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Developing Pre-service Elementary Science Teachers' Science Teaching Efficacy Beliefs through Microteaching by Promoting Efficacy Sources

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Abstract

Science teaching efficacy belief (STEB) is of paramount importance as it motivates teachers to teach science or hinders them from teaching science. Pre-service teachers' efficacy beliefs may change during their method courses. Knowing how pre-service teachers' beliefs change over time can significantly contribute to teacher educators to improve teacher efficacy. This study examined the effect of microteaching on pre-service elementary science teachers' STEB. Pretest-posttest control group design was utilized. Data was collected using the Science Teaching Efficacy Beliefs Instrument (STEBI-B) developed by Enochs and Riggs (1990) both at the beginning and end of the study. The treatment group planned and taught mini-lessons. The lessons were videotaped and evaluated in detail by watching the videotapes. The microteachers replanned and retaught the mini-lessons based on the feedback. The microteaching practices were conducted to support efficacy sources. The control group only planned and taught mini-lessons and received brief and undetailed feedback. Results showed significant differences in participants' personal science teaching efficacy beliefs and student outcome expectancy beliefs in terms of the treatment group. The STEB scores of the control group also decreased at the end of the study. It is suggested that pre-service teachers should have the opportunity to reflect on their performances, artifacts, or lesson plans and to design them several times.

Introduction

Teacher preparation programs must be attentive to preservice teachers' science content knowledge, pedagogical methods, and teaching skills, but should also include experiences that emphasize the development of pre-service teachers' attitudes and self-efficacy (Appleton, 1995; Bandura, 1997; Kartal, 2020; Mulholland & Wallace, 2000; Senler, 2016). Science educators need to take pre-service teachers' beliefs into account in science teacher education as beliefs affect teachers' classroom practices. Tobin, Tippins, and Gallard (1994) stated that teacher beliefs are critical factors affecting classroom behavior and should not be ignored. Science education reforms will be more fruitful when teacher preparation programs consider pre-service teachers' beliefs. Beliefs are one of the most valuable psychological structures in teacher education (Pintrich, 1990). Many studies (Nespor, 1987; Pajares, 1992; Richardson, 1996) suggested that pre-service teachers' beliefs are influential in (i) acquiring and interpreting pedagogical knowledge, (ii) analyzing course content and teaching processes and tasks, and (iii)

evaluating curriculum and teaching. Researchers (Bandura, 1981; Beck, Czerniak, & Lumpe, 2000; Enochs & Riggs, 1990; Haney, Czerniak, & Lumpe, 1996; Kartal & Çinar, 2018; Pintrich, Marx, & Boyle, 1993; Ramey-Gassert & Schroyer, 1992) argued that teachers' beliefs related to science teaching significantly contributed to their teaching practices and intentions to use innovative and constructive science teaching strategies.

It may be possible for future science teachers to provide appropriate learning environments and positive science experiences for their students if they improve their science teaching efficacy beliefs (Mulholland & Wallace, 1996; Riggs & Enochs, 1990; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). For this reason, examining pre-service teachers' beliefs about science teaching and developing these beliefs before starting the profession will be an essential endeavor for effective science teaching in schools. Considering the importance of science teaching efficacy beliefs, we examined the effect of microteaching on the development of pre-service elementary science teachers' science teaching efficacy beliefs.

Science Teaching Efficacy and Efficacy Sources

Self-efficacy is the confidence in a person's ability to complete tasks that require the highest potential to achieve specific goals (Bandura, 1997). Ford (1992) expressed self-efficacy as part of personal skills that motivate individuals to achieve and perform the desired behavior competently. Motivation includes beliefs about the purpose, emotion, and both context and capacity (self-efficacy). He argued that capacity beliefs are related to personal skills, and these skills are about individual perceptions.

Teachers may have certain beliefs about their abilities and skills, which can affect their success in teaching. Teacher beliefs not only affect their actions; at the same time, classroom and school environment can also support or hinder the development of teachers' beliefs (Clark & Peterson, 1985). Many factors can affect a teacher's self-efficacy before starting to teach in the classroom. Self-efficacy is associated with structures such as student achievement (Arsal, 2014; Ashton & Webb, 1986; Avery & Meyer, 2012; Bandura, 1995; Helms-Lorenz, Slof, Vermue, & Canrinus, 2012; Lumpe, Czerniak, Haney, & Beltyukova, 2012; Wheatley, 2002; Zee & Koomen, 2016) and motivation (Arsal, 2014; Ashton, 1984; Ashton & Webb, 1986; Bandura, 1977; Darling-Hammond, Chung, & Frelow, 2002; Gibson & Dembo, 1984; Senler, 2016); teachers' willingness to adopt innovative teaching strategies (Allinder, 1994; Bandura, 1997; Czerniak, 1990; Sandholtz & Ringstaff, 2014); time spent to teach specific subjects (Ashton & Webb, 1986; Bandura, 1997; Carter & Sottile, 2002; Gibson & Dembo, 1984; Ramey-Gassert, & Shroyer, 1992) and alternative science concepts (Riggs & Jesunathadas, 1993; Flores, 2015); and classroom management beliefs (Çapa, Çakıroğlu, & Sarıkaya, 2005; Tschannen-Moran & Hoy, 2001).

Several researchers explored the relationship between self-efficacy and teaching. Some of these studies have shown that teaching behaviors such as retention in tasks, risk-taking, and being open to innovations are related to self-efficacy levels (Ashton & Webb, 1986; Bandura, 1982). For example, in science teaching, teachers with high self-efficacy are more likely to use inquiry-based and student-centered teaching methods. In contrast, teachers with low self-efficacy are more likely to adopt a teacher-centered approach (Czerniak, 1990).

In Bandura's theory, the behavior is based on two sources: self-efficacy expectations and outcome expectations (Figure 1). According to Bandura (1997), self-efficacy expectation is defined as a belief that he can successfully carry out the behavior required for the desired results. However, outcome expectancy is a specific behavior that will lead to particular results. Bandura (1986) explains the difference between self-efficacy and outcome expectations as follows: "They differ from each other because individuals may believe that a certain course of action will produce certain results, but they do not act according to this outcome belief, because they question whether they can carry out the necessary activities" (p.392). Individuals with a high level of outcome and self-efficacy expectations behave in a desired and determined manner and insist on completing the activity. Individuals with high self-efficacy and low outcome expectations concentrate their efforts temporarily but may eventually be disappointed. Individuals with low self-efficacy beliefs and low outcome expectations may give up more quickly if desired results are not achieved immediately (Bandura, 1982).

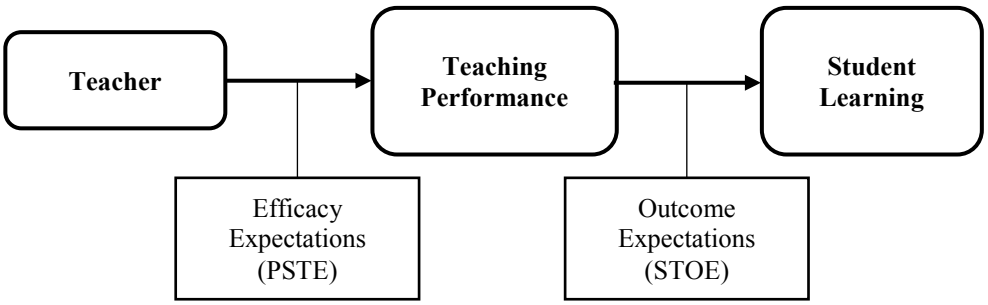

Figure 1. Two Dimensions of Self-efficacy, PSTE and STOE (Bandura, 1977)

Science teaching efficacy beliefs (STEB) have a significant effect on teachers either in being motivated to teach science (those with high teacher efficacy) or avoiding science teaching (those with low teacher efficacy) (Ramey-Gassert & Shroyer, 1992). Riggs and Enochs (1990) concluded that the way pre-service teachers see their roles in science teaching is partly due to their self-efficacy. These roles affect their permanence in a challenging task, academic achievement in the classroom, and other classroom behaviors. According to Enochs and Riggs (1990), STEB consists of two specific, unrelated belief types: Personal Science Teaching Competence (PSTE) and Science Teaching Outcome Expectancy (STOE) (Figure 1). PSTE expresses one's belief in the ability to teach science effectively. Teacher candidates have different opinions about their abilities for teaching science. In this sub-dimension, the question that is sought is: "How effectively do you think you can teach your science lessons?"(D'Alessio, 2018). STOE expresses the belief that students will learn if the teacher teaches science effectively using appropriate methods. Teacher candidates may think that external factors, such as daily life and socioeconomic status, affect student performance. In this sub-dimension, generally, the question that is sought is: "How much, in general, do you think good teaching of science lessons contributes to student achievement?" (D'Alessio, 2018).

Ashton (1984) defined teacher efficacy as "the beliefs of teachers about the extent to which they will affect student performance." (p.28). Tschannen-Moran and Woolfolk Hoy (2001) suggested that teacher efficacy should be evaluated by considering a wide variety of teaching tasks such as classroom management. The researchers defined teacher efficacy as the judgment of their abilities to achieve desired outcomes, such as

student engagement, classroom management, and student motivation and success, based on Bandura's (1977) concept of self-efficacy. Teacher efficacy is related to how teachers think and feel in the teaching process, how they motivate themselves, how they behave in the classroom (Bandura, 1997; Cantrell, Young, & Moore, 2003; Ford, 1992; Pajares, 1997; Tschannen-Moran & Woolfolk Hoy, 2001), how they select activities to use in the classroom, and the amount of time and effort they invest in overcoming the challenges in the school (Ashton & Webb, 1986; Bandura, 1997; Pintrich, 1990; Pintrich & Schunk, 2002).

Teachers with a high level of efficacy feel confident about themselves, are more willing to use learner-centered pedagogical techniques, and they think that they have enough knowledge and experience to employ strategies to remove the barriers to student learning (Allinder, 1994; Kartal, 2020; Ramey-Gassert & Shroyer, 1992; Sandholtz & Ringstaff, 2014). A high level of efficacy encourages teachers to seek and use innovative techniques to meet the students' different needs and correct student mistakes (Ashton & Webb, 1986; Riggs & Enochs, 1990; Stein & Wang, 1988). Compared to teachers with a low level of efficacy, teachers with a high level of efficacy would spend more time on instruction and would not give up because of the difficulties (Bandura, 1997). Teachers who rely on their teaching abilities believe that effective teaching can promote student learning. They provide more academic focus in their classes, and they give additional feedback to their students (Gibson & Dembo, 1984). Ginns and Watters (1990) argued that pre-service teachers' beliefs about their inadequacies in science teaching could result in poorly designed learning experiences that cause students to use effort and time in a meaningless and excessive way.

Given the importance of self-efficacy, it is essential to focus on ways of enhancing or developing it. Bandura (1977, 1981, 1997) identified four sources of self-efficacy. These sources are (i) mastery experiences (performance achievements, direct experiences, real teaching experiences), (ii) vicarious experiences (observing the teaching of others), (iii) verbal persuasion and social influences, and (iv) physiological and emotional states (indicators of success and failure during instruction).

Mastery Experiences

It has been stated that mastery experiences have the most excellent effect on teacher efficacy (Bandura, 1995; Tschannen-Moran et al., 1998). Experiences in the classroom are considered mastery experiences that will affect prospective teachers' feeling that they can be effective teachers in the classroom and promote student success (Cantrell et al., 2003). If teacher candidates are successful in the teaching process, their self-efficacy will increase, raising their expectations for future success in a similar teaching assignment (Bandura, 1997; Bautista, 2011; Tschannen-Moran & Woolfolk Hoy, 2007). Achievement in problematic situations makes a strong sense of efficacy. If a person succeeds under challenging conditions, he believes that he can also be successful in similar or less challenging conditions. With a strong self-efficacy sustained after such successes, occasional failures are less likely to weaken the teacher's efficacy (Bandura, 1981, 1997). In Bursal's (2012) study, education that focuses on mastery experience increased teacher efficacy. The study stated that the proficiency of teacher candidates increased after the science teaching method course. Mastery experiences in this course have helped trainees to increase their efficacy beliefs.

Vicarious Experience

Developing one's efficacy through vicarious experiences is related to social interactions. The ability to relate to the experiences of other teachers who are similar to him will enhance self-efficacy. Pre-service teachers often view their peers' achievements as predictions of their abilities (Bandura, 1997; Tschannen-Moran & Woolfolk Hoy, 2007). The more similar the preservice teacher feels to the comparison peer, the more likely they will expect success for themself (Bandura, 1997). Trainees can observe another trainee's positive or negative experiences and see how they handle different situations or lessons. It can also directly influence their teacher efficacy by creating distinct experiences through communication and discussion with other pre-service teachers (Bautista, 2011; Deehan, Danaia, & McKinnon, 2017; Garvis, Twigg, & Pendergast, 2011; Hastings, 2012; Hawkey, 1995; Johnson, 2010; LoCasale-Crouch, Davis, Wiens, & Pianta, 2012). Bandura (1997) suggests that another teacher or pre-service teacher's model may affect the observer pre-service teacher's efficacy. Teacher competence will then help students succeed in the classroom (Bruce, Esmonde, Ross, Dookie, & Beatty, 2010; Cantrell et al., 2003; Fancera & Bliss, 2011; Shidler, 2009; Wheatley, 2002).

Verbal Persuasion

Verbal persuasion is about the influence of others, just like vicarious experiences. However, Bandura (1995) stated that verbal persuasion might not be as strong as other sources to improve a person's efficacy. In this efficacy source, individuals are guided by suggestions to believe that they have specific abilities and overcome difficulties (Bandura, 1981). Verbal persuasion that consists of encouraging effort and determination, and emphasizing positive behavior early in the learning process, will positively affect efficacy beliefs (Tschannen-Moran et al., 1998). The probability of decreasing a person's efficacy with words is much more substantial than increasing one's effectiveness with terms. Negative feedback to a teacher by school administers, colleagues, or even students and their families may reduce his efficacy. Verbal cues of others can strongly influence teacher efficacy (Cantrell et al., 2003; D'Alessio, 2018; Garvis et al., 2011; Tschannen-Moran & Woolfolk Hoy, 2007). Verbal persuasion can inform about the nature of teaching, encourage overcoming difficulties, raise familiarity with strategies, and provide specific feedback on teacher performance.

Physiological and Emotional States

The fourth source of developing and increasing self-efficacy is helping teachers be attentive to their psychological and emotional states. Bandura (1981) suggests that individuals tend to determine their capacity to perform a task based on their emotional arousal. Highly emotional situations can interfere with the ability to perform and result in increased fear. Negative thoughts about performing an action may reduce the likelihood of performance being revealed, and conversely, more comfortable individuals are more likely to expect a successful outcome (Bandura, 1981). Although factors such as physical achievements and health functioning are essential for teachers, coping with stress factors is also related to their profession (Cantrell et al., 2003). Learning to cope with emotions such as stress, anxiety, or excitement early in teacher education programs can eliminate psychological barriers to learning and progress.

The Development of Science Teaching Efficacy Beliefs

Many studies have examined the effect of method courses, professional development programs, extra science lessons, or other science learning experiences on pre-service teachers' science teaching efficacy beliefs (Avery & Meyer, 2012; Bergman & Morphew, 2015; Deehan et al., 2017; Lumpe et al., 2012; Wingfield, Nath, Freeman, & Cohen, 2000). Although many method courses aim to provide pre-service teachers the skills and knowledge for effective science teaching, many pre-service teachers enter the classroom with low efficacy beliefs about their science teaching. Therefore, the content of the courses developed for pre-service science teachers' professional development is of great importance (Ramey-Gassert & Shroyer, 1992). Pre-service teachers need a variety of experiences with the situations they may encounter as teachers in schools' real context. Effectively designed experiences and teacher education programs can support pre-service teachers' science teaching efficacy beliefs, improve pedagogical knowledge, and increase content knowledge (D'Alessio, 2018; Kartal, Öztürk, & Ekici, 2012). School-based curricula (Posnanski, 2007) and hands-on or field experience-based methods (Erawan, 2011; Gurvitch & Metzler, 2009; Huinker, & Madison, 1997; Kartal & Çinar, 2018) affect teacher candidates' efficacy beliefs. Microteaching is one of these techniques and can be used in pre-service teachers' professional development (Allen & Ryan, 1969; D'Alessio, 2018; Kartal, 2013).

As in many professions, the more pre-service teachers can plan and experience, the more confident and talented they become in real teaching practices (Ramey-Gassert & Shroyer, 1992). Researchers have found that experiences that do not involve teaching children can be quite useful in changing teacher efficacy beliefs. Techniques including microteaching, collaborative learning, good role models, supportive learning environment, experiential learning, and computer use are helpful in positively changing teacher efficacy (Amobi, 2005; D'Alessio, 2018; Huinker & Madison, 1997; Kartal, 2013; Kartal et al., 2012; Mergler & Tangen, 2010; Ramey-Gassert & Shroyer, 1992; Scharmann & Hampton, 1995; Watters & Ginns, 1995).

Microteaching is a technique used in teacher education programs to increase domain-specific knowledge and skills (Long, Harrell, Pope, & Subramaniam, 2019) and develop beliefs (Arsal, 2014). Engaging pre-service teachers in microteaching can enable them to become aware of the complex nature of teaching and establish a link between theory and practice (Kartal et al., 2012; Nespor, 1987; Pringle, Dawson, & Adams, 2003). Teachers can increase their efficacy in planning and implementing activities by quickly changing many microteaching factors (Allen & Ryan 1969; Amobi, 2005; Arsal, 2014; D'Alessio, 2018; Fernandez & Robinson, 2006; Hawkey 1995; Kpanja 2001; Wilkinson, 1996). Microteaching can reduce pre-service teachers' anxiety towards teaching by improving their teaching competencies (Mergler & Tangen, 2010).

Significance of the Study

Some previous researchers employed microteaching in science teaching method courses (Bautista, 2011; Bursal, 2012; D'Alessio, 2018; Deehan et al., 2017; Deehan, McKinnon, & Danaia, 2019; Mergler & Tangen, 2010; Ramey-Gassert & Shroyer, 1992). In those studies, the pre-service teachers planned and carried out a lesson and received feedback about their performance. In this study, pre-service teachers in the experimental group could

re-plan and re-teach the lesson after feedback. It is thought that the opportunity to re-teach would strengthen the mastery experience of pre-service teachers. It is believed that the effect of replanning and reteaching can be better understood with the presence of a control group in this study. The research questions that will contribute to revealing the impact of microteaching on pre-service teachers' science teaching efficacy beliefs are stated as follows:

1. How much does planning and teaching a lesson to small groups of peers affect science teaching efficacy beliefs in pre-service science teachers?
2. Does detailed feedback, peer discussion, and reteaching of that lesson have further effects on science teaching efficacy beliefs in pre-service science teachers?

Method

Research Design

This study examines the effect of microteaching on pre-service elementary science teachers' science teaching efficacy beliefs. This study uses an experimental research design with a pretest-posttest control group (Fraenkel, Wallen, & Hyun, 2011). Two groups are randomly assigned to a control group and a treatment group (see Table 1). Measurements are conducted at the beginning and end of the study in both groups (Leavy, 2017). Pretesting allows researchers to determine the equality of groups at the beginning. Pretests and posttests help to see the extent to which the independent variable affects (Fraenkel et al., 2011).

Table 1. Pretest-posttest Control Group Design

Treatment Group	n=26	STEBI-B pretest	Plan & teach lesson	Review video*, Discuss with peers*, Reteach*	STEBI-B posttest
Control Group	n=23	STEBI-B pretest	Plan & teach lesson	Generic feedback	STEBI-B posttest

*Treatment

Participants

Senior pre-service science teachers who studied in a faculty of education in Middle Anatolia participated in this study. Senior pre-service science teachers were included in the study because they may be considered as having knowledge and experience in content, pedagogy, and technology-related courses. Furthermore, senior pre-service science teachers are at the end of their preparation programs and close to being teachers in a real classroom (Kartal, Yamak, & Kavak, 2017). Forty-nine pre-service teachers ($N_{treatment}$=26, $N_{control}$=23) participated in the study based on their voluntariness among 74 pre-service science teachers ($N_{treatment}$=38, $N_{control}$=36). STEBI was administered to both control and treatment groups at the beginning of the study. Pretest scores were also used to identify the equivalence of the groups. Table 2 demonstrates the pretest scores of groups and independent samples t-test results.

Table 2. Independent Samples t-test Results Comparing Pretest Scores of the Control and Treatment Groups

Construct		N	M	Sd	t	p
Science Teaching Efficacy Belief Instrument (STEBI-B)	Treatment Group	26	5.120	0.690	1.117	0.270
	Control Group	23	5.338	0.674		

It was seen that the mean score of the control group is larger than the mean score of the treatment group ($M_{control}$-$M_{treatment}$=0.218). However, the mean difference was not statistically significant (t=1.117; p>0.05). It is possible to say that the treatment and control groups are equivalent in terms of science teaching efficacy beliefs.

Data Collection Tools

This study investigated the change in pre-service science teachers' science teaching efficacy beliefs. Examining pre-service teachers' science teaching efficacy beliefs may help predict the extent to which their future teaching would affect their students (Cantrell et al., 2003). "Science Teaching Efficacy Beliefs Instrument (STEBI-B)" was used to examine the effect of microteaching on pre-service science teachers' science teaching efficacy beliefs. STEBI that benefits from the self-efficacy concept of Bandura (1995) was developed by Enochs and Riggs in 1990. There are 23 five-point Likert type items in the scale.

STEBI was adapted into Turkish by Tekkaya, Çakiroglu, and Ozkan in 2004. The STEBI-B has two independent subscales that align with Bandura's psychosocial theory. The PSTE subscale is determined through 13 survey items, and the STOE subscale comes from ten items. The PSTE factor (α=0.89) and STOE factor (α=0.76) is reliable and valid to use in science education (Enochs & Riggs, 1990). Tekkaya and her colleagues calculated the reliability coefficients as 0.84 and 0.76 for PSTE and STOE, respectively.

Much research conducted with pre-service teachers suggested using seven-point Likert items instead of five-point Likert items (Koh, Chai, & Tsai, 2010; Kartal, Kartal, & Uluay, 2016). A seven-point Likert scale can collect more valid and reliable data when respondents' cognitive levels are close to university students (Weng, 2004). Therefore, this study consisted of seven-point Likert items (1=strongly disagree, 7=strongly agree). Researchers re-examined the data collection tool's reliability and validity before the research and calculated the reliability coefficients as 0.926 for PSTE and 0.821 for STOE. The calculated values show that the items are consistent and can measure the phenomenon to be measured. Reliability coefficients that are equal to or more than 0.70 are enough for test reliability (Cohen, 1977; Field, 2009; Weng, 2004). These reliability values showed that the data collection tool is reliable for the participants of this study. Therefore, the data collection tool was used as a pre-test and a post-test in the study.

Data Collection Process

This study was conducted within the context of a teaching method course that took 14 weeks. Microteaching was incorporated into the course to provide pre-service teachers to apply their theoretical knowledge that they

gained through courses of pedagogy and content. At the end of the course, the effect of microteaching on pre-service teachers' science teaching efficacy belief was investigated. There are two sections of the teaching method course, and one of them was assigned as a treatment group, and the other was a control group. Both groups planned and taught mini-lessons, but what we define as 'Microteaching' was only employed in the treatment group. In microteaching, pre-service teachers evaluate themselves, collaborate, and share (Pringle et al., 2003). Microteaching requires the cycle of teach-reteach that allows one to try and evaluate. Microteaching consists of the following steps: (i) planning, (ii) teaching, (iii) evaluation and feedback, and (iv) reteaching (Kartal et al., 2017). The following section explains how these steps occurred in this study.

i. Planning: Pre-service science teachers planned a middle school science lesson (such as electricity, series, and parallel connection of bulbs) to teach. The lesson was 15-20 minutes and contained a limited number of learning objectives. Pre-service teachers planned the mini-lesson based on the science curriculum. They used textbooks, teaching materials, or technological hardware and software (such as inspiration, eclipse crossword, simulations, PhET, SmartBoards).

ii. Teaching: Pre-service science teachers taught their planned lessons to their peers. This step provided pre-service teachers to experience the real context of teaching. Pre-service teachers observed, reflected, created, and performed innovative approaches related to authentic learning with these experiences. Bandura (1981, 1997) asserted that mastery experiences have the most effect on efficacy beliefs as these experiences inform the individual about what is needed for success. Failure may affect efficacy negatively if the individual's efficacy beliefs have not been reinforced, while success affects efficacy positively.

One pre-service teacher taught the lesson, and the others acted as students. Pre-service teachers who observed the enacted lesson had the opportunity to compare themselves in a similar situation. This may be regarded as a vicarious experience. According to Bandura (1981), people tend to compare themselves with others with whom they claim to be similarly competent in similar situations. If these individuals perform successfully, perceived competence may increase; perceived competence may decrease in case of poor performance. Teacher candidates who have little knowledge of their capacities are more likely to have their efficacy beliefs affected by vicarious experiences (Bandura, 1997). In other words, observing the lessons of their peers and/or teachers was a vicarious experience for pre-service teachers.

The enacted lessons were recorded in the video. It is reported that videotapes are more beneficial than audiotapes. Videotapes make it easy to analyze and interpret some of the behaviors and skills that are impossible to see in audiotapes. In the video analysis, the instructor may help pre-service teachers see their strengths and weaknesses in their teaching and give them feedback that supports pre-service teachers to correct their undesired behaviors (Kpanja, 2001). The instructor also may take field notes if videotaping is not possible. However, Gall, Dell, Dunning, and Galassi (1971) reported that pre-service teachers who got audible and video feedback made a more significant improvement in asking descriptive questions and using multiple representations than others who did not get such feedback.

iii. Evaluation and Feedback: Teachers may not reflect on their efficacies unless asked to evaluate their teaching on students' learning (Ashton, 1984). Therefore, it is essential to provide opportunities for pre-service teachers to assess their teaching efficacies. Videotapes were watched within the context of the course. After watching the videos, the pre-service teachers also evaluated themselves (self-assessment). The peers (peer assessment) and the instructor evaluated all teaching performances by highlighting the strength of the microteacher. The evaluation sessions were also videotaped. Bandura (1997) addressed that teacher efficacy may be affected by observing other teachers, getting feedback about performance, and other supportive factors. Furthermore, observing a teacher with positive attitudes towards teaching also helps develop positive attitudes (Senler, 2016).

Field notes or observation protocols can be used for the evaluation. Observation protocols are related to the pre-service teachers' efficacy related to instructional strategies, student learning, classroom management, measurement and assessment, and content knowledge. The reflections about the pedagogical approaches used by pre-service teachers and techniques or methods that help determine misconceptions would encourage pre-service teachers to evaluate their teaching skills and performance (Brent, Wheatley, & Thomson, 1996). Self-assessment helped pre-service teachers to reflect on their capabilities. Reflection may lead to change in their future beliefs and actions (Bandura, 1986). The instructor and the peers gave constructive feedback about the effectiveness of their performance and suggestions about how to deal with difficulties. This feedback may support the pre-service teacher to perform better in the next teaching.

It is possible to consider feedback as a verbal persuasion (Kpanja, 2001). Feedback helps pre-service teachers to be aware of the effectiveness of their teaching and support them for better and more efficient teaching practices. It is stated that pre-service teachers valued feedback and addressed the effects of feedback on their efficacy beliefs (Fernandez & Robinson, 2006).

iv. Reteach: Pre-service teachers re-planned their lessons based on the feedback that was given from the instructor and peers. The microteacher implemented the re-planned mini-lesson to the same group. The cycle of teach-evaluate-reteach may be followed until the desired teaching skills are acquired, but participants taught only two lessons in this study. The reteach step allowed pre-service teachers to enact a more successful mini-lesson than their first attempt. It is possible that pre-service teachers felt more confident in the second mini-lesson (psychological and emotional states), and the second lesson improved their efficacy by providing a mastery experience.

The pre-service teachers in the control group planned and taught a 15-20 minutes lesson. The lessons were not videotaped. The instructor took field notes and talked about the performance in an undetailed and brief way. The peers also took notes and similarly gave feedback. The evaluation session was short and occurred just after the performance.

Additionally, pre-service teachers taught only one lesson in the control group. The main distinguishing feature of the treatment group from the control group was the evaluation and reteaching steps. The evaluation step can

promote vicarious experiences and verbal persuasion, while the reteaching step might encourage mastery experiences and psychological and emotional states. While making the evaluation, the lecturer highlighted the positive characteristics of the teacher candidates. Because negative feedback from a teacher candidate's environment (e.g., friends, students, cooperating teacher) about the teaching process causes a stronger negative motivation in his / her perception of competence. This situation can reduce the perception of competence of pre-service teachers (Cantrell et al., 2003; Tschannen-Moran & Woolfolk Hoy, 2007; Wingfield et al., 2000). STEBI was administered at the end of the course in both groups.

Data Analysis

SPSS was used to analyze data. Firstly, data were examined for each item separately, and missing data and extreme values were extracted from the data set. The negatively worded items were re-coded, ranging from 1 (strongly agree) to 7 (strongly disagree). To analyze the normality of data, we calculated Kolmogorov-Smirnov (Z=0,786; p>0.05) and skewness-kurtosis (+1,732; -1,864) values, and the values showed that data approximately approached normal distribution (Field, 2009; Tabachnick & Fidell, 2013). The arithmetic mean and standard deviation were utilized for descriptive analysis. t-tests were also conducted to compare the mean in and between groups. If there was a significant difference between mean scores in/between groups, Cohen's d was calculated to identify the effect size (Cohen, 1977). Seven-point Likert items were used in the STEBI.

Results

The first research question is related to the changes within groups, while the second question is related to the differences between groups.

Pretest and Posttest Scores of The Treatment Group

Table 3 reports the descriptive statistics and t-test results that compare the pretest and posttest scores of the treatment group.

Table 3. Dependent Samples t-test Results Comparing Pretest and Posttest Mean Scores of the Treatment Group

		M	Sd	t	p	Cohen's d
Personal Science Teaching Efficacy (PSTE)	Pretest	5.284	1.034	2.079	0.043*	0.565
	Posttest	5.742	0.440			
Science Teaching Outcome Expectancy (STOE)	Pretest	4.907	0.617	0.695	0.490	-
	Posttest	5.038	0.733			

*p<0.05

The statistically significant difference (t=2.079; p<0.05) occurred only in participants' PSTE between their posttest (M=5.742; Sd=0.440) and pretest (M=5.284; Sd=1.034). The effect size of the difference is *large*. In other words, microteaching affected pre-service science teachers' personal science teaching efficacy beliefs

positively in the treatment group. Mean posttest score for STOE (M=5.038; Sd=0.733) is slightly larger than the pretest (M=4.907; Sd=0.617), but the difference is not statistically significant (t=0.695, p>0.05). We can say that microteaching does not seem to affect the participants' outcome expectancy beliefs in the treatment group.

Pretest and Posttest Scores of the Control Group

Table 4 demonstrates the sample descriptive statistics and t-test results of pretest and posttest mean scores of the control group.

Table 4. Dependent Samples t-test Results Comparing Pretest and Posttest Mean Scores of the Control Group

		M	Sd	t	p	Cohen's d
Personal Science Teaching Efficacy (PSTE)	Pretest	5.592	0.923	-1.918	0.062	-
	Posttest	5.066	0.933			
Science Teaching Outcome Expectancy (STOE)	Pretest	5.008	0.704	1.930	0.060	-
	Posttest	4.560	0.861			

*p<0.05

When it comes to examining participants' PSTE and STOE, it is seen that pre-service teachers outperformed in the pretest (M_{PSTE}=5.592; M_{STOE}=5.008) than posttest (M_{PSTE}=5.066; M_{STOE}=4.560). Personal science teaching efficacy and student outcome expectancy beliefs of participants in the control group decreased. It is worth stating that the differences are not statistically significant but had relatively low p values (p~0.06). It is possible to say that planning and teaching a lesson in the science teaching method course did not help pre-service teachers develop their efficacy beliefs. Also, the mean scores' decrease may be implied that the planning and teaching cycle may have hurt their efficacy beliefs.

Posttest Scores of the Control and Treatment Groups

Table 5 demonstrates the posttest scores of the control and treatment groups and t-test results that find out the effectiveness of the microteaching on pre-service science teachers' science teaching efficacy beliefs.

Table 5. Independent Samples t-test Results Comparing Posttest Scores of the Control and Treatment Groups

		N	M	Sd	t	p	Cohen's d
Personal Science Teaching Efficacy (PSTE)	Treatment Group	26	5.742	0.440	3.301	0.002*	0.926
	Control Group	23	5.066	0.933			
Science Teaching Outcome Expectancy (STOE)	Treatment Group	26	5.038	0.733	2.097	0.041*	0.597
	Control Group	23	4.560	0.861			

*p<0.05

Pre-service teachers in the treatment group outperformed in PSTE ($M_{Treatment}$=5.742; $M_{Control}$=5.066) and in STOE ($M_{Treatment}$=5.038; $M_{Control}$=4.560) than control group, and the differences are statistically significant

(t_{PSTE}=3.301, p_{PSTE}<0.05; t_{STOE}=0.041, p_{STOE}<0.05). Microteaching affected positively personal science teaching efficacy beliefs and student outcome expectancy beliefs.

Self-reported measures can help the researcher to identify the perceptions of respondents about their efficacies and capabilities. The last section of the findings reveals how participants' self-perceptions change during the study. Tables 3 and 4 demonstrate the change of mean scores in each group. We also created graphical representations that illustrate a comparison of mean scores and standard deviations of groups in each subscale.

Figure 2 demonstrates the mean scores and standard deviations in both groups' PSTE factor at the beginning and end of the study.

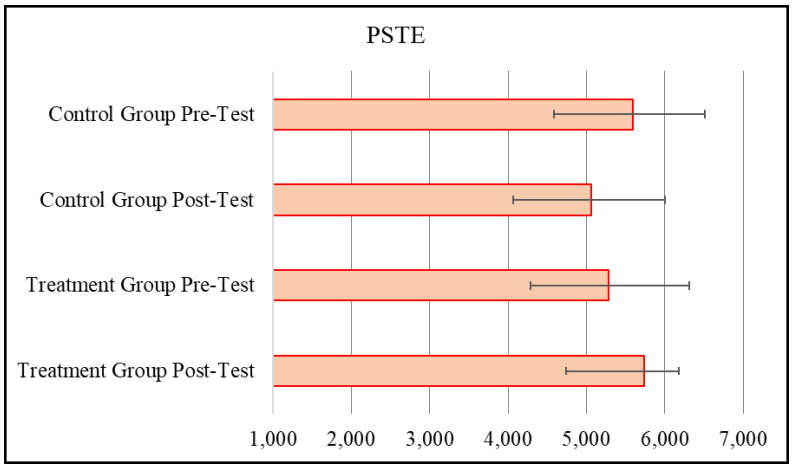

Figure 2. Pretest and Posttest Mean Scores of Groups in PSTE

Figure 3 is related to mean scores and standard deviations of the groups in STOE at the beginning and end of the study.

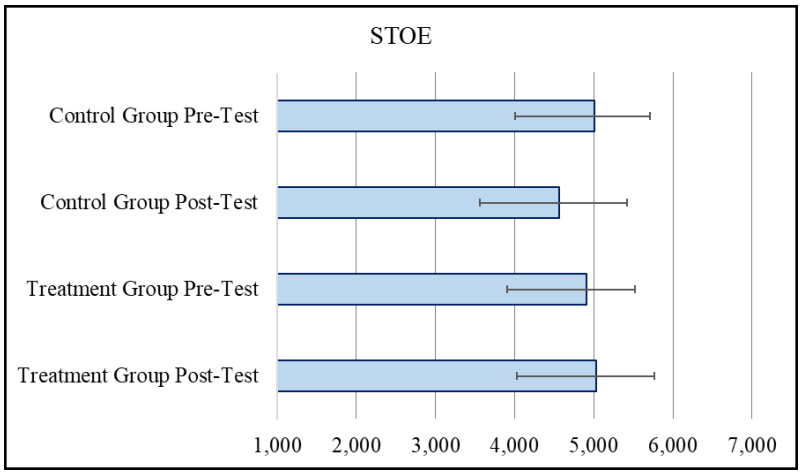

Figure 3. Pretest and Posttest Mean Scores of Groups in STOE

Participants in the treatment group increased their mean scores while participants in the control group decreased their mean scores in both subdomains. However, we need to note that the differences between groups are not

statistically significant. The cycle of plan-teach-evaluate-reteach may help pre-service elementary science teachers feel more efficacious in PSTO and STOE. On the other hand, pre-service teachers in the control group only planned and taught a lesson, and the teaching practices may have made them feel less efficacious in PSTE and STOE.

Discussion and Conclusion

In this study, the effect of microteaching on PSTE and STOE beliefs of preservice elementary science teachers was examined. For this purpose, two groups, namely the treatment (26 pre-service teachers) and the control (23 pre-service teachers) groups, were used. Microteaching consisted of planning, teaching, evaluation, and re-teaching stages in the treatment group. In the control group, pre-service teachers were asked to plan a mini-lesson and teach their peers within the scope of the science teaching methods course. The Science Teaching Efficacy Belief Instrument (STEBI-B) scale was administered to pre-service teachers in the treatment and control groups at the beginning and end of the study as a pre-test and post-test.

Observing and evaluating their peers' teaching has been a vicarious experience for other prospective teachers. Peer teacher candidates can make inferences by seeing the mistakes and providing indirect results for themselves (Bandura, 1997; Tschannen-Moran & Woolfolk Hoy, 2007). Also, pre-service teachers had different experiences in the teaching process by communicating and discussing with their peers. These experiences can directly influence pre-service teachers' professional competence (Garvis et al., 2011; Hastings, 2012; Johnson, 2010; LoCasale-Crouch et al., 2012). The pre-service teachers retaught the same or a different lesson to his peers based on the evaluation and feedback. Microteaching, which consists of four stages, is designed to support pre-service teachers' self-efficacy sources. This process was completed by repeating for each pre-service teacher in the treatment group.

The treatment group developed personal science teaching efficacy beliefs (PSTE). Applying field-specific teaching methods and techniques (e.g., microteaching) can improve teaching efficacy beliefs and teaching skills (Allen & Ryan, 1969; Al Sultan, Henson, & Fadde, 2018; Cantrell et al., 2003; Cooper, 2015; Fernandez & Robinson 2006; Kpanja 2001; Riggs & Enochs, 1990). Some research demonstrated an increase in teaching efficacy beliefs after science teaching method courses (Arsal, 2014; Hechter, 2011). It is thought that the teacher candidates' successful performance was influential in the development of this belief. Personal science teaching efficacy beliefs are individuals' beliefs about whether they can teach science effectively. Planning and conducting a science lesson within the scope of microteaching and considering the feedback related to this lesson, performing a more effective second lecture, may have promoted teacher candidates' mastery experiences and emotional states. Mastery experiences are the source that most affect individuals' self-efficacy.

During the evaluation sessions, pre-service teachers in the treatment group may have had vicarious experiences through positive and negative experiences of other pre-service teachers, and these vicarious experiences may also affect the development of PSTE (Bandura, 1997; Fernandez & Robinson, 2006; Garvis et al., 2011; Hastings, 2012; Johnson, 2010; LoCasale-Crouch et al., 2012; Tschannen-Moran & Woolfolk Hoy, 2007;

Wingfield et al., 2000). During the evaluation sessions, pre-service teachers' awareness of the nature of teaching may have increased. Other friends appreciated the positive qualities of the microteacher. The suggestions on overcoming the problems experienced in the teaching may also have been useful in enhancing pre-service teachers' PSTE. Wingfield and her colleagues (2000) argue that pre-service teachers' competence may increase with teacher preparation program lecturers' and mentor teachers' feedback. In a study conducted by Fernandez and Robinson (2006), in which 74 pre-service teachers participated in microteaching, pre-service teachers found it beneficial to work in the same group with their peers and share their ideas process of evaluating the lectures. In another study conducted by D'Alessio (2018), pre-service teachers' efficacy beliefs seemed to be affected more by their peers' evaluation and feedback rather than their self-evaluation. This result shows that verbal and social persuasion may be as effective as performance success.

It is worthwhile not to ignore the physiological and emotional states of the pre-service teachers. The pre-service teachers' mastery or vicarious experiences in the micro-teaching motivated them and developed their personal science teaching efficacy. This result may have positively affected the emotional states of pre-service teachers regarding the teaching process. Especially, teaching the second mini-lesson may have helped pre-service teachers feel more confident as they could strengthen their lessons' efficacy with the help of feedback. Because while negative thoughts about performing an action reduce the likelihood of the behavior's occurrence, more comfortable individuals tend to achieve more successful results (Bandura, 1981; Cantrell et al., 2003).

The standard deviations of the treatment group in PSTE scores in the post-test also decreased ($SD_{Pre\text{-}test}$ = 1.034; $SD_{Post\text{-}test}$ = 0.440). This result shows that the pre-service teachers' PSTE scores gathered around the average. It can be said that pre-service teachers with different PSTE scores before micro-teaching had higher and closer scores after the microteaching. In the study conducted by D'Alessio (2018), it was stated that pre-service teachers with low pre-test scores had higher score increases after their teaching experience. With this result, we can imply that micro-teaching is useful and, at the same time, indirectly, benefits teachers with a range of initial efficacy beliefs.

On the other hand, the STOE mean scores of pre-service teachers in both groups did not change during the study. Due to the nature of microteaching and research, the absence of real students in the classroom may be the reason why there is no change in STOE mean scores. In the study conducted by Wingfield and her colleagues (2000), pre-service teachers dealt with real teaching experiences in the classroom. They were supported continuously throughout the year. However, similarly to the results of this study, science teaching outcome expectations did not change.

Similarly, the result that STOE did not change easily was found in much research (Bleicher, 2004; Palmer, 2002). There is a reliability issue with this subscale. Bleicher (2004) modified two items in the STOE, and D'Alessio (2018) used these modified items in his study. He found that one of these items had an internal correlation below 0,30. Additionally, McDonnough and Matkins (2010) highlighted that the items of STOE were written in third-person, while the items of PSTE were written in first-person. They reported that Guskey and Passaro (1994) determined that the second factor is related to perceptions outside the classroom (p.16).

McDonnough and Matkins (2010) stated that this construct might be more connected to the external locus of control than self-efficacy beliefs (p.16). This may be why microteaching that was designed to support efficacy sources did not seem to affect pre-service teachers' STOE beliefs.

Unlike the treatment group, the PSTE and STOE scores in the control group did not increase. In fact, both subscales showed a large but statistically insignificant decrease. It is possible that there was no growth because the evaluation session was not conducted for them. The lectures were not recorded with any audio or video. Therefore, the evaluation process regarding the lecture was limited. In the evaluation of pre-service teachers, the field notes taken by the lecturer and peers were utilized. Pre-service teachers may have been inadequate in expressing many positive or negative features of the microteacher for peer assessment. For this reason, prospective teachers may have had difficulties in deciding how effectively they would teach science. Pre-service teachers may have noticed in these first experiences that teaching was more complicated than they expected (Weinstein, 1988), and this shock may have decreased their self-efficacy scores. Considering the effect of receiving feedback about their performances and sharing ideas about their performances with peers on teacher efficacy (Rosenholtz, 1989), the decrease in self-efficacy beliefs would not be surprising.

When the factors in the STEBI-B are examined, it is seen that the difference between the mean scores in the personal science teaching self-efficacy (PSTE) and science teaching outcome expectation (STOE) is in favor of the treatment group. Considering that the groups' pre-test scores are equal, we can say that micro-teaching has a positive effect on the treatment group. In other words, the treatment group felt more competent than the control group in terms of effective science teaching and supporting student learning. This finding is in line with many studies (Arsal, 2014; Kartal, 2013; Mergler & Tangen, 2010). The feedback given to the treatment group (self-evaluation, peer evaluation, and expert evaluation) positively changed their competence perceptions (e.g., pedagogical and field knowledge). We can say that the treatment group believes that students will be better and more successful than ever with their teaching. Similarly, beliefs that they can increase the success in low-achieving students may have promoted their expectations for the outcome.

Recommendations

This study examined the effect of microteaching on pre-service elementary science teachers' science teaching efficacy beliefs by assigning a control group. Considering the significant difference in pre-service teachers' PSTE and STOE beliefs in favor of the treatment group, we may imply that microteaching is a useful technique in developing science teaching efficacy beliefs. Pre-service teachers should be engaged with activities that make them reflect on their performances, artifacts, or lesson plans. It is important to note that the control group also taught lessons and received generic feedback from the course instructor and peers, but this experience was not beneficial enough to affect their self-efficacy beliefs. It was only after they had the opportunity to collaboratively evaluate a videotape with peers and reteach the lesson, that they became more confident in their teaching ability. Future research may investigate the effect of microteaching on other efficacy beliefs such as teacher efficacy, mathematics teaching self-efficacy, technology integration self-efficacy since microteaching has an impact on the sources of self-efficacy.

References

Al Sultan, A., Henson Jr, H., & Fadde, P. J. (2018). Pre-service elementary teachers' scientific literacy and self-efficacy in teaching science. *IAFOR Journal of Education*, *6*(1), 25-41.

Allen, D., & Ryan, K. (1969). *Microteaching. Reading.* Boston, MA: Addison-Wesley.

Allinder, R. M. (1994). The Relationship between Efficacy and the Instructional Practices of Special Education Teachers and Consultants. *Teacher Education and Special Education, 17*, 86-95.

Amobi, F. A. (2005). Preservice teachers' reflectivity on the sequence and consequences of teaching actions in a microteaching experience. *Teacher Education Quarterly*, *32*(1), 115-130.

Appleton, K. (1995). Student teachers' confidence to teach science: Is more science knowledge necessary to improve self- confidence?. *International Journal of Science Education*, *17*(3), 357-369.

Arsal, Z. (2014). Microteaching and pre-service teachers' sense of self-efficacy in teaching. *European Journal of Teacher Education*, *37*(4), 453-464.

Ashton, P. (1984). Teacher efficacy: A motivational paradigm for effective teacher education. *Journal of teacher education*, *35*(5), 28-32.

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. New York: Longman.

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

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavior change. *Psychological Review, 84*(2), 191-215.

Bandura, A. (1981). Self-referent thought: A developmental analysis of self-efficacy. In J. H. Flavell & L. Ross (Eds.), *Social cognitive development frontiers and possible futures* (pp. 200-239). New York: Cambridge University Press.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*, 122-147.

Bandura, A. (1986). *Social foundations of thought and action: a social cognitive theory.* Englewood Cliffs: Prentice-Hall, Inc.

Bandura, A. (1997). *Self-Efficacy: The exercise of control.* New York: W. H. Freeman and Company.

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

Bautista, N. U. (2011). Investigating the use of vicarious and mastery experiences in influencing early childhood education majors' self-efficacy beliefs. *Journal of Science Teacher Education*, *22*(4), 333-349.

Beck, J., Czerniak, C. M. & Lumpe, A. T. (2000). An exploratory study of teachers' beliefs regarding the implementation of constructivism in their classroom. *Journal of Science Teacher Education, 11(4)*, 323-343.

Bergman, D. J., & Morphew, J. (2015). Effects of a science content course on elementary preservice teachers' self-efficacy of teaching science. *Journal of College Science Teaching*, *44*(3), 73-81.

Bleicher, R. E. (2004). Revisiting the STEBI- B: Measuring self- efficacy in preservice elementary teachers. *School Science and Mathematics*, *104*(8), 383-391.

Brent, R., Wheatley, E., & Thomson, W. S. (1996). Videotaped microteaching: Bridging the gap from the university to the classroom. *The Teacher Educator*, *31*(3), 238-247.

Bruce, C. D., Esmonde, I., Ross, J., Dookie, L., & Beatty, R. (2010). The effects of sustained classroom-embedded teacher professional learning on teacher efficacy and related student achievement. *Teaching and Teacher Education: An International Journal of Research and Studies, 26*(8), 1598-1608.

Bursal, M. (2012). Changes in American preservice elementary teachers' efficacy beliefs and anxieties during a science methods course. *Science Education International, 23*(1), 40-55.

Cantrell, P., Young, S., & Moore, A. (2003). Factors affecting science teaching efficacy of preservice elementary teachers. *Journal of Science Teacher Education*, *14*(3), 177-192.

Çapa, Y., Çakıroğlu, J., & Sarıkaya, H. (2005). The development and validation of a Turkish version of teachers' sense of efficacy scale. *Education and Science, 30*(137), 74-81.

Carter, W., & Sottile, J. M. (2002). Changing the ''ecosystem'' of preservice math and science methods classes to enhance students' social, cognitive, and emotional development. Paper presented at the annual meeting of the Eastern Educational Research Association, Sarasota, FL.

Clark, C. M., & Peterson, P. L. (1985). Teachers' thought processes. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 255-296). New York: Macmillan.

Cohen, J. (1977). *Statistical power analysis for the behavioral sciences* (Rev. Ed.). New York: Academic.

Cooper, T. O. (2015). *Investigating the effects of cognitive apprenticeship-based instructional coaching on science teaching efficacy beliefs.* Doctoral dissertation. Retrieved from Florida International University.

Czerniak, C. M. (1990, April). *A study of self-efficacy, anxiety, and science knowledge in pre-service elementary teachers*. Paper presented at the annual meeting of the National Association of Research in Science Teaching, Atlanta, GA.

D'Alessio, M. A. (2018). The effect of microteaching on science teaching self-efficacy beliefs in preservice elementary teachers. *Journal of science teacher education*, *29*(6), 441-467.

Darling-Hammond, L., Chung, R., & Frelow, F. (2002). Variation in teacher preparation: How well do different pathways prepare teachers to teach? *Journal of Teacher Education, 53*(4), 286-302.

Deehan, J., Danaia, L., & McKinnon, D. H. (2017). A longitudinal investigation of the science teaching efficacy beliefs and science experiences of a cohort of preservice elementary teachers. *International Journal of Science Education*, *39*(18), 2548-2573.

Deehan, J., McKinnon, D. H., & Danaia, L. (2019). A long-term investigation of the science teaching efficacy beliefs of multiple cohorts of preservice elementary teachers. *Journal of Science Teacher Education*, *30*(8), 923-945.

Enochs, L. G., & Riggs, I. M. (1990). Further development of an elementary science teaching efficacy belief instrument: A preservice elementary scale. *School Science and Mathematics*, *90*(8), 694-706.

Erawan, P. (2011). A path analysis for factors affecting pre-service teachers' teaching efficacy. *American Journal of Scientific Research,* 13,47-58.

Fancera, S. F., & Bliss, J. R. (2011). Instructional leadership influence on collective teacher efficacy to improve school achievement. *Leadership and Policy in Schools, 10*(3), 349-370.

Fernandez, M., & Robinson, M. (2006). Prospective teachers' perspectives on microteaching lesson study. *Education, 127*(2), 203-215.

Field, A. (2009). *Discovering statistics using SPSS (and sex and drugs and rock 'n' roll) (*3rd Ed.). Los Angeles, CA: SAGE Publication.

Flores, I. M. (2015). Developing Preservice Teachers' Self-Efficacy through Field-Based Science Teaching Practice with Elementary Students. *Research in Higher Education Journal*, *27*, 1-19.

Ford, M. E. (1992). *Motivating humans: Goals, emotions, and personal agency beliefs*. Newbury Park, CA: Sage.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). *Validity and reliability, how to design and evaluate research in science education* (8th Ed.). Mc Graw–Hill Companies.

Gall, M.D., Dell, H., Dunning, B., & Galassi, J. (1971, February). *Improving teachers' mathematics tutoring skills through microteaching: a comparison of videotape and audiotape feedback.* Paper presented at the annual meeting of the American Educational Research Association, New York.

Garvis, S., Twigg, D., & Pendergast, D. (2011). Breaking the negative cycle: The formation of self-efficacy beliefs in the arts. A focus on professional experience in pre-service teacher education. *Australasian Journal of Early Childhood, 36*(2), 36-41.

Gibson, S., & Dembo, M. H. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology*, *76*, 569-582.

Ginns, I. S., & Watters, J. J. (1990). *A longitudinal study of preservice elementary teachers' personal and science teaching efficacy* (Reports–Research/Technical ED 404 127).

Gurvitch, R., & Metzler, M. W. (2009). The effects of laboratory-based and field-based practicum experience on pre-service teachers' self-efficacy. *Teaching and Teacher Education*, *25*(3), 437-443.

Guskey, T. R., & Passaro, P. D. (1994). Teacher efficacy: A study of construct dimensions. *American educational research journal*, *31*(3), 627-643.

Haney, J. J., Czerniak, C.M., & Lumpe, A.T. (1996). Teacher beliefs and intentions regarding the implementation of science education reform strands. *Journal of Research in Science Teaching, 33*(9), 971-993.

Hastings, P. (2012). Early career teachers' self-efficacy for balanced reading instruction. *Australian Journal of Teacher Education, 37*(6), 55-72.

Hawkey, K. (1995). Learning from peers: The experience of student teachers in school-based teacher education. *Journal of Teacher Education*, *46*(3), 175-183.

Hechter, R. P. (2011). Changes in preservice elementary teachers' personal science teaching efficacy and science teaching outcome expectancies: The influence of context. *Journal of Science Teacher Education*, *22*(2), 187-202.

Helms-Lorenz, M., Slof, B., Vermue, C. E., & Canrinus, E. T. (2012). Beginning teachers' self efficacy and stress and the supposed effects of induction arrangements. *Educational Studies, 38*(2), 189-207.

Huinker, D., & Madison, S. K. (1997). Preparing efficacious elementary teachers in science and mathematics: The influence of methods courses. *Journal of Science Teacher Education*, *8(2)*, 107-126.

Johnson, D. (2010). Learning to teach: The influence of a university-school partnership project on pre-service elementary teachers' efficacy for literacy instruction. *Reading Horizons, 50*(1), 23-48.

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), 42-61.

Kartal, B., & Çinar, C. (2018). Examining pre-service mathematics teachers' beliefs of TPACK during a method course and field experience. *Malaysian Online Journal of Educational Technology*, *6*(3), 11-37.

Kartal, T. (2013). *Mikro öğretimin fen bilgisi öğretmen adaylarının ısı ve sıcaklık konusundaki pedagojik alan bilgilerinin gelişimine etkisi.* Yayımlanmamış Doktora Tezi. Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Kartal, T., Kartal, B., & Uluay, G. (2016). Technological pedagogical content knowledge self-assessment scale (TPACK-SAS) for pre-service teachers: Development, validity and reliability. *International Journal of Eurasia Social Sciences, 7*(23), 1-36.

Kartal, T., Öztürk, N., & Ekici, G. (2012). Developing pedagogical content knowledge in preservice science teachers through microteaching lesson study. *Procedia-Social and Behavioral Sciences, 46*, 2753-2758.

Kartal, T., Yamak, H., & Kavak, N. (2017). Fen bilgisi öğretmen adaylarının mesleki tutumlarının gelişiminde mikro öğretimin etkisi. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 30*(2), 881-907.

Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore pre- service teachers with a large- scale survey. *Journal of Computer Assisted Learning*, *26*(6), 563-573.

Kpanja, E. (2001). A study of the effects of video tape recording in microteaching training. *British Journal of Educational Technology*, *32*(4), 483-486.

Leavy, P. (2017). *Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches*. Guilford Publications.

LoCasale-Crouch, J., Davis, E., Wiens, P., & Pianta, R. (2012). The role of the mentor in supporting new teachers: Associations with self-efficacy, reflection, and quality. *Mentoring & Tutoring: Partnership in Learning, 20*(3), 303-323.

Long, C. S., Harrell, P. E., Pope, E., & Subramaniam, K. (2019). Using microteaching to improve preservice elementary teachers' physical science content knowledge. *The Electronic Journal for Research in Science & Mathematics Education*, *23*(4), 16-31.

Lumpe, A., Czerniak, C., Haney, J., & Beltyukova, S. (2012). Beliefs about teaching science: The relationship between elementary teachers' participation in professional development and student achievement. *International Journal of Science Education, 34*(2), 153-166.

McDonnough, J. T., & Matkins, J. J. (2010). The role of field experience in elementary preservice teachers' self- efficacy and ability to connect research to practice. *School Science and Mathematics*, *110*(1), 13-23.

Mergler, A. G., & Tangen, D. (2010). Using microteaching to enhance teacher efficacy in pre- service teachers. *Teaching Education*, *21*(2), 199-210.

Mulholland, J., & Wallace, J. (1996). Breaking the cycle: Preparing elementary teachers to teach science. *Journal of Elementary Science Education*, *8*(1), 17-38.

Mulholland, J., & Wallace, J. (2000). Beginning primary science teaching: Entryways to different worlds. *Research in Science Education*, *30*(2), 151-171.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies, 19*(4), 317-328.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62(3)*, 307-332.

Pajares, M. F. (1997). Current Directions in Self-Efficacy Research. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement*, 10, 1-49. Greenwich, CT: JAI Press.

Palmer, D. H. (2002). Factors contributing to attitude exchange amongst preservice elementary teachers. *Science Education*, *86*(1), 122-138.

Pintrich, P. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*(1), 33-40.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications.* Columbus, OH: Merrill.

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational research*, *63*(2), 167-199.

Posnanski, T. J. (2007). A redesigned Geoscience content course's impact on science teaching self-efficacy beliefs. *Journal of Geoscience Education, 55(2), 152-157.*

Pringle, R. M., Dawson, K., & Adams, T. (2003). Technology, science and preservice teachers: Creating a culture of technology-savvy elementary teachers. *Action in Teacher Education*, *24*(4), 46-52.

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

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In: J. Sikula (Ed.), *Handbook of research on teacher education* (pp.102 – 119). New York: Macmillan.

Riggs, I. M., & Enochs, L. (1990). Toward the development of an elementary teachers' science teaching efficacy belief instrument. *Science Education, 74*, 625-638.

Riggs, I., & Jesunathadas, J. (1993, April). *Preparing elementary teachers for effective science teaching in diverse settings.* Paper presented at the National Association for Research in Science Teaching, Atlanta.

Rosenholtz, S. J. (1989). *Teachers' workplace: The social organization of schools.* New York: Longman.

Sandholtz, J. H., & Ringstaff, C. (2014). Inspiring instructional change in elementary school science: The relationship between enhanced self-efficacy and teacher practices. *Journal of Science Teacher Education, 25*(6), 729–751.

Scharmann, L. C., & Hampton, C. M. O. (1995). Cooperative learning and preservice elementary teacher science self-efficacy. *Journal of Science Teacher Education*, *6(3)*, 125-133.

Senler, B. (2016). Pre-service science teachers' self-efficacy: The role of attitude, anxiety and locus of control. *Australian Journal of Education*, *60*(1), 26-41.

Shidler, L. (2009). The impact of time spent coaching for teacher efficacy on student achievement. *Early Childhood Education Journal, 36*(5), 453-460.

Stein, M. K. & Wang, M. C. (1988). Teacher development and school improvement: the process of teacher change. *Teaching & Teacher Education, 4*, 171-187.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using Multivariate Statistics* (6th Ed.). New York: Pearson Education.

Tekkaya, C., Cakiroglu, J., & Ozkan, O. (2004). Turkish pre-service science teachers' understanding of science and their confidence in teaching it. *Journal of Education for Teaching*, *30*(1), 57-68.

Tobin, K., Tippins, D.J., & Gallard, A.J. (1994). Research on instructional strategies for teaching science. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 55-64). New York: Macmillan.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*(7), 783-805.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2007). The differential antecedents of self-efficacy beliefs of novice and experienced teachers. *Teaching and Teacher Education, 23*, 944-956.

Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research*, *68*(2), 202-248.

Watters, J. J., & Ginns, I. S. (1995). *Origins of, and changes in preservice teachers' science teaching self-efficacy*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco.

Weinstein, C. S. (1988). Preservice teachers' expectations about the first year of teaching. *Teaching and Teacher Education*, *4*(1), 31-40.

Weng, L. J. (2004). Impact of the number of response categories and anchor labels on coefficient alpha and test-retest reliability. *Educational and Psychological Measurement*, *64*(6), 956-972.

Wheatley, K. F. (2002). The potential benefits of teacher efficacy doubts for educational reform. *Teaching and Teacher Education, 18*(1)*,* 5-22.

Wilkinson, G. A. (1996). Enhancing microteaching through additional feedback from preservice administrators. T*eaching and Teacher Education*, *12*(2), 211-221.

Wingfield, M., Nath, J. L., Freeman, L., & Cohen, M. (2000, April). *The effect of site-based preservice experiences on elementary social studies, language arts, and mathematics teaching self-efficacy beliefs.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA. (ERIC Document Reproduction Service No. ED440972).

Zee, M., & Koomen, H. M. (2016). Teacher self-efficacy and its effects on classroom processes, student academic adjustment, and teacher well-being: A synthesis of 40 years of research. *Review of Educational research*, *86*(4), 981–1015.

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