Australian Journal of Teacher Education

Volume 45 | Issue 9 Article 3

2020

Pre-service Science and Mathematics Teachers' Teaching Efficacy Beliefs and Attitudes toward Teaching: A Partial Correlation Research

Büşra Kartal
Kırşehir Ahi Evran University, Turkey, busra.kartal@ahievran.edu.tr

Recommended Citation
Kartal, B. (2020). Pre-service Science and Mathematics Teachers' Teaching Efficacy Beliefs and Attitudes toward Teaching: A Partial Correlation Research. *Australian Journal of Teacher Education, 45*(9).
http://dx.doi.org/10.14221/ajte.2020v45n9.3

Pre-Service Science And Mathematics Teachers' Teaching Efficacy Beliefs And Attitudes Toward Teaching: A Partial Correlation Research

Büşra Kartal
Kırşehir Ahi Evran University, Turkey

Abstract: Teachers with a high level of self-efficacy and positive attitudes are more likely to use new and constructivist approaches and to create a learning environment in which students may develop 21st-century skills. Examining pre-service teachers' attitudes and beliefs related to teaching allow teacher preparation programs to evaluate their effectiveness on beliefs and attitudes. This correlational research investigated pre-service elementary science and mathematics teachers' beliefs and attitudes due to gender, grade level, and department, and revealed the reliable correlation between beliefs and attitudes performing partial correlation. Results show that females feel more efficacious in teaching and have more positive attitudes than males. 4th grades also perceive a higher level of efficacy for student engagement and using instructional strategies than 1st grades. Partial correlation coefficients revealed positive strong relationships between attitudes and efficacy beliefs. Recommendations are suggested based on implications.

Introduction

Science and mathematics achievement have been a particular topic of interest to the education community, the business world, policymakers, and administrators as it also refers to being successful in technology and economics (Kalender & Berberoglu, 2009; NAS, 2006). Success in science and mathematics help communities to overcome challenges to be competitive in the global economy. It is needed new approaches and trends such as STEM, in science and mathematics education to overcome the challenges faced in the global and knowledge-based world (Acar, Tertemiz, & Taşdemir, 2018). Therefore, the focus in science and mathematics education shifted from rote memorisation to comprehension and application of scientific and mathematical concepts in real-life (Siebert & Draper, 2012). The reforms around the world have aimed to achieve the goal of creating mathematically and scientifically literate students (Atar & Atar, 2012).

The shift in the focus of education worldwide has also affected the role of teachers and students in the 21st century (Uyanık, 2016). Teachers are expected to share knowledge with students and to guide them to construct new knowledge as well as students are expected to become effective problem solvers in daily lives using mathematical and scientific knowledge and language (Colwell & Enderson, 2016). This may occur when students rely on their skills (Özgen & Bindak, 2008) as trusting in their skills encourage students to make more effort in performing a particular task (Bandura 1977). However, students' self-efficacy related to mathematics seemed to decrease in grade 7 or earlier (Chang, 2015). Promoting students' mathematics and science self-efficacy and problem-solving skills and creating scientifically/mathematically literate students may be possible with efficacious teachers who use instructional methods that engage students in reasoning, modelling, and communicating

(Colwell & Enderson, 2016). These teachers also act as a facilitator for the activities that support students to participate in making sense of mathematical and scientific concepts (Doyle, 2007).

Effective teaching and learning in which students are active knowledge-constructors include a productive and positive relationship between teacher and students, and this relationship may occur when teachers feel efficacious and confident about their teaching (Ashton, 1984). Teacher efficacy is a teacher's self-trust to train students effectively (Guskey & Passaro, 1994), and the assessment of a teacher related to his/her knowledge, skills, and abilities related to teaching (Üstüner, 2017). Mathematics or science teachers with a high level of efficacy feel confident about own teaching, believes the positive effect of own teaching on students' learning, and seek ways to improve teaching when students fail (Ashton, 1984). Highly efficacious teachers tend to use student-centred and inquiry-based teaching strategies that will promote students' achievement and motivation in science and mathematics instead of teacher-centred strategies. They may also be more likely to use manipulatives or ICT (Swars, 2005).

Teachers with a high level of efficacy believe that students can achieve, and encourage them to take responsibility for their learning. This encouragement leads to better self-regulation and better study habits (Bruce, Esmonde, Ross, Dookie, & Beatty, 2010). The higher efficacy of a mathematics or science teacher accepts and values students' suggestions, ideas, and judgements (Liu & Zhou, 2007), and as a result, students' achievement, motivation, performance, and self-efficacy beliefs related to science and mathematics increase (Aydin & Woolfolk Hoy, 2005; Çaycı, 2011; Chang, 2015; Işıksal-Bostan, 2016; Liu & Zhou, 2007; Tschannen-Moran & Hoy, 2001; Uyanık, 2016; Zamir, Arshad, & Nazir, 2017). Students with a high level of efficacy determine higher goals, work harder, and become more successful in science and mathematics than others with low self-efficacy (Chang, 2015; Pajares, 1992). Improving performance, achievement, and motivation may help students feel more confident in class (Zamir et al., 2017). Confidence promotes associational, divergent, and creative thinking which are the essential thinking skills in the 21st century (Allen & Toth-Cohen, 2019). Moreover, students can participate in decision-making in a class in which teachers feel more efficacious (Ashton, 1984; Rimm-Kaufman & Sawyer, 2004). Thus, students may feel more enthusiastic and interested and take responsibility for their learning (Ashton, 1984).

Increasing the quality of science and mathematics teacher education programs in Turkey is crucial because the scores of Turkey in international assessments such as Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) are still under the average. In 2018 PISA, the average score of Turkey was 468 in science literacy and 454 in mathematics literacy while the average scores of OECD countries were 489 in both science and mathematics literacy. Turkey is ranked 32nd in mathematics literacy and 30th in science literacy among 37 OECD countries. In 2015 TIMSS, 8th-grade Turkish students got 493 average points in science achievement and 458 average points in mathematics achievement. The TIMSS average was determined as 500 average points. Turkey is ranked 21st among 47 countries that participate in TIMMS in science achievement and 24th among 39 countries in mathematics achievement. Besides, Turkey made significant increases in the scores of mathematics and science literacy (OECD, 2019). The results showed that we still need to put more effort forth for preparing scientifically and mathematically literate students. Therefore, it is still needed a focus on science and mathematics teacher efficacy.

Teachers' efficacy beliefs and attitudes impact their intentions and their behaviours in class (Ajzen, 2002). Therefore, science and mathematics teachers' efficacy beliefs and attitudes have attracted researchers' attention for a long time (Chang, 2015; Gencer &

Çakiroglu, 2007; Gür, Çakıroğlu, & Aydın, 2012; Mahajna, 2014; Petersen & Treagust, 2014; Senler, 2016; Tarkın & Uzuntiryaki, 2012; Ualesi & Ward, 2018). Teacher education programmes have a great effect on supporting future teachers to use various instructional techniques that would increase students' achievement, efficacy, and motivation (Colwell & Enderson, 2016; Işıksal-Bostan, 2016). Identifying preservice science and mathematics teachers' efficacy beliefs and attitudes may inform us about how they would behave in their future classrooms (Ajzen, 2002). However, there is limited research conducted with pre-service science and mathematics teachers. There is still a need to learn how teacher efficacy relates to other variables, which factors lead an increase or decrease in teacher efficacy, and to what extent it is context-specific (Philipp, 2007; Utley, Moseley, & Bryant, 2005). Considering the importance of mastery in science and education and the effect of teacher beliefs and attitudes on students' efficacy and achievement, I examined the levels of preservice elementary science and mathematics teachers' efficacy beliefs and attitudes toward the teaching profession, and the relationship between the constructs. The results of this study may help us how to prepare pre-service teachers who feel efficacious and have positive attitudes toward teaching, and as a natural consequence, they would help their students be successful literates of the world around them. The following sections discuss teacher efficacy and attitudes and the science and mathematics teacher education in Turkey.

Teacher Efficacy

Ashton (1984) identified teacher efficacy as "the extent to which teachers believe that they can affect student performance" (p. 28). Tschannen-Moran and Hoy (2001) proposed that teacher efficacy should be evaluated considering a broad range of teaching task such as classroom management and ensuring student engagement. They defined teacher efficacy as the judgement of his/her capabilities in order to achieve desired outcomes such as student engagement, classroom management, and increasing student motivation and achievement.

Teaching efficacy links teacher knowledge, skills, and behaviour to maintain a positive learning environment (Erawan, 2011), and affects what they think about teaching, how they feel and motivate themselves, and how long they try and persist when faced with challenges (Pajares, 1992; Pintrich & Schunk, 2002). Teacher efficacy may be a predictor of teachers' instructional behaviours such as the effort they make, the goals they set, and their level of willingness (Tschannen-Moran & Hoy, 2001). Teachers' ways of implementing curriculum depends on their efficacy beliefs (Fettahlıoğlu, Öztürk, Yücel Dağ, Kartal, & Ekici, 2012). Teacher efficacy and attitude may also be indicative to what extent they could use the school resources available to them. Sabah and Hammouri (2010) found that school resources did not lead a significant difference in students' science achievement in TIMMS 2007, and they argued that this might be because teachers could not effectively use these resources.

Teachers who feel efficacious in teaching also feel good about teaching, students, and themselves (Ashton, 1984). Teachers with a high level of self-efficacy are more social, optimistic, and energetic and are more eager to look for and use new and innovative methods and techniques due to students' different needs (Cousins & Walker, 2000; Weiner, 2003). It is possible to say that higher efficacy beliefs may support mathematics and science teachers to integrate disciplinary approaches into their lessons. Conscientiousness and openness are also found as considerable predictors of teacher efficacy. Teachers' efficacy beliefs are negatively correlated with burnout and positively correlated with job satisfaction and commitment to teaching (Aydin & Woolfolk Hoy, 2005) and with teacher motivation and success (Senler, 2016).

Struggling with challenges requires high motivation and feeling efficacious enough to overcome problems. Teachers with a high sense of efficacy do not give up working with challenging students, they are more open-minded for students' mistakes and they support students' positive attitudes and higher levels of efficacy (Rimm-Kaufman & Sawyer, 2004). Teachers with a high level of efficacy keep higher academic standards, express clearer expectations from students, and use more activities in class (Rimm-Kaufman & Sawyer, 2004), are more likely to seek and use different techniques and student-centred approaches (Weiner, 2003; Yıldız-Duban & Gökçakan, 2012). Ross (1998) identified that the relationship between teacher efficacy and student performance is bidirectional. Teachers feel more efficacious when their students do well, and students do better when teachers feel efficacious.

Lewitt (2002) proposed that teacher beliefs regarding teaching lead to develop an attitude toward teaching. Teachers' efficacy beliefs and attitudes form a theoretical basis for their instructional decisions, behaviours, and practices to maintain a productive learning environment and to motivate students (Rimm-Kaufman & Sawyer, 2004). It is crucial to note that teacher efficacy and attitudes are related to each other (Üstüner, 2017). It is essential to reveal the relationship between teaching efficacy and attitudes toward teaching because changes in attitudes and beliefs would lead to changes in teacher behaviours (Çaycı, 2011). Preservice teachers usually make their decisions regarding what it means to be a "good" or "bad" teacher (Pajares, 1992) in their preparation programs. Identifying the variables that lead to changes on teacher efficacy and attitude would help teacher educators to design teacher preparation programs to prepare pre-service teachers (PSTs) with a high level of teacher efficacy (Rimm-Kaufman & Sawyer, 2004).

Attitude toward Teaching

Attitude is an unobservable trait that has a significant effect on individuals' choices and decision about action, and on individuals' behaviours (Ashton, 1984; Erawan, 2011). Individuals usually develop positive or negative attitudes towards people, places, events or ideas, and the attitudes lead to the acceptation or rejection of these stimuli (Papanastasiou, 2002).

Teacher efficacy beliefs are more related to teachers' beliefs about the effectiveness of their teaching on students' learning, including struggling students. On the other hand, attitudes mostly are associated with how teachers would act, feel, and think in the classroom (Philipp, 2007). Attitudes toward teaching affect how a teacher teaches (Turkmen, 2013). Positive attitudes improve teachers' motivation and enthusiasm, as well as students' motivation and achievement (Senler, 2016). Having positive attitudes towards teaching help teachers overcome the problems they face in their class. Overcoming problems without giving up is related to teacher persistence which is also related to teacher efficacy (Tschannen-Moran & Hoy, 2001). Teachers who have student-centred attitudes are more likely to encourage the students to participate in the lesson actively and to allow them to predict, infer, evaluate, and decide about their instruction.

Pre-service teachers may develop positive attitudes toward teaching by observing peers, cooperating teachers, and teacher educators who have positive attitudes in their field experiences (Senler, 2016). Identifying an individual's attitude toward an object or a stimulus would help to predict the individual's behaviour related to that object or stimulus (Üstüner, 2017). Unpacking teacher efficacy and attitude by examining how it develops and what affects these constructs positively would help to develop teacher preparation. It is difficult to change beliefs when PSTs graduate and become in-service teachers. Therefore, it is crucial to

train PSTs in a way that they feel efficacious in teaching before they graduate (Woodcock, 2011).

Teachers' attitudes toward teaching are correlated with teacher efficacy beliefs in maintaining a positive learning environment and in participating in making decisions related to school policy (Çaycı, 2011; Erawan, 2011; Rimm-Kaufman & Sawyer, 2004). Therefore, educating PSTs with a high level of efficacy requires helping them to develop positive attitudes toward teaching (Senler, 2016). High teacher efficacy beliefs combined with positive attitudes would create a desirable learning environment that support students' mathematical and scientific learning (Chang, 2015).

Examining Teacher Efficacy and Attitude in Terms of Different Variables

Some factors such as gender, grade level, and department are related to both teacher efficacy and attitude toward teaching. The teaching profession is predominantly considered as a female profession (Çaycı, 2011; Kalaian & Freeman, 1994). For example, the number of employed female teachers (N=216979) was greater than the number of employed male teachers (N=195134) in Turkey (MoNE, 2019). Researchers have investigated whether teacher efficacy and attitudes differ by gender until recently (Table 1).

Grade level reflects the number of PSTs' experiences in their preparation programs. It is well known that experiences affect efficacy (Aydin & Woolfolk Hoy, 2005). PSTs may develop their teaching efficacy beliefs and attitudes toward teaching as they experience success (mastery experiences) and observe successful peers, teacher educators or cooperating teachers (vicarious experiences). Hoy and Spero (2005) found that teaching efficacy of PSTs increased during teacher preparation conjunction with the increasing amount of mastery and vicarious experiences. Furthermore, Ross, Cousins, and Gadalla (1996) argued that teacher efficacy is depended upon the department. Table 1 demonstrates the literature that has investigated whether teacher efficacy and attitudes towards teaching differ in terms of gender, grade level, and department of participants.

	Teacher Efficacy		**Attitude toward Teaching**	
	There is a significant difference in terms of….	**There is not a significant difference in terms of….**	**There is a significant difference in terms of….**	**There is not a significant difference in terms of….**
Gender	Fives & Looney, 2009; Özdemir, 2008; Riggs, 1991; Tran, 2015; Zamir et al., 2017	Cakiroglu, 2008; Çaycı, 2011; Gencer & Cakiroglu, 2007; Pendergast, Garvis, & Keogh, 2011; Tschannen-Moran & Hoy, 2007	Çapri & Çelikkaleli, 2008; Çaycı, 2011; Donmuş, Akpınar & Eroğlu, 2015; Fadlelmula, 2013; Parylo, Süngü, & Ilgan, 2015	Demirtaş, Cömert, & Özer, 2011; Tok, 2012
Grade Level	Bayraktar, 2011; Çaycı, 2011; Uyanık, 2016; Woodcock, 2011; Yıldız Duban & Gökçakan, 2012; Zehir Topkaya & Yavuz, 2011	Gencer & Cakiroglu, 2007; Lin & Gorrell, 2001; Plourde, 2002	Uyanık, 2016; Yıldız Duban & Gökçakan, 2012	Çapri & Çelikkaleli, 2008; Çaycı, 2011
Department	Demirtaş et al., 2011; Saracaloğlu & Yenice, 2009	Pendergast et al., 2011; Woodcock, 2011	Donmuş et al., 2015; Parylo et al., 2015;	Demirtaş et al., 2011

Table 1: The literature review that examines the significant differences in teacher efficacy and attitude toward teaching in terms of gender, grade level, and department

Gender, grade level, and department are associated with both teaching efficacy and attitude toward teaching (Table 1), which are also related to each other (Çapri & Çelikkaleli, 2008; Çaycı, 2011; Demirtaş et al., 2011; Erawan, 2011; Senler, 2016; Uyanık, 2016). Centring on these findings, this study aims to investigate the differences in pre-service science and mathematics teachers' teacher efficacy and attitudes towards teaching in terms of gender, grade level, and department; and to reveal the relationship between teacher efficacy and attitude toward teaching when the effect of gender was held constant. Holding constant the effect of gender may help to understand better the relationship between teacher efficacy and attitudes as female educators outnumber their male counterparts. It may be worthwhile to describe science and mathematics teacher education in Turkey before informing about the methodology.

Science and Mathematics Teacher Education in Turkey

Entering a bachelor's degree for four years requires a national examination called Higher Education Institutions Entrance Exam. Pre-service teachers must graduate from a 4-year teacher preparation program with a bachelor's degree (Gencer & Cakiroglu, 2007) to be recruited as a science or mathematics teacher. Elementary science and mathematics teachers teach to grade 5-8. Science teacher education program consists of different branches of science such as biology, chemistry, and physics and their laboratory activities in the first years, while mathematics teacher education program includes lessons such as general mathematics, abstract mathematics, and geometry. Pre-service teachers begin to take several courses related to general teaching such as educational psychology, introduction to teaching profession from the beginning. We can say that the first two years of science and mathematics teacher preparation programs are based on content and pedagogy. They enrol in a course related to instructional strategies in the third year and classroom management in the fourth year. They learn how to teach science/mathematics from the third year of the program by taking courses such as methods of science/mathematics teaching, and they meet with the real context of schools in their last years. In the first semester of the final year, pre-service science and mathematics teachers observe how cooperating teachers teach, assess student learning, ensure student engagement, and which techniques and strategies they prefer in the cooperating schools. In student teaching, pre-service science and mathematics teachers begin to teach in real classrooms six-hour per week.

In the study of Ashton (1984), she stated that asking teachers to assess their teaching might help them to consider their effectiveness on student learning. It is also worth noting that scaffolding and support are the key factors in the reflection processes. Therefore, it is vital to ask PSTs to evaluate their effectiveness. Within this context, this study aims to investigate pre-service science and mathematics teachers' teaching efficacy and attitudes towards teaching in terms of variables such as gender, grade level, and department, and to reveal the relationship between PSTs' efficacy beliefs and attitudes when the effect of gender is controlled.

The research questions are as follows:

1. Is there a significant difference in pre-service science and mathematics teachers' efficacy beliefs in terms of gender, grade level, and department?
2. Is there a significant difference in pre-service science and mathematics teachers' attitudes toward teaching in terms of gender, grade level, and department?
3. What is the direction and strength of the relationship between pre-service science and mathematics teachers' teacher efficacy beliefs and attitudes toward teaching when the effect of gender was controlled?

Method

Research Design

This study is exploratory correlational research that aims to investigate the relationship between teacher efficacy beliefs and attitudes toward teaching in terms of different variables. Exploratory correlational research enables researchers to reveal and interpret the relationships between two or more variables to see if they influence each other (Creswell, 2012; Fraenkel, Wallen, & Hyun, 2011; Plano-Clark & Creswell, 2015). Correlational research is an appropriate first step before investing time and sources in an experiment (Fraenkel et al., 2011). For example, a researcher who plans an experimental design to develop pre-service teacher efficacy beliefs and attitudes can design their own research considering the results of this study. Relationships between teacher efficacy and attitudes that would be found in correlational research may contribute to the content of professional development or teacher preparation programs.

Participants

The population is the pre-service elementary science and mathematics teachers in Turkey, as well as the accessible population, is the ones with similar national exam-based results to enter the science and mathematics education in the Middle Anatolia. The elementary science and mathematics education departments follow a similar curriculum proposed by the Higher Education Institution. Therefore, it may be possible to assume that the findings of the accessible population can be generalised for the population. There were 1639 pre-service elementary science and mathematics teachers in the accessible population (elementary science and mathematics teacher education departments that require similar national exam results in the middle Anatolia). Furthermore, a sample size of 311 participants is enough to generalise the findings with a significance level of .05 and the deviance level of .05 to a population of 1639 participants (URL 1). Data collected from 352 PSTs who voluntarily completed the tools completely were included in data analysis. Two hundred sixty-one of participants were pre-service science teachers, and 91 were pre-service mathematics teachers. The sample size of this study makes it possible to generalise the findings of this study to the accessible population. The participants ranged in age from 18 to 27 years (M=20,63; Sd=1,59). Table 2 demonstrates the number of participants' gender and grade level.

		Gender			
		Male	**Female**	**Total**	**Percent**
Grade Level	**1. Grade**	32	116	148	42,0
	2. Grade	24	47	71	20,2
	3. Grade	20	51	71	20,2
	4. Grade	20	42	62	17,6
Total		96	256	352	100,0

Table 2: Participants demographics in terms of gender and grade level

Data Collection Tools

Teachers' Sense of Efficacy Scale (TSES)

Teachers' Sense of Efficacy Scale (TSES) was developed by Tschannen-Moran & Hoy (2001) and was adapted into Turkish by Çapa, Çakıroğlu, and Sarıkaya (2005). TSES has 24 items and three factors, namely *Student Engagement* (SE), *Instructional Strategies* (IS), and *Classroom Management* (CM). Each factor has eight items which are in 5-Likert point scale ranging from not efficient (1) to very efficient (5). The possible scores range from 24 to 120. I calculated the Cronbach's alpha values as .81 for SE, .83 for IS, .81 for CM, and .93 for overall scale.

Confirmatory factor analysis was conducted to see whether the factor structure of TSES would fit the data of this study. Fit indices (χ^2/df =2,78; RMR=0,4; GFI=0,85; AGFI=0,81; RMSEA=0,071; CFI=0,87) that obtained from CFA show that the original three-factor model has acceptable fit to data (Jöreskog & Sorbom, 1993).

Sample items for each factor are as follows.

Efficacy for Student Engagement

- How much can you do to motivate students who show low interest in schoolwork?
- How much can you do to foster student creativity?

Efficacy for Instructional Strategies

- To what extent can you use a variety of assessment strategies?
- To what extent can you craft good questions for your students?

Efficacy for Classroom Management

- How much can you do to get children to follow classroom rules?
- How well can you respond to defiant students?

Attitude Scale toward Teaching Profession (ASTP)

Attitude Scale toward Teaching Profession (ASTP) was developed by Özgür (1994) to measure pre-service teachers' attitudes toward teaching. ASTP is unidimensional and involves 33 items which are in 5-Likert point scale ranging from strongly disagree to strongly agree. ASTP consists of both positively worded (such as *"Teaching is a profession that enables valuing people"*) and negatively worded (such as *"Teaching is not a favourite profession."*) items. The internal reliability was .75 for this study.

Data Analysis

The instruments were administered to 419 pre-service elementary science and mathematics teachers, but 386 of them voluntarily completed the instruments. Data obtained from 386 pre-service teachers were analysed via SPSS. Data obtained from pre-service teachers who did not complete all instruments and gave the same response for all items (extreme value) were extracted from data set, and 352 pre-service teachers' data were included in data analysis.

Before data analysis, negatively worded items were reverse-coded ranging from 1 (completely agree) to 5 (completely disagree). After these adjustments, the normality of data

was investigated with the Kolmogorov-Smirnov test and skewness and kurtosis values (Table 3).

Scale/sub-scale	Statistic	Sig.	Skewness	Kurtosis
Teachers' Sense of Self Efficacy (TSES)	,090	,000*	-,685	,444
Student Engagement (SE)	,105	,000*	-,589	,316
Instructional Strategies (IS)	,097	,000*	-,652	,528
Classroom Management (CM)	,113	,000*	-,576	,251
Attitude Scale toward Teaching Profession (ASTP)	,064	,002*	,542	,437

*p<.05

Table 3: Results of the Kolmogorov-Smirnov test and Skewness-Kurtosis values

Data of this study is significantly different from a normal distribution (Table 3). Therefore, nonparametric tests, Kruskal Wallis and Mann Whitney U tests were used to comparing means, and descriptive statistics such as frequency (f), percentage (%), mean, and standard deviation (Sd) were calculated. The partial correlation coefficient was also utilised to reveal the reliable relationship between teacher efficacy beliefs and attitudes toward teaching when the effect of gender was controlled. Partial correlation hinders the possibility that other variables may explain the relationships that are found (Fraenkel et al., 2011), and it is an efficient way of minimising the threats to internal validity in correlational research.

Findings

This study has three sub-problems given above. Findings are presented in an order that corresponds to sub-problems.

Pre-Service Science and Mathematics Teachers' Efficacy Beliefs

In response to the first research question, Table 4 demonstrates gender differences in pre-service science and mathematics teachers' efficacy beliefs.

Scale/Sub-scales	Gender	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	p
Teachers' Sense of Efficacy Scale	Male	96	153,58	14744,00	10088,000	-2,589	,010*
	Female	256	185,09	47384,00			
Student Engagement (SE)	Male	96	150,74	14471,00	9815,000	-2,917	,004*
	Female	256	186,16	47657,00			
Instructional Strategies (IS)	Male	96	153,84	14768,50	10112,500	-2,566	,010*
	Female	256	185,00	47359,50			
Classroom Management (CM)	Male	96	160,51	15409,00	10753,000	-1,810	,070
	Female	256	182,50	46719,00			

*p<.05

Table 4: Gender differences in pre-service teachers' efficacy belief

Female pre-service teachers had higher mean scores in all sub-scales and overall scale than males. These differences are statistically significant in overall teacher efficacy ($U = 10088;\ p = .01 < .05$), in student engagement ($U = 9815;\ p = .004 < .05$), and in instructional strategies ($U = 10112{,}5;\ p = .01 < .05$). In other words, female pre-service teachers feel more efficacious in student engagement and instructional strategies than males.

Department in which pre-service teachers enrol is another investigated demographic whether it leads to significant differences. Table 5 gives the results related to the differences due to department.

Scale/Sub-scales	Department	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	p
Teachers' Sense of Efficacy Scale	Science Education	261	182,28	47574,50	10367,500	-1,805	,071
	Mathematics Education	91	159,93	14553,50			
Student Engagement (SE)	Science Education	261	184,93	48267,50	9674,500	-2,641	,008*
	Mathematics Education	91	152,31	13860,50			
Instructional Strategies (IS)	Science Education	261	180,79	47186,00	10756,000	-1,343	,179
	Mathematics Education	91	164,20	14942,00			
Classroom Management (CM)	Science Education	261	181,62	47404,00	10538,000	-1,605	,109
	Mathematics Education	91	161,80	14724,00			

*p<.05

Table 5: Differences in teacher efficacy beliefs in terms of department

Pre-service science teachers have higher scores in all subscales and overall scale than pre-service mathematics teachers. Still, the differences between groups are not statistically significant except for student engagement. Science teacher education programs seem to affect pre-service teachers' efficacy in student engagement more than mathematics teacher education programs in this study ($U = 9674{,}5;\ p = .008 < .05$).

Pre-service teachers' knowledge, skills, and practices improve as they progress through their preparation programs. Therefore, the effect of grade level is also examined in pre-service teachers' efficacy beliefs (Table 6).

Grade Level	N	Teachers' Sense of Efficacy Scale	Student Engagement (SE)	Instructional Strategies (IS)	Classroom Management (CM)
1. Grade (a)	**148**	160,93	156,69	159,29	169,06
2. Grade (b)	**71**	186,74	188,41	184,06	186,79
3. Grade (c)	**71**	192,33	195,04	197,95	181,42
4. Grade (d)	**62**	183,81	188,91	184,35	176,83
Chi-Square (χ^2)		6,226	9,916	8,196	1,692
df		3	3	3	3
Asymp. Sig.(p)		,101	,019*	,042*	,639
Difference		-	a<c a<d	a<d	-

*p<.05

Table 6: Differences in pre-service teachers' efficacy beliefs in terms of grade level

Kruskal Wallis test was conducted to investigate whether pre-service science and mathematics teachers' efficacy beliefs differ in terms of grade levels, and it was found that there were significant differences in student engagement and instructional strategies. In order to find the source of the differences, I performed six Mann Whitney tests (1st grade vs. 2nd grade, 1st grade vs. 3rd grade, 1st grade vs. 4th grade, 2nd grade vs. 3rd grade, 2nd grade vs. 4th grade, and 3rd grade vs. 4th grade) to compare means of each grade level, as suggested by Field (2013). Mann Whitney tests reveal that there are significant differences between 1st and 3rd grades in favour of 3rd grades ($U = 4109{,}5;\ p = .009 < .05$) and between 1st and 4th grades in favour of 4th grades ($U = 3747;\ p = .036 < .05$) in student engagement. Besides, there is a significant difference in instructional strategies between 1st and 4th grades in favour of 4th grades ($U = 4147;\ p = .011 < .05$).

Pre-Service Science and Mathematics Teachers' Attitudes Toward Teaching

The second research question is related to the pre-service teachers' attitudes and the demographic differences in attitudes. Table 7 demonstrates whether gender and department lead to significant differences in pre-service teachers' attitudes.

Scale	Demographics	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	p
Attitude Scale toward Teaching Profession (ASTP)	Male	96	159,45	15307,50	10651,500	-1,925	,044*
	Female	256	182,89	46820,50			
	Science Education	261	181,37	47337,00	10605,000	-1,521	,128
	Mathematics Education	91	162,54	14791,00			

*p<.05

Table 7: Gender and department differences on pre-service teachers' attitudes toward teaching

Female pre-service teachers have higher scores than males, and pre-service science teachers have higher scores than pre-service mathematics teachers. However, just gender leads to a significant difference in attitudes ($U = 10651{,}5; p = .044 < .05$). Female pre-service teachers have more positive attitudes than male pre-service teachers.

Grade level is the last demographic variable that is investigated whether it leads to a significant difference in pre-service teachers' attitudes (Table 8).

Grade Level	N	Attitude Scale toward Teaching Profession (ASTP)
1. Grade (a)	**148**	168,46
2. Grade (b)	**71**	185,55
3. Grade (c)	**71**	183,67
4. Grade (d)	**62**	177,11
Chi-Square (χ^2)		6,226
df		3
Asymp. Sig.(p)		,101
Difference		-

Table 8: Kruskal Wallis test result related to grade level differences on attitudes toward teaching

Second grade pre-service teachers have the highest mean scores, as well as first grades have the lowest. There is no significant difference in pre-service teachers' attitudes in terms of grade level ($\chi^2 = 6{,}226; p = .101 > .05$), while grade level leads to significant differences in teacher efficacy beliefs.

The Relationship Between Pre-Service Teachers' Efficacy Beliefs and Attitudes Toward Teaching

One of the main aims of this study is to reveal the relationship between teaching efficacy beliefs and attitudes toward teaching. I first applied a zero-order correlation analysis in which none of the variables was controlled (Table 9). Zero-order correlation analysis showed that gender has significant correlations with both teacher efficacy beliefs and attitudes toward teaching (Table 9).

	SE	IS	CM	TSES	ASTP	Department	Gender	Grade Level
SE	-	,811**	,792**	,928**	,756**	-179**	,168**	157**
IS		-	,808**	,938**	,792**	-,115**	,141**	,138**
CM			-	,931**	,959**	-,118**	,102	,054
TSES				-	,898**	-,146**	,146**	,124**
ASTP					-	-,043	,107**	,046
Department						-	,187**	-358**
Gender							-	-,085
Mean	3,72	3,80	3,82	3,78	3,4	-	-	-
Sd	,53	,56	,56	,51	,39	-	-	-

Note: ** indicates significant at probability levels of 0.01

Table 9: Mean, standard deviation, and Zero-Order correlations of all variables

Due to the potential effect of gender on efficacy beliefs and attitudes, I also performed a first-order correlation analysis in which the effect of one variable, gender, was held constant (Field, 2013). The effect of gender was controlled to calculate the partial correlation coefficients (Table 10).

Control Variables		TSES	SE	IS	CM	ASTP
Gender	Teachers' Sense of Efficacy Scale	-				
	Student Engagement (SE)	,926**	-			
	Instructional Strategies (IS)	,936**	,807**	-		
	Classroom Management (CM)	,931**	,790**	,806**	-	
	Attitude Scale toward Teaching Profession (ASTP)	,897**	,753**	,789**	,959**	-

Note: ** indicates significant at probability levels of 0.01

Table 10: Partial correlation among teachers' sense of efficacy, student engagement, instructional strategies, classroom management, and attitudes toward teaching controlling for gender

The partial correlation coefficients demonstrate the reliable relationships among teachers' sense of efficacy, efficacy for student engagement, efficacy for instructional strategies, efficacy for classroom management, and attitudes toward teaching. Pre-service science and mathematics teachers' attitudes toward teaching have positive and strong correlations with their efficacy beliefs in engaging students ($r = .753; p < .001$), using instructional strategies ($r = .789; p < .001$), managing classroom ($r = .959; p < .001$), and in teaching ($r = .897; p < .001$). Pre-service teachers' efficacy beliefs in classroom management explain the most variance in their attitudes ($r^2 = .92$) when the effects of other variables are controlled.

Discussion

This study aims to investigate pre-service elementary science and mathematics teachers' efficacy beliefs and attitudes in terms of different variables and to reveal the reliable relationships between these constructs. Teachers' efficacy beliefs and attitudes have an impact on their behaviours in class. Therefore, examining pre-service teachers' efficacy beliefs and attitudes allow seeing how they would behave in their future classes. Three hundred fifty-two participants completed the data collection tools (Teachers' Sense of Efficacy Scale, Attitude Scale toward Teaching Profession) wholly and voluntarily. Results show that participant student teachers have a high level of efficacy beliefs and a medium level of attitude toward teaching. High level of teacher efficacy is a common finding in the literature (Aydin & Woolfolk Hoy, 2005; Tschannen-Moran & Hoy, 2007; Üstüner, 2017).

We can say that participants of this study may have a great enthusiasm for teaching and may be more likely to adapt practices that have been associated positively with their students' achievement, motivation, and efficacy (Tschannen-Moran & Hoy, 2001).

It is found that female pre-service teachers have higher scores than male pre-service teachers in the overall teacher efficacy scale and all sub-domains and the attitudes scale. In other words, female pre-service teachers may perceive higher teaching efficacy and more positive attitudes toward teaching than males. The differences between means of females and males are statistically significant for the overall scale of teaching efficacy, efficacy for student engagement, efficacy for instructional strategies, and attitude scale towards the teaching profession. Some of the researchers found a significant difference in teacher efficacy (Fives & Looney, 2009) and in attitudes toward teaching (Çapri & Çelikkaleli, 2008; Çaycı, 2011; Fadlelmula, 2013) in favour of females, consistently with this study. A few researchers found that males feel more efficacious (Demirtaş et al., 2011; Tran, 2015) and have more positive attitudes (Parylo et al., 2015). On the other hand, most of the researchers found no difference in teaching efficacy (Çaycı, 2011; Cakiroglu, 2008; Pendergast et al., 2011; Saracoğlu & Yenice, 2009; Tschannen-Moran & Hoy, 2007; Zehir Topkaya & Yavuz, 2011) and in attitudes toward teaching (Demirtaş et al., 2011; Tok, 2012). These results show that it may not be precisely accurate to consider teaching as a predominantly female profession as it is referred to in the literature (Kalaian & Freeman, 1994).

Teachers' efficacy beliefs may change due to the department (Ross et al., 1996). They may feel more efficacious in teaching a specific subject than others (Uzuntiryaki, 2008). From this point of view, the department of PSTs is another variable that is examined to see whether it leads to significant differences in teachers' efficacy beliefs and attitudes. Findings revealed that pre-service science teachers feel more efficacious in ensuring student engagement. Student engagement mostly requires guiding students to increase their interest, motivation, and values related to learning. High efficacy for student engagement may play a crucial role in supporting students' active participation and knowledge construction. It may be not easy to indicate the reasons for the significant difference between pre-service science and mathematics teachers. However, one can imply that science teacher education courses may contribute more to pre-service teachers' efficacy for student engagement than mathematics teacher education. Therefore, pre-service mathematics teachers need more scaffolding to improve their efficacy beliefs for student engagement. This scaffolding becomes essential given the importance of student engagement in preparing mathematically literate and successful students.

It is known that pre-service teachers' efficacy beliefs increase during their preparation program until they begin to practice in the field (Tschannen Moran & Hoy, 2007; Woodcock, 2011). Participants' mean scores in teacher efficacy scale and attitude scale progressed up to 4th grades, but 4th grade pre-service teachers mean scores were less than 3rd grades. Significant differences considered, results show that 4th-grade pre-service teachers feel more efficacious in ensuring student engagement and using instructional strategies than 1st grades, and 3rd grades perceive higher efficacy for student engagement than 1st grades. These findings show that more experienced pre-service teachers have higher efficacy beliefs. The result that indicates higher efficacy levels of 4th grades than 1st grades are frequently encountered in much research (Bayraktar, 2011; Çaycı, 2011; Uyanık, 2016; Woodcock, 2011; Zehir Topkaya & Yavuz, 2011).

Mastery experiences are the most influential source of self-efficacy (Hoy & Spero, 2005; Uzuntiryaki, 2008). The more pre-service teachers have the opportunity to perform different tasks such as using different instructional strategies, ensuring student engagement, and managing classroom effectively and efficiently, the more efficacious they feel. However, the real context of schools may confront pre-service teachers with a shock that makes them

realise the difficulties of achieving their hopes (Pendergast et al., 2011). Therefore 4th grades mean scores of teaching efficacy might have decreased. It is essential to note that data was not collected at the end of the year, so they might not have gained enough practical experience that hinders them overestimating their levels of efficacy (Zehir Topkaya & Yavuz, 2011). However, Aydin and Woolfolk Hoy (2005) found that pre-service teachers who have more hours of field experience exhibit lower levels of efficacy.

It is also found that grade level made no difference in pre-service science and mathematics teachers' attitudes toward teaching. This finding supports the results of Çapri and Çelikkkaleli (2008) and Çaycı (2011). Teacher education programs in which this study was conducted seemed to have no impact on pre-service teachers' attitudes. Parylo et al. (2015) found that pre-service teachers' attitudes did not change after they took pedagogical formation courses. They proposed that participants could have exhibited the highest level of their attitudes before they took courses. This interpretation may be also applied to this study. I can conclude that pre-service teachers may have the highest level of attitude they can when they entered their preparation programs, and therefore their attitudes may not have changed during programs.

Attitudes play a vital role because they can impact teachers' practices. It is also known that attitude is significantly related to efficacy (Çaycı, 2011; Demirtaş et al., 2011; Mahajna, 2014; Üstüner, 2017). Zero-order correlation coefficients showed that gender had relationships with both teacher efficacy beliefs and attitudes toward teaching. Variance explained by the attitude in efficacy beliefs may also be explained by gender. To reveal the reliable correlation between efficacy and attitude, the first-order correlation analysis was performed. Partial correlation coefficients showed that attitude had a strong positive correlation with teaching efficacy beliefs, efficacy for student engagement, efficacy for instructional strategies, and efficacy for classroom management. Pre-service teachers with more positive attitudes tend to feel more efficacious in classroom management, and then in using instructional strategies and ensuring student engagement, respectively. Classroom management explains 91,97% of the variance in the attitudes when the effects of other variables are controlled. The more pre-service teachers may feel efficacious in classroom management, the more positive attitudes they may have. The correlation between the overall efficacy scale and its sub-domains are also positive and strong. The high correlation coefficients among the overall scale and its sub-domains confirm the three-factor model for this study.

Implications and Recommendations

This study has some major implications, and recommendations are made within the context of these implications.

1. Pre-service teachers' efficacy belief and attitudes toward teaching differed by gender. There is not a consensus about the effect of gender. Future researches should investigate the context variables and participants' characteristics (such as the reason for choosing teaching as a profession) to understand better when gender lead to significant differences.
2. Teacher education program in which this study was conducted seemed to effect PSTs' efficacy for ensuring student engagement and using instructional strategies and not to impact classroom management and attitude toward teaching. Pre-service teachers take the course related to classroom management in their final year. It will be effective for PSTs to take more courses related to classroom management earlier in their preparation programs. Attitude also did not differ in terms of grade level. Further

researches should examine the development of attitudes toward teaching during PSTs' preparation and the effect of well-designed activities and courses on PSTs' attitudes.

3. Pre-service mathematics teachers perceived less efficacy in ensuring student engagement than pre-service science teachers. It may be needed a qualitative follow up study to comprehend the factors that impact efficacy on ensuring student engagement. Then, the findings of the follow-up study may contribute to the design of teacher preparation programs. For example, pre-service mathematics teachers may take more courses that make them think about student engagement and emphasise working with struggling students in mathematics classrooms.
4. It is needed further researches that examine the variables affecting both teacher efficacy and attitudes toward teaching. These researchers may control the effect of these variables. The more variables that affect teacher efficacy and attitudes are controlled the more reliable relationship between teaching efficacy and attitudes toward teaching are revealed.

Limitations

This study has some limitations with the sample and data collection tools. Participants studied in two universities. It may be difficult to generalise the findings to all pre-service science and mathematics teachers in Turkey. Therefore, it is needed more researches that examine the efficacy and attitudes of different participants from different universities. The similarities and differences between findings may provide opportunities for researchers to discuss the underlying reasons for findings. On the other hand, data collection tools are self-reported measures which may not always give adequate and accurate information about student teachers' efficacy beliefs and attitudes toward teaching. Pre-service teachers' perceived and observed efficacy beliefs and attitudes should be examined by using in-depth interviews or observations.

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