensions of teaching. Assuming that sources of teaching self-efficacy may vary for these three dimensions, teacher educators will be able to decide which source to pay more attention to during pre-service teacher training. In addition, science teaching is characterised by the fact that different teaching strategies (e.g., inquiry-based learning, problem-based learning, project-based learning, etc.) can be used and laboratory sessions require special attention in terms of classroom management. Accordingly, it is believed that the current study adds depth to the knowledge base on pre-service science teacher self-efficacy with a large sample from Turkey. This study aims to reveal the sources of science teaching self-efficacy of final year pre-service science teachers in three teaching self-efficacy dimensions which are student engagement, instructional strategies, and classroom management. Accordingly, this study seeks answers to the research questions below:

- Which sources (mastery experience, vicarious experience, verbal persuasions, and emotional states) predict final year pre-service science teachers' self-efficacy in student engagement?
- Which sources (mastery experience, vicarious experience, verbal persuasions, and emotional states) predict final year pre-service science teachers' self-efficacy in instructional strategies?
- Which sources (mastery experience, vicarious experience, verbal persuasions, and emotional states) predict final year pre-service science teachers' self-efficacy in classroom management?

Method

This study uses a quantitative methodology in which data are obtained from participants' self-reports. Moreover, statistical analyses are conducted on the data to derive meaningful explanations. The study design could be stated as a correlational study. The purpose is to predict which sources of efficacy beliefs are related to pre-service teachers' science teaching efficacy beliefs.

Participants

The current study participants were 238 (185 women, 42 men, 11 gender missing) final year pre-service science teachers from five state universities of Turkey. The universities that the sample was drawn were located in the Central Anatolia Region and the number of participants from each university was roughly equal. The convenience sampling method was used for selecting participants. Age range of the participants varied between 20 and 29 ($M = 22.34$, $SD = 1.15$). Cumulative grade point average ranged from 1.81 to 3.95 ($M = 2.90$, $SD = .31$).

Instruments

Teachers' Sense of Efficacy Scale

Teachers' Sense of Efficacy Scale (TSES) was utilized to assess the self-efficacy beliefs of pre-service science teachers. TSES is a 9-point Likert type scale ("1 = nothing" to "9 = a great deal"). It was developed by Tschannen-Moran and Woolfolk-Hoy (2001) and Çapa, Cakiroglu, and Sarıkaya (2005) translated and adapted TSES into Turkish. TSES assesses three basic teacher capabilities, which are efficacy for student engagement (eight items), efficacy for instructional strategies (eight items), and efficacy for classroom management (eight items) with twenty-four items. TSES items were reworded to address science classes that comply with science teacher self-efficacy. For example, the efficacy for student engagement item "How much can you do to motivate students who show low interest in schoolwork?" was reworded to "How much can you do to motivate students who show low interest in science class?". Similarly, the instructional strategies item was "How well can you implement alternative teaching strategies in your science class?" and the classroom management item was "How much can you do to calm a student who is disruptive or noisy in science class?". The reliability coefficients (Cronbach's alpha) for the dimensions in the current study are α=.79 for student engagement, α=.82 for instructional strategies, and α=.84 for classroom management.

Sources of Self-Efficacy Inventory (SOSI)

Sources of Self-Efficacy Inventory (SOSI) was developed by Kieffer and Hanson (2000) to assess the four sources of teaching self-efficacy beliefs (mastery experiences, vicarious experiences, verbal persuasions, and emotional states). It is a seven-point Likert type scale ranging from "1 = definitely not true for me" to "7 definitely true for me". The Scale was translated into Turkish by Çapa-Aydın et al., (2013). The translated version included twenty-seven items. These items were distributed to sub-dimensions as eight items for mastery experiences, seven items for vicarious experiences, five for verbal persuasions, and seven for emotional states. Similar to TSES, items in

SOSI were reworded to address science class and tap to sources of science teacher self-efficacy. Example items for the dimensions are "I have had many positive opportunities to teach science" (mastery experiences), "When I see other teachers do poorly, I am able to learn how to teach science more effectively" (vicarious experiences), "When people I respect tell me I will be a good science teacher, I tend to believe them" (verbal persuasion), and "The idea of being in a classroom as a science teacher makes me nervous" emotional states. The reliability coefficients (Cronbach's alpha) for the dimensions in the current study are $\alpha=.77$ for mastery experiences, $\alpha=.76$ for vicarious experiences, $\alpha=.77$ for verbal persuasion, and $\alpha=.70$ for emotional or physiological arousal.

Teacher Preparation Context in Turkey

Teacher preparation programs last four years in Turkey and are provided by faculties of education under the rule of universities. Teacher candidates have theoretical courses in the first three years of their teacher preparation. In the final year, they visit public and private schools to experience a real classroom environment (early childhood and primary education teacher candidates begin visiting schools in their junior years) in teaching practice courses. In the first semester of the final year, pre-service teachers just observe the mentor teacher to increase their experience and teaching skills. In the second semester, they are required to teach at least two hours per week. Faculty supervisors attend pre-service teachers' teaching performances at least four hours during the semester to observe the development of teaching skills. Finally, pre-service teachers are graded on a consensus reached by the mentor teacher and faculty supervisor.

Procedure

The data were collected at the final weeks of the semester to ensure that final year pre-service science teachers have almost completed practice teaching courses in which they visit middle schools for twelve weeks, experience real classroom settings, and have the opportunity to teach science to middle schoolers. Since the aim of the study is to identify the potential sources of self-efficacy beliefs of trainee teachers, it is assumed that the experience gained by the teachers in teaching practice contributes greatly to the self-efficacy beliefs of the trainee teachers. The instruments were given to the participants by their instructors who were informed by the author. Participants were informed that completion of the questionnaires was voluntary and that they were free to opt out at any point during data collection.

Data Analyses

Data were analyzed by using descriptive statistics and inferential statistics analyses. Firstly, descriptive statistics such as means, standard deviations, and bivariate correlations were calculated. Then, inferential statistics were used to predict which source(s) tap into the dimensions of pre-service science teachers' teaching self-efficacy beliefs. Regression analyses were conducted to reveal the sources of teaching self-efficacy beliefs. The hypotheses below were proposed:

- H1: Bandura's four hypothesized sources (mastery experiences, vicarious experiences, verbal persuasions, and emotional states) predict final year pre-service science teachers' teaching self-efficacy for student engagement.
- H2: Bandura's four hypothesized sources (mastery experiences, vicarious experiences, verbal persuasions, and emotional states) predict final year pre-service science teachers' teaching self-efficacy for instructional strategies.
- H3: Bandura's four hypothesized sources (mastery experiences, vicarious experiences, verbal persuasions, and emotional states) predict final year pre-service science teachers' teaching self-efficacy for student engagement.

Results

Data cleaning, missing data analysis, and linearity and normality assumption controls were performed as an initial step. No violations were detected for the inferential statistics and analyses were conducted. For descriptive purposes, the means and standard deviations of study variables were presented in tables. Regression analyses, which revealed the answers to main research questions, followed.

Descriptive Statistics

Table 1 indicates the means and standard deviations of pre-service science teachers' self-efficacy beliefs in student engagement, instructional strategies, classroom management, and sources of efficacy beliefs.

Table 1. Descriptive statistics for variables included in the study

		M	*SD*	Scale
Preservice Teacher Self-efficacy	Student Engagement	6.86	1.00	1-9
	Instructional Strategies	7.03	1.02	
	Classroom Management	6.84	1.02	
Sources of Self-efficacy	Mastery Experiences	5.65	.69	1-7
	Vicarious Experiences	5.70	.71	
	Verbal Persuasions	5.78	.81	
	Emotional States	4.64	.97	

Final year preservice science teachers had the highest teaching "self- efficacy" beliefs in instructional strategies ($M = 7.03$, $SD = 1.02$), followed by student engagement ($M = 6.86$, $SD = 1.00$), and classroom management ($M = 6.84$, $SD = 1.02$) (see Table 1). For the sources of science teaching self-efficacy beliefs, verbal persuasions had the highest mean ($M = 5.78$, $SD = .81$), followed by vicarious experiences ($M = 5.70$, $SD = .71$), mastery experiences ($M = 5.65$, $SD = .69$), and emotional states ($M = 4.64$, $SD = .97$).

Pearson correlations of study variables are presented in the table below to depict intercorrelations among the variables.

Table 2. Pearson correlations of study variables

	1	2	3	4	5	6	7
1. Student Engagement		.73*	.68*	.58*	.49*	.43*	-.07
2. Instructional Strategies			.74*	.56*	.46*	.44*	-.08
3. Classroom Management				.48*	.37*	.44*	-.06
4. Mastery Experiences					.77*	.65*	.09
5. Vicarious Experiences						.71*	.15*
6. Verbal Persuasions							.14*
7. Emotional States							

* $p < .05$

All three efficacy dimensions correlated positively with sources except emotional arousal (see Table 2). Sources of efficacy beliefs correlated positively with each other. However, mastery experiences and emotional states had not a significant relationship (see Table 2).

Inferential Statistics

The regression analysis has the potential to reveal the predictive role of an independent variable on a dependent variable. In other words, regression analyses are run for making predictions or assessing the influence of one or more independent variables on a dependent variable. Thus, regression analyses have revealed to what degree Bandura's hypothesized sources of efficacy tap to final year pre-service science teachers' self-efficacy beliefs in student engagement, instructional strategies, and classroom management.

Table 3. Sources of teaching self-efficacy beliefs for student engagement

Predictors	***B***	**St. Error of *B***	**β**
Mastery experiences	.68	.12	.47*
Vicarious Experiences	.13	.13	.09
Verbal Persuasions	.10	.10	.08
Emotional States	-.14	.06	-.14*

$R^2 = .36$, * $p < .05$

Regression analysis indicated that the model explained a considerable variance in final year pre-service science teachers' teaching self-efficacy beliefs for student engagement ($R^2 = .36$). For predictors, pre-service science

teachers' mastery experiences (β = .47) predicted efficacy for student engagement positively and emotional states (β = -.14) predicted it negatively (see Table 3). Vicarious experiences and verbal persuasions were not significant predictors of final year pre-service science teachers' science teaching efficacy beliefs in student engagement.

Table 4. Sources of teaching self-efficacy beliefs for instructional strategies

Predictors	*B*	St. Error of *B*	β
Mastery experiences	.70	.13	.47*
Vicarious Experiences	.00	.13	.00
Verbal Persuasions	.19	.10	.15
Emotional States	-.15	.06	-.14*

$R^2 = .35$; * $p < .05$

Table 4 shows that similar to efficacy for student engagement dimension of TSES, final year pre-service science teachers' self-efficacy for instructional strategies were significantly predicted by their mastery experiences and emotional states. While mastery experiences predicted it positively (β = .47), emotional states predicted it negatively (β =-.14). The regression model explained 35% of the variance in efficacy for instructional strategies. In efficacy for instructional strategies, vicarious experiences and verbal persuasions nor found as significant predictors.

Table 5. Sources of teaching self-efficacy beliefs for classroom management

Predictors	*B*	St. Error of *B*	β
Mastery experiences	.60	.13	.41*
Vicarious Experiences	-.18	.14	-.13
Verbal Persuasions	.35	.10	.28*
Emotional States	-.12	.06	-.11*

$R^2 = .28$; * $p < .05$

For the last model, regression analysis revealed that in addition to mastery experiences (β = .41), verbal persuasions (β = .28) positively predicted final year pre-service science teachers' efficacy for classroom management. As in the previous analysis, emotional arousal (β = -.11) was found to be a negative significant predictor of efficacy beliefs for classroom management. The model explained 28% of the variance in self-efficacy beliefs for classroom management. Final year pre-service science teachers' vicarious experiences did not contribute to their efficacy beliefs for classroom management.

Discussion and Conclusions

This study examined the sources of final year pre-service science teachers' self-efficacy beliefs in three dimensions, namely, student engagement, instructional strategies, and classroom management, which are considered critical to science teaching. The sources of these self-efficacy beliefs examined were Bandura's four hypothesized sources. Concerning the sources of final year pre-service science teachers' teaching self-efficacy beliefs, regression analysis for predicting self-efficacy for student engagement indicated that pre-service science teachers' mastery experiences predicted it positively. In other words, as pre-service science teachers' mastery experiences increase, so their self-efficacy in student engagement. However, emotional states predicted it negatively. That means as pre-service science teachers experience bodily reactions such as worrying, sweating, or stomach-ache during teaching, their self-efficacy beliefs for student engagement tend to decrease. Neither vicarious experiences nor verbal persuasions were found as significant predictors of self-efficacy beliefs for student engagement. As the primary source of self-efficacy beliefs, pre-service science teachers' mastery experiences are mainly gained through their practicum courses. They visit public schools and have the opportunity to teach in real classroom settings. Such an experience helps to develop strong teaching self-efficacy beliefs through mastery experiences. Pre-service science teachers experience methods to motivate and engage students in their science classes. Previous studies have indicated consistent results for the leading predictive role of mastery experiences. For final year pre-service science teachers, mastery experiences are the strongest predictor of self-efficacy beliefs as it is for students and in-service teachers (Bandura, 1986; Bandura, 1997). Similar results were found in sources of efficacy beliefs for instructional strategies. Like self-efficacy for student engagement, while mastery experiences were found as the positive significant predictor, emotional states were found as the negative

predictor of self-efficacy for instructional strategies. Apart from these two teaching self-efficacy dimensions, verbal persuasions were found as the second positive predictor of self-efficacy for classroom management in addition to mastery experiences. Similar to the other two dimensions, emotional states were found again as the negative predictor of efficacy for the classroom management dimension of TSES.

Previous studies conducted both in national and international contexts reported mixed results. While mastery experiences were consistently found as the leading source of self-efficacy beliefs, the predictive role of other sources differed based on the domain of teaching, grade level of pre-service teachers, and cultural differences. For example, in a study conducted in the United States, Clark and Newberry (2019) reported that all sources except emotional states predicted pre-service primary teachers' efficacy beliefs measured by TSES, the same measure used in the current study. Clark and Newberry (2019) considered TSES as a composite measure and treated it as single-dimensional. Moreover, verbal persuasions were measured as received from mentor teachers and faculty supervisors. Similarly, O'Neill and Stephenson (2012) used TSES as a composite score and found that emotional arousal negatively predicted pre-service primary teachers' teaching self-efficacy beliefs. As mentioned in the above section, the current study found that emotional states were found as the negative predictor for all the three dimensions of TSES. As emotional states increase, efficacy beliefs in student engagement, instructional strategies, and classroom management decrease. This finding was expected since the items assessing emotional states mainly focus on negative feelings. Such a negative relationship could be explained in several ways. Firstly, pre-service science teachers could feel stress since their teaching practice performance in real classroom settings is mostly observed by their mentor teachers. Being observed by an experienced faculty member may cause stress for young teacher candidates. Second, because of the broad content of middle school science education (integrated science), which includes physics, chemistry, biology, earth science, environmental science, and astronomy, prospective science teachers may feel inadequately informed in the face of student questions. Such a broad array of topics may produce a huge number of student questions. This situation may make pre-service science teachers feel underconfident and preparing for a teaching practice performance could turn into a stressful issue. Finally, prospective science teachers know that they will be graded by their faculty supervisor and mentor after their performance is observed in teaching practice. Just being graded on a performance could lead to increased heartbeat, stomach pain, or depressed mood, which are typical forms of emotional states. This result is inversely confirmed by van Rooij et al. (2019). Emotional states predicted science students' self-efficacy beliefs, but positive emotions were positive significant predictors.

The predictive capability of sources shows differentiation across cultures. While mastery experiences consistently predict pre-service teachers' self-efficacy beliefs, other sources' predictive capability differed in countries. For instance, Pouluo (2007) measured Greek pre-service primary teachers' self-efficacy beliefs by TSES using its three domains. Pouluo (2007) combined mastery experiences with verbal persuasions in a single dimension and added vicarious experiences and emotional arousal as other sources of teaching self-efficacy beliefs. Separate analyses for efficacy domains indicated that mastery experiences in conjunction with verbal persuasions were the sole positive significant predictor of efficacy beliefs in student engagement, instructional strategies, and classroom management. Neither vicarious experiences nor emotional states were found as significant predictors of teaching self-efficacy domains for Greek pre-service primary teachers. Using the same instruments as Poulou (2007), Oh (2011) studied with pre-service teachers in the United States. Unlike Poulou (2007), mastery experiences in conjunction with verbal persuasions and emotional states were found as significant positive predictors of self-efficacy for the classroom management dimension.

A study conducted with science undergraduates in the Netherlands yielded similar results to the current study. Van Rooij et al. (2019) used TSES as a composite measure and assessed sources of teaching self-efficacy beliefs of science undergraduates with four hypothesized sources of efficacy. Similar to the current research findings, they reported that science undergraduates' science teaching self-efficacy beliefs were predicted positively by their mastery experiences and emotional (positive) states. The only difference was van Rooij et al. (2019) measured emotional states with positive and negative emotions. Only positive emotions predicted teaching self-efficacy beliefs positively. Negative emotions were not significant predictors.

In the current study, vicarious experiences have a divergent feature in final year pre-service science teachers' self-efficacy beliefs that these experiences were not found as significant predictors for any teaching efficacy dimension. Findings indicated that pre-service science teachers could not develop their teaching efficacy beliefs by observing or taking others as models in any teaching self-efficacy dimension. Mentor teachers, faculty supervisors, and peers could be pre-service science teachers' models as examples. However, in the current study Turkish pre-service science teachers could not benefit from significant others as their counterparts in various countries (see Clark & Newberry, 2019; Rogers-Haverback & Mee, 2015). To benefit more from mentor teachers, it is advisable to extend the duration of the teaching practicum and select experienced mentor teachers who have

worked with prospective teachers. It was found that vicarious experiences are not significant not only for prospective teachers but also for students' self-efficacy beliefs in Turkey. Kıran and Sungur (2012) found that science self-efficacy of eighth grade elementary students was not predicted by vicarious experiences. Observing others to gather information or experiences could be a cultural problem in Turkish society. Such a problem could be studied in a larger context in collaboration with a sociological perspective.

Recommendations

The current study revealed significant findings that may yield valuable recommendations for teacher education programs. Pre-service science teachers' primary source of teaching self-efficacy belief was found as mastery experiences. However, vicarious experiences were not found as a significant predictor in any teaching self-efficacy dimension. Moreover, emotional arousal has a negative influence on their efficacy beliefs. These findings imply that teacher education programs may pay more attention to micro-teaching courses in addition to teaching practice courses. Because emotional states negatively affect prospective science teachers' self-efficacy beliefs, increasing the number of lived teaching experiences could help them to moderate emotional reactions when they have to teach lessons. Pre-service teachers may develop teaching self-efficacy beliefs vicariously from their peers or mentor teachers, but the vicarious experience was not a significant predictor in the current study. This could mean that prospective science teachers do not consider their colleagues knowledgeable enough or that they do not consider their mentor teachers worthy of serving as role models and examples. To overcome such a problem, teacher education programs may pay more attention to selecting experienced mentor teachers for pre-service science teachers. Moreover, faculty supervisors may undertake leading roles for creating opportunities to organize science teaching activities to behave as a model for pre-service science teachers.

Limitations

Some limitations should be mentioned concerning the current study. Firstly, as stated in the literature section of this paper, a considerable number of qualitative studies on sources of self-efficacy beliefs of pre-service teachers have been conducted. These studies have brought about other sources of teaching self-efficacy beliefs belonging to pre-service teachers. The current research has focused only on the four hypothesized sources of self-efficacy. Future research may develop scale items based on the findings of qualitative studies to assess multiple sources other than those hypothesized four sources. Secondly, descriptive statistics results have indicated that the correlation between the sources of efficacy beliefs is high. Pallant (2007) recommends taking actions in these conditions such as combining highly correlated dimensions or omitting the variable. Moreover, Pallant (2007) also cautions that independent variables in a regression model should correlate to some degree with the dependent variable. These two conditions are present in the current research. Low or no correlation between independent and dependent variables but a significant predictor in the regression analysis may point suppression effect. According to Pandey and Elliot (2010) "The idea that a variable, which is unrelated to the dependent variable, should be retained not only for theoretical purposes but also to improve overall predictive power of the model is appealing" (p. 38). Additionally, suppressor variables contribute to eliminating the risk of rejecting a true hypothesis as if it was false (Rosenberg, 1973). Since the purpose of the regression analysis was to reveal the predictive role of sources, it was decided to continue regular regression analysis. Lastly, as multiple sources exist for pre-service teachers' self-efficacy beliefs, there possibly are self-efficacy dimensions in addition to student engagement, instructional strategies, and classroom management. For science education purposes, teaching science in laboratory self-efficacy, teaching science through argumentation self-efficacy, and nature of science self-efficacy could be investigated as self-efficacy dimensions particular to science education.

Acknowledgements or Notes

Please collate acknowledgements or notes in a separate section at the end of the article before the references.

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