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Science Teaching Efficacy of Preservice Elementary Teachers: Examination of the Multiple Factors Reported as Influential

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Abstract This study explores the science teaching efficacy beliefs of pr-service elementary teachers and the relationship between efficacy beliefs and multiple factors such as antecedent factors (participation in extracurricular activities and number of science and science teaching methods courses taken), conceptual understanding, classroom management beliefs and science teaching attitudes. Science education majors (n=71) and elementary education majors (n=262) were compared with respect to these variables. Finally, the predictors of two constructs of science teaching efficacy beliefs, personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE), were examined by multiple linear regression analysis. According to the results, participation in extracurricular activities has a significant but low correlation with science concept knowledge, science teaching attitudes, PSTE and STOE. In addition, there is a small but significant correlation between science concept knowledge and outcome expectancy, which leads the idea that preservice elementary teachers' conceptual understanding in science contributes to their science teaching self-efficacy. This study reveals a moderate correlation between science teaching attitudes and STOE and a high correlation between science teaching attitudes and PSTE. Additionally, although the correlation coefficient is low, the number of methodology courses was found to be one of the correlates of science teaching attitudes. Furthermore, students of both majors generally had positive self-efficacy beliefs on both the STOE and PSTE. Specifically, science education majors had higher science teaching self-efficacy than elementary education majors. Regression results showed that science teaching attitude is the major factor in predicting both PSTE and STOE for both groups.

Keywords Alternative conception · Attitudes towards science teaching · Preservice education · Science teaching efficacy beliefs · Teacher education · Classroom management

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Introduction

Possessing scientific facts and knowledge does not guarantee that an elementary teacher will be able to teach science well. The teacher must understand the students' approaches to scientific content, be aware of possible alternative conceptions, know how to improve student motivation and create a classroom environment conducive to allowing students to construct knowledge. Some research studies have revealed that teachers who possess a high sense of efficacy concerning the teaching of science are more willing to apply instructional innovations and proficient teaching methods to be a competent teacher (Czerniak and Lumpe 1996; Guskey 1988; Stein and Wang 1988), more willing to spend time teaching science and more capable of student-centred science teaching compared to those teachers who have a low sense of efficacy (Enochs and Riggs 1990; Finson and Beaver 1994; Wilson and Scharmann 1994). Correspondingly, science educators tend to include improving teacher self-efficacy in their objectives for science teaching methods courses (Bandura 1997; Bleicher 2007; Cantrell et al. 2003; Wingfield et al. 2000).

The factors affecting the science teaching self-efficacy of preservice elementary teachers have been explored in numerous studies. These studies suggest that science content knowledge (Bleicher 2002; Schoon and Boone 1998; Tosun 2000), beliefs about classroom management (Gencer and Cakiroglu 2007; Henson 2001), antecedent factors such as participating in science activities in and out of school, the number of science and science teaching methods courses taken, teacher preparation and science teaching experiences (Cantrell et al. 2003; Hechter 2011), attitudes towards science teaching (Sarikaya 2004; Sünger 2007), context beliefs which "are beliefs about the responsiveness of the environment (external factors and/or people)" (Lumpe et al. 2000, p. 277), and perceptions of control (Lumpe et al. 2000) have influence on or correlate with the educator's science teaching efficacy. Becoming aware of the variables that affect positive efficacy beliefs of student teachers regarding the teaching of science may be beneficial in designing coursework and practicum experiences throughout the teacher preparatory years. Elementary teachers usually teach many subjects, although they may not be equally effective in teaching all of them. As a result, assessing science teaching efficacy beliefs may predict the future science teaching success of preservice teachers and the extent of their positive influence on student achievement in science. Research on teacher efficacy investigates the correlates and factors related to the improvement of science teaching efficacy among preservice teachers; however, few studies have concentrated on the interplay of the multiple factors in predicting science teaching efficacy beliefs among the students from different majors, especially in Turkey (Sarikaya 2004; Tekkaya et al. 2002). The purposes of this study were to determine whether preservice teachers participate in extracurricular activities; to explore their level of science concept knowledge, their classroom management beliefs, science teaching attitudes and science teaching efficacy beliefs; to compare elementary education majors and science education majors with respect to these variables; and, finally, to reveal the predictors of two constructs of science teaching efficacy beliefs: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). Concordantly, data were collected from multiple factors (participating in science activities in and out of school, number of science and science teaching methods courses taken, science concept knowledge, classroom management beliefs and science teaching attitudes) to identify how the factors that influence science teaching self-efficacy work together in a group of 333 preservice elementary teachers.

Theoretical Background

Personal science teaching self-efficacy is based on Bandura (1977)'s social cognitive theory of behaviour and motivation. Bandura's theory suggests that people are motivated to perform an action if they believe the action will have a favourable result (outcome expectancy) and if they believe in their abilities to perform the action (personal efficacy). When applied to elementary science teaching, it can be deduced that elementary teachers will be more inclined to devote more time to the teaching of science if they believe in their abilities to effectively teach science (PSTE) and if they believe that their instruction will lead to improved student achievement and learning (STOE). Gibson and Dembo (1984) suggest that teacher efficacy is multidimensional and is composed of at least two dimensions: personal teaching efficacy assumed to illustrate self-efficacy and general teaching efficacy assumed to capture outcome expectancy. Similarly, Riggs and Enochs (1990) constructed an instrument to assess science teaching efficacy—the Science Teaching Efficacy Belief Instrument (STEBI)—and identified two distinct dimensions: PSTE and STOE.

Studies further suggest that these two dimensions of teacher efficacy can work independently of each other (Enochs and Riggs 1990; Gibson and Dembo 1984; Tosun 2000). For instance, although a teacher may believe that he/she can teach science effectively (high PSTE), he/she may not be certain if his/her teaching will have a great influence on student learning (low STOE). Therefore, different interventions in the courses of preservice teacher preparation programmes can produce changes in either PSTE (e.g. Schoon and Boone 1998; Tosun 2000) or STOE (e.g. Ginns et al. 1995), and sometimes in both (e.g. Bleicher and Lindgren 2005). This was supported by studies that implemented specific interventions to improve science teaching efficacy. For instance, Bleicher and Lindgren (2005) found significant improvement in both the PSTE and STOE of preservice elementary teachers after the implementation of a constructivist-oriented science methods course. However, Cantrell et al. (2003) reported a significant increase in the PSTE of students who were able to teach science to children for more than 3 hours in science methods course, but not in STOE. However, they revealed that the students who had taken more than the required number of college science content courses had higher STOE than those who took only the required number of courses. Similarly, Hechter (2011) conducted a study with preservice elementary teachers and reported that post-secondary science courses taken and prior school science experiences had a significant impact on PSTE. As a result, although two dimensions of science teaching efficacy beliefs are significantly correlated, some factors may affect personal science teaching efficacy and outcome expectancy differently. Therefore, knowing the factors influencing these dimensions may lead science educators to redesign teacher preparation programmes and may help them understand how to motivate teachers to teach science and how to address barriers to the teaching of science.

Bandura (1997) defined four sources of self-efficacy: mastery experiences, vicarious experiences, verbal persuasion, and emotional arousal. Mastery experiences are derived from personal practical experiences and are the most influential source of self-efficacy as they provide authentic experiences to succeed at a task. Vicarious experiences are the observation of another person's performance or modelling of successful classroom teaching practices. Verbal persuasion refers to encouragement that the preservice teacher receives from his or her peers, course instructor/s and/or supervisor/s. Emotional arousal implies how preservice teachers react to their own stress and anxiety about teaching. Palmer (2006) suggested cognitive content mastery (success in understanding science), cognitive pedagogical mastery (success in understanding how to teach science) and simulated modelling (tutor and the students simulating the conditions of a primary classroom by a type of role playing) as sources of self-efficacy in addition to the ones described by Bandura. As a result of the aforementioned studies, it can be deduced that science content knowledge is a substantial contributor to the science teaching efficacy of prospective teachers. Bleicher and Lindgren (2005) maintained that "if preservice teachers have personal success learning science, they will then be more confident to teach it" (p. 206). Accordingly, Bleicher and Lindgren's study on preservice teachers revealed that students who had a greater conceptual understanding were more likely to have higher self-efficacy, and vice versa.

Ramey-Gassert et al. (1996) specified antecedent factors related to science teaching efficacy as extracurricular science activities in and out of school, teacher preparation and science teaching experiences. Ramey-Gassert and her colleagues found that science teaching self-efficacy and its subcomponents, PSTE and STOE, were affected by antecedent factors and professional development experiences. Similarly, Cantrell et al. (2003) claimed that participation in extracurricular science activities, time spent teaching science in an elementary classroom and the number of high school science courses taken influenced the science teaching efficacy beliefs of preservice elementary teachers. Some researchers found that taking a science teaching methods course also had a positive role in improving the science teaching self-efficacy of preservice elementary teachers (Hechter 2011; Tosun 2000). Consistent with them, Settlage (2000) confirmed that taking a science methods course enhanced self-efficacy regarding the teaching of science and claimed that "Microteaching would be classified as a performance accomplishment, the classroom videos as vicarious experiences, lectures and discussion as verbal persuasion, and visits to the classrooms…as emotional arousal" (p. 49). In the present study, student teachers had the opportunity to experience microteaching, hands-on activities and experiments in their (previously taken) science teaching methods courses.

A teacher's classroom management orientation is another correlate of teacher efficacy (Henson 2001; Woolfolk and Hoy 1990). Wolfang (1995) suggested three approaches that reflect a continuum from high teacher control to low teacher control with respect to teachers' beliefs about classroom management and discipline. Low teacher control corresponds to non-interventionist models of classroom management. The non-interventionist model assumes that the child has an inner drive to find his or her expression in the real world. This approach considers that what a child does changes his or her environment. High teacher control implies an interventionist approach that focuses on the environment's effect on an individual's behaviour. Moderate levels of teacher control indicate an interactionist model of classroom management, presuming that internal and external forces are constantly interacting. Interactionists concentrate on the individual behaviours to modify the external environment and what the external environment in return does to shape the individual (Martin et al. 1998; Laut 1999; Sokal et al. 2003). Woolfolk and Hoy (1990) posited that beliefs about how to manage and motivate students may be related to the improvement of efficacy for prospective teachers. Teachers having a high sense of efficacy are more likely to favour more humanistic and less controlling classroom management orientations (Enochs et al. 1995; Henson 2001), use more positive behaviour management strategies (Emmer and Hickman 1991) and have more preventive rather than strengthening beliefs about behavioural problems (Jordan et al. 1993). In the same manner, efficacious teachers insist on motivating students and criticise less after incorrect student answers (Gibson and Dembo 1984).

Furthermore, science teaching attitudes of preservice teachers have an impact on their teaching. For example, research indicates that positive attitudes tend to motivate teachers to improve their teaching skills and enhance their enthusiasm for the teaching of science (Pigge and Marso 1997). In addition, teachers who have positive attitudes may also positively influence student achievement (Ramsay and Ransley 1986). Some studies have indicated that the number of science or science teaching methods courses taken by preservice teachers affects their attitude towards science teaching. The more courses taken, the more positive are the attitudes towards the teaching of science. Similarly, as their level of education increases from freshmen to senior, their attitudes towards science teaching also become more positive (Gabel 1980; Ateaq 1995; Turkmen 2007). On the other hand, Sarikaya (2004) found no significant relationship between the number of science courses taken in college and preservice elementary teachers' attitudes towards the teaching of science. Nevertheless, Sarikaya argued that the level of science knowledge and the attitude towards science teaching significantly explained 40 % and 4 % of the variations in self-efficacy and outcome expectancy regarding the teaching of science, respectively. This implies that preservice teachers having a high level of knowledge about science and a positive attitude towards the teaching of science had a high level of self-efficacy and improved outcome expectancy with respect to science education.

Based on the aforementioned literature, this study examined preservice elementary teachers in terms of multiple factors, as reported by many studies, with respect to their science teaching efficacy beliefs. The variables to be examined as the predictors of science teaching efficacy are selected based on the four sources of self-efficacy suggested by Bandura (1997) and three more sources suggested by Palmer (2006), as described in the preceding paragraphs. These variables operate together, and the influence each variable has on science teaching efficacy needs to be examined all at once. Actually, the variance explained by certain variables may change when new variables are included. Sometimes, a factor seeming to be a strong correlate of a variable may lose some of its predictive validity when other variables are incorporated. Therefore, it is important to explore the interplay of the variables reported as the sources of science teaching efficacy. A stepwise multiple linear regression analysis was performed to determine the predictors of science teaching efficacy and how these variables differ between elementary education majors and science education majors. Specifically, it focused on their participation in extracurricular science activities, science concept knowledge levels, number of science and science teaching methods courses they had taken, classroom management beliefs, science teaching attitudes and science teaching efficacy beliefs. Accordingly, the following research questions were addressed:

1. What are the variables affecting the science teaching efficacy beliefs of preservice elementary teachers?
2. How does the effect of the variables differ between elementary education majors and science education majors?

Methodology

Participants

The data were collected from 417 preservice elementary teachers from a large university in southern Turkey. However, because those subjects who did not complete all of the instruments were excluded, there were 333 complete sets of responses out of the original 417 student teachers. Of the 333 preservice elementary teacher responses, 262 were enrolled in the Department of Elementary Education and 71 were enrolled in the Department of Science Education. Elementary education majors (EEM) will teach all subjects to grade 1–5 students and science education majors (SEM) will teach science to grade 6–8 students. Of the participants, 207 were juniors and 126 were seniors at the time of the study; the average age was 22.2 years. These preservice teachers were selected because they had already taken the appropriate science teaching methodology courses. Specifically, EEM had taken one or two science teaching methodology courses, whilst SEM had taken four or five science methodology courses. Additionally, EEM had taken at least five science courses and SEM had taken 22–27 science courses, depending on their level of training. Science education majors and elementary education majors were selected because they will teach science when they become teachers. They were compared because they significantly differ in terms of antecedent factors (participation in extracurricular activities and the number of science and science teaching methods courses taken) and science understanding which are designated as important factors in determining the science teaching efficacy beliefs. It was expected to reveal how significant these factors are in the formation of science teaching efficacy beliefs.

Instruments

Four Turkish version instruments—the Science Teaching Efficacy Belief Instrument Form B (STEBI-B), the Science Concept Test, the Attitudes and Beliefs on Classroom Control (ABCC) Inventory and the Science Teaching Attitude Scale—were used to gather data. The STEBI-B was developed by Enochs and Riggs (1990) to measure preservice elementary teachers' science teaching efficacy. The questionnaire contains 23 five-point Likert-scaled items concerning personal beliefs about teaching science. Response categories range from "strongly agree" to "strongly disagree". The STEBI-B consists of two subcomponents: (1) PSTE and (2) STOE. PSTE is a teacher's belief about his or her own ability to effectively teach science and is measured in 13 items. STOE, measured through 10 items, is a teacher's belief about his or her own expectation that the students will successfully learn science as a consequence of the teacher's teaching of science. STEBI-B is adapted to Turkish by Tekkaya et al. (2004), and they revealed the same factorial structure as Enochs and Riggs. Reliability coefficients for the two scales are 0.79 and 0.71 for the PSTE and STOE, respectively. For the present study, the coefficients of PSTE and STOE were 0.77 and 0.70, respectively.

The second instrument, the Science Concept Test, was constructed by Tekkaya et al. (2004) in Turkish to assess preservice science teachers' conceptual understanding of basic science concepts. It includes 23 multiple choice and 17 true–false items and was designed by considering students' alternative conceptions. Cronbach's alpha was reported as 0.70. In the present study, the reliability coefficient of 40 items was determined to be 0.70. Furthermore, the participants were asked to report certain demographic information such as age, department, semester, and the number of science courses and science teaching methodology courses taken. They were also asked to indicate whether or not they participated in extracurricular science activities such as science fairs, science clubs or scientist–teacher mentoring programmes.

The ABCC Inventory measures teachers' perceptions of classroom management beliefs (Martin et al. 1998) and includes 26 four-point Likert-scaled items. Response categories range from "strongly agree" to "strongly disagree". It measures three dimensions of classroom management: instructional, behavioural and people management. The instructional management scale (14 items) "includes aspects such as monitoring seatwork, structuring daily routines, and allocating materials"; the people management scale (eight items) "pertains to what teachers believe about students as people and what teachers do to develop the teacher-student relationship"; and the behavioural management scale (four items) "includes setting rules, establishing a reward structure, and providing opportunities for student input" (Martin et al. 1998, p. 7). Each scale assesses a range of control from interventionist to interactionist to non-interventionist. The interventionist shows a great need to control the classroom environment. The ABCC Inventory was adapted to Turkish by Savran (2002). The Turkish version includes two subscales: the instructional management (12 items) scale and the people management (10 items) scale. Four items were deleted because of low factor loadings. The reliability coefficients for the instructional management and the people management scales were 0.71 and 0.73, respectively. In the present study, the reliability coefficients were 0.71 and 0.70 for the instructional management and the people management scales, respectively. Example items from ABCC Inventory are given in the Appendix.

The Science Teaching Attitude Scale was developed by Thompson and Shrigley (1986) to assess preservice elementary teachers' attitudes towards science teaching and has a reliability coefficient of 0.83. The scale consists of 22 items using a five-point Likert scale with responses ranging from "strongly agree" to "strongly disagree". It has been found to be a valid and reliable instrument by Thompson and Shringley. The Science Teaching Attitude Scale was adapted to Turkish by Tekkaya et al. (2002). In the present study, the reliability coefficient was found to be 0.84.

Data Collection and Analysis

The instruments were administered to the participants during class near the end of the spring semester. The STEBI-B and the Science Concept Test were administered in the first class hour (45 min) and the ABCC inventory and the Science Teaching Attitude Scale administered during the second class hour. The instruments were administered to all students over a period of 2 weeks because the students were in different classes and different departments, making it difficult to administer the questionnaire to all of the participants in the same week. The students were assured that their responses would not be used to grade them by their teachers. Actually, they were accustomed to answering questionnaires or tests occasionally since their instructors were also researchers in education.

The data were analysed using the SPSS package from which the descriptive and inferential statistics were generated. Specifically, a two-sample chi-square test was conducted to examine the relationship between the majors and participation in extracurricular science activities in high school and college. One-way analysis of variance (ANOVA) was performed to investigate whether any differences existed between EEM and SEM with respect to their conceptual understanding of science, their classroom management beliefs, their science teaching attitudes and their science teaching efficacy beliefs. The ANOVA is preferred to the independent sample *t* test because it calculates effect size statistics—the partial eta squared (η^2). In addition, Pearson's product–moment correlation coefficients were computed to investigate the relationship between science concept knowledge and the number of science courses and science methodology courses separately. Finally, multiple regression analysis was conducted to determine the influencing factors for science teaching efficacy beliefs.

Results

Participating in Extracurricular Science Activities According to Majors

Two sample chi-square tests indicated that participating in extracurricular activities was significantly related to college major [Pearson χ^2 (1, N=333]=47.04, p=0.0, phi=0.376]. The phi value implies that the strength of the relation is moderate. Whilst 5 % of the EEM participated in extracurricular science activities at the high school and university levels, 33.8 % of SEM did so. Comparison of the proportions of both groups with respect to participation in extracurricular science activities is presented in Fig 1.

As evidenced in Fig 1, the majority of the preservice teachers in the present study did not engage in extracurricular science activities.

Level of Science Concept Knowledge

The mean score of the Science Concept Test for all respondents was 20.05 out of a maximum score of 40. An ANOVA was performed to examine how the majors differed in terms of their science concept knowledge level, and it was found that there was a significant difference between elementary education majors and science education majors with respect to their understanding of science concepts [$F(1,331)=217.4$, $p=0.00$, partial $\eta^2=0.39$]. A partial η^2 of 0.39 indicates a strong relationship between majors and science concept knowledge. The mean scores of EEM and SEM are 18.77 and 24.80, respectively.

The relationship between science concept knowledge and the number of science courses taken was also examined using Pearson's product–moment correlation coefficient. According to the results, the correlation between science concept knowledge and the number of science courses taken was significant [$r(331)=0.60$, $p<0.01$]. Similarly, the correlation between science concept knowledge and the number of science teaching methodology courses was explored, and a significant positive correlation was detected [$r(331)=0.56$, $p<0.01$].

Classroom Management Beliefs

Two one-way ANOVAs were conducted on two subscales of the ABCC Inventory (instructional management and people management) to explore the difference between classroom management beliefs of elementary education majors and science education majors. There was no significant difference between the majors with regard to their classroom management beliefs on either the instructional management or the people management subscales of the ABCC Inventory. Table 1 shows the descriptive statistics and ANOVA results for both subscales of the ABCC Inventory.

For both subscales, the possible minimum score shows non-interventionist ideology, whilst the possible maximum score corresponds to interventionist ideology. Possible

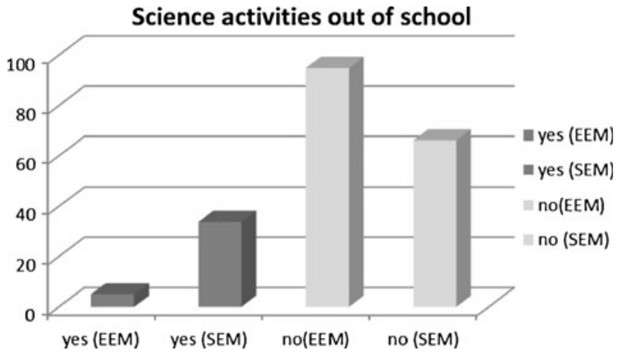

Fig. 1 Percentage comparison of elementary education majors (*EEM*) and science education majors (*SEM*) with respect to participation in extracurricular science activities

Table 1 Descriptive statistics and ANOVA results for the subscales of the ABCC Inventory

Subscale		Mean	SD	*N*	Source	*df*	*F*	Sig.	Partial η^2
Instructional	EEM	36.78	4.29	262					
Management	SEM	37.22	4.01	71	Major	1	0.59	0.44	0.002
People	EEM	19.14	3.68	262					
Management	SEM	20.07	3.41	71	Major	1	3.63	0.58	0.01

minimum and maximum scores for the instructional management subscale are 12 and 48, and 10 and 40 for the people management subscale, respectively. Accordingly, the mean scores of both majors show that the students of both groups are interventionist in the instructional management subscale and non-interventionist in the people management subscale. Furthermore, Figs. 2 and 3 display the mean scores of the students from EEM and SEM for the items of instructional management and people management subscales, respectively. They also confirm that the answers of SEM and EEM for each subscale were similar. Specifically, Fig. 2 shows that the answers of the students from groups tend to be between "agree" and "strongly agree", which could be evidence to claim that they are interventionist in the instructional management subscale. On the other hand, Fig. 3 shows that the answers of the students from both groups tend to be around "disagree" or "strongly disagree", which could be evidence to claim that they are non-interventionist in the people management subscale.

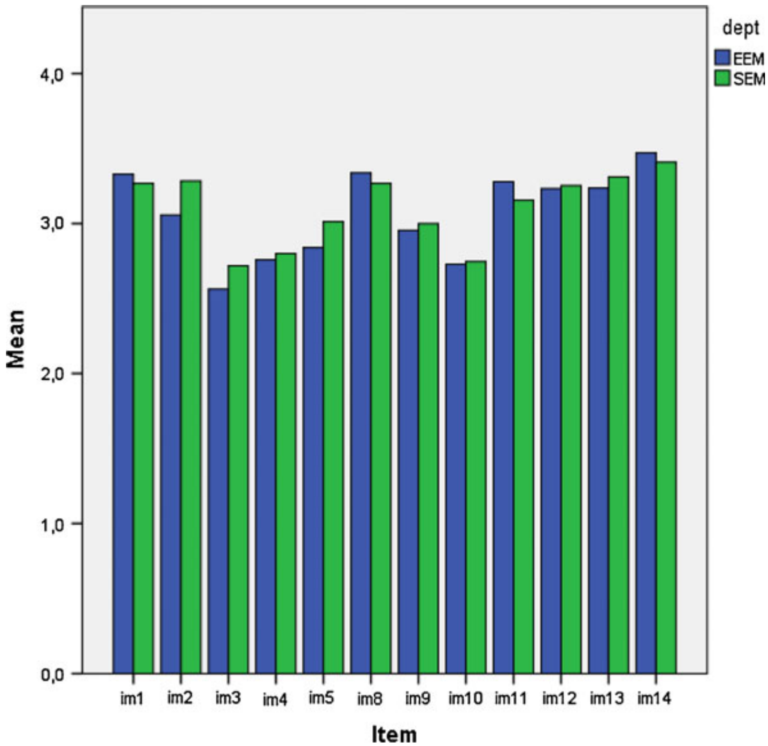

Fig. 2 Mean scores of the students from EEM and SEM for the items of instructional management subscale

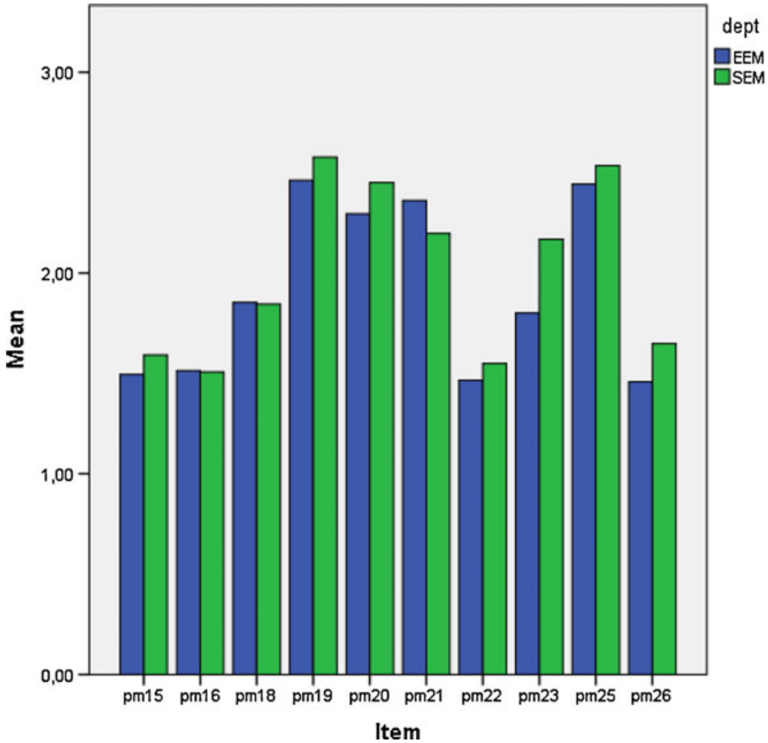

Fig. 3 Mean scores of the students from EEM and SEM for the items of people management subscale

Science Teaching Attitudes

Descriptive statistics were used to analyse the preservice teachers' scores on the Science Teaching Attitude Scale. Possible minimum and maximum scores are 20 and 100, respectively. The mean scores of both groups (69.04 for EEM and 75.45 for SEM) imply a positive attitude towards science teaching. One-way ANOVA was performed to compare EEM and SEM regarding science teaching attitudes. The results showed that the difference between the groups is significant [$F(1,331)=25.72$, $p=0.00$, partial $\eta^2=0.072$]. However, the effect size is moderate, with the major factor accounting for only approximately 7 % of the variance in the attitudes.

Science Teaching Efficacy Beliefs

One way-ANOVA for each subscale of the STEBI-B (STOE and PSTE) was conducted to determine the difference between EEM and SEM in terms of their science teaching efficacy beliefs. Science education majors' self-efficacy (PSTE) mean was found to be significantly higher than that of elementary education majors, with a small effect size [$F(1,331)=10.91$, $p=0.001$, partial $\eta^2=0.032$]. On the other hand, no significant difference was found for STOE means of the groups [$F(1,331)=0.224$, $p=0.637$]. Descriptive statistics are given in Table 2.

Possible minimum and maximum scores for the PSTE scale are 12 and 60, and 8 and 40 for the STOE subscale, respectively. Accordingly, the mean scores of both majors show that the students of both groups generally had positive self-efficacy beliefs on both subscales.

Table 2 Descriptive statistics for the subscales of STEBI-B

Subscale		Mean	SD	*N*
PSTE	EEM	47.39	5.99	262
	SEM	50.07	6.30	71
STOE	EEM	35.30	4.35	262
	SEM	35.58	4.60	71

Results of Stepwise Multiple Linear Regression

Stepwise multiple linear regression was performed to explore how well participating in extracurricular science activities, science concept knowledge, classroom management beliefs, science teaching attitudes and number of science teaching methods courses predict PSTE and STOE as they have been found to be significant correlates of science teaching efficacy beliefs in previous studies (Bursal 2008; Cantrell et al. 2003; Gencer and Cakiroglu 2007; Hechter 2011; Sarikaya 2004; Tekkaya et al. 2004) and designated as the sources of self-efficacy in science teaching (Bandura 1997; Palmer 2006). Table 3 presents Pearson's correlation coefficients among all the variables used in this study. As evidenced in the table, correlations of classroom management beliefs with both PSTE and STOE are negative and not significant. Similarly, the correlation between science concept knowledge and outcome expectancy is not significant. Moreover, the correlations of the number of science teaching methods courses taken with classroom management beliefs and outcome expectancy tended to be lower and not significant. On the other hand, significant correlation among the dependent variables implies high internal consistency among the two subscales of the instrument, STEBI-B. However, there is a striking correlation between science concept knowledge and the number of science teaching methods courses. Furthermore, participating in extracurricular science activities has low correlations with the other independent variables (science concept knowledge, classroom management beliefs, science teaching attitudes and number of science teaching methods courses). However, it is remarkable that the correlations are significant.

Before regression, assumptions of normality, multicollinearity and independence of errors with constant variance were checked. No violations of the assumptions were observed.

To detect which variables have an effect on the dependent variables, given that the other variables are present, two stepwise multiple linear regressions, one for each dependent

Table 3 Pearson's correlation coefficients among predictor and criterion variables

Variable number and name	1	2	3	4	5	6	7
Independent variables							
1. Participating in extracurricular science activities	1.00						
2. Science concept knowledge	0.21*	1.00					
3. Classroom management beliefs	0.13*	0.11*	1.00				
4. Science teaching attitudes	0.17*	0.21*	−0.09	1.00			
5. No. of science teaching methods courses	0.38*	0.56*	0.01	0.30*	1.00		
Dependent variables							
6. PSTE	0.12*	0.18*	−0.08	0.55*	0.20*	1.00	
7. STOE	0.10*	0.04	−0.06	0.31*	0.04	0.59*	1.00

$^*p<0.05$

Table 4 Results of stepwise multiple linear regressions for all preservice teachers for each dependent variable

Factor	R	R^2	Adjusted R^2	F	p
(a) Dependent variable as PSTE	0.55	0.303	0.301	143.97	0.000
Science teaching attitudes					
(b) Dependent variable as STOE	0.31	0.096	0.093	35.12	0.000
Science teaching attitudes					

variable, were conducted for all of the participants and for each major. The first stepwise multiple linear regression analysis performed for all of the participants indicated that the only factor predicting PSTE is science teaching attitudes. Similarly, the second regression analysis showed that STOE is also influenced significantly by only science teaching attitudes. Table 4, which summarises the results of multiple linear regression analyses for all preservice teachers regarding each dependent variable, indicates that science teaching attitude explains 30.3 % of the variability in personal science teaching efficacy and 9.6 % of the variability in the science teaching outcome expectancy of the preservice teachers in the present study.

Among EEM, science concept knowledge and science teaching attitude are the statistically significant predictors of PSTE. Specifically, science teaching attitude alone accounted for 34.8 % of the variance of PSTE, whilst science concept knowledge contributed only an additional 1.2 %. On the other hand, only science teaching attitude had an influence on STOE for EEM, explaining 9.8 % of the variability in STOE. Table 5 indicates the results of the multiple linear regression analyses for EEM regarding each dependent variable.

Among SEM, only science teaching attitude contributed significantly to PSTE as approximately 7.8 % of the variance of PSTE can be accounted for by this variable. Similarly, in the second stepwise multiple linear regression, the only useful predictor of STOE is, again, science teaching attitude, which accounted for 11 % of the variance of STOE. Table 6 presents the results of stepwise multiple linear regressions for SEM regarding each dependent variable.

As understood from the results of the multiple linear regressions, participating in extracurricular science activities, classroom management beliefs and the number of science teaching methods courses are not significant contributors to science teaching efficacy beliefs for the participants of this study.

Table 5 Results of stepwise multiple linear regressions for elementary education majors for each dependent variable

Factor	R	R^2	Adjusted R^2	F	p
(a) Dependent variable as PSTE	0.60	0.360	0.355	72.76	0.000
Science teaching attitudes	0.59	0.348	0.345		
Science concept knowledge	0.01	0.012	0.010		
(b) Dependent variable as STOE	0.313	0.098	0.095	28.29	0.000
Science teaching attitudes					

Table 6 Results of stepwise multiple linear regressions for science education majors for each dependent variable

Factor	R	R^2	Adjusted R^2	F	p
(a) Dependent variable as PSTE	0.28	0.078	0.065	5.86	0.018
Science teaching attitudes					
(b) Dependent variable as STOE	0.332	0.110	0.097	8.52	0.005
Science teaching attitudes					

Discussion and Conclusions

To improve the teacher education programs, it is essential to examine, shortly before graduation, preservice elementary teachers in terms of certain variables such as content knowledge, classroom management beliefs, attitudes towards the subjects that they will teach and their self-efficacy to teach those subjects. This will also contribute to evaluating the existing procedures. Accordingly, this study reports the findings about the preservice teachers' participation level in extracurricular science activities at the high school or university, level of science concept knowledge, classroom management beliefs, science teaching attitudes, science teaching efficacy beliefs and factors predicting science teaching efficacy beliefs. The results indicated that participation level in extracurricular science activities, which has been found to be one of the antecedent sources of science teaching efficacy (Ramey-Gassert et al. 1996; Cantrell et al. 2003), was low for both majors, although the percentage for SEM was far more than it was for EEM. Not surprisingly, it appears that SEM were more interested in science than EEM at the high school or the university level. In addition, as seen in Table 3, participation in extracurricular activities has a significant but low correlation with science concept knowledge, science teaching attitudes, PSTE and STOE. This implies that student teachers who participated in extracurricular science activities may be more likely to develop higher science teaching efficacy and outcome expectancy over the course of their teacher preparation program and, therefore, have a positive effect on their future elementary students understanding of science. Correspondingly, providing students with opportunities for extracurricular science activities during the science methods course may supply additional ways of promoting the development of science teaching efficacy for those preservice teachers who participated less in science experiences throughout their previous educational period (Cantrell et al. 2003).

In general, science concept knowledge level of preservice elementary teachers in this study was low. This shows that preservice teachers' conceptual understanding in science is not sufficient and that they had some alternative conceptions in science concepts. Specifically, SEM was superior to EEM. The difference between the two groups is significant, with a large effect size. This is most likely because the number of science and science teaching methodology courses that SEM had taken was considerably more than EEM. Correspondingly, the correlations of science concept knowledge with the number of science courses and the number of science methodology courses taken were significantly large. Apparently, preservice elementary teachers who participated in this study will start their teaching career with many alternative conceptions. As Schoon and Boone (1998) confirmed, despite a large number of studies performed in the past 20 years to specify common alternative conceptions and to organise ways of coping with alternative conceptions in the classroom, students still graduate from high school and university with many alternative conceptions in the context of science. Furthermore, the lower interest in science at the high school and university levels for EEM may be because they took fewer science courses in high school compared to SEM in Turkey. This might also have affected their conceptual understanding in science at university. In addition to the number of courses, the quality of teaching science may be another reason for this low conception and lack of interest. Science-related courses are usually taught by traditional methods in high schools and universities in Turkey. Accordingly, Tekkaya et al. (2004) supported the results of this study, finding that Turkish preservice elementary science teachers in their study had a low level of understanding and many alternative conceptions in science concepts. They also found that science concept knowledge of preservice elementary science teachers had a small but significant correlation with PSTE (r=0.12) and no correlation with STOE. These results are similar to those for the participants of the present study, where the correlation between science concept knowledge and PSTE is small but significant (r=0.18) and the correlation between science concept knowledge and STOE is not significant. This implies that preservice elementary teachers' conceptual understanding in science contributes to their science teaching self-efficacy. Similarly, Bleicher and Lindgren (2005) revealed that preservice elementary teachers who had more conceptual understanding tended to have higher self-efficacy. However, they found no significant relationship between conceptual understanding and outcome expectancy. They suggest that how science is taught is more critical than how many science courses are taught. Activities requiring reflection, discussion and experiential learning must be integrated into the instructional design of the courses. Hands-on activities with discussions improve conceptual understanding, which contributes to confidence in teaching science. Correspondingly, Grossman et al. (1989) reported that teachers with a low level of content knowledge usually depend heavily on the textbook instead of using student-centred teaching methods that provide real student understanding. On the other hand, Schoon and Boone (1998) found no correlation between the number of alternative conceptions and self-efficacy or outcome expectancy. However, they revealed that having certain alternative conceptions was associated with low self-efficacy.

Classroom management beliefs may affect teachers' perceived success before they even start their profession (Henson 2001; Woolfolk and Hoy 1990). In the present study, preservice teachers' classroom management beliefs and the difference between EEM and SEM in terms of these beliefs were explored. The difference in classroom management beliefs on both the instructional management and the people management subscales between SEM and EEM was not significant. The mean scores for both majors indicate that they were interventionist on the instructional management subscale and non-interventionist on the people management subscale. This implies that the students of both groups hold beliefs that focus on the external environment and on behaviour modification in managing instruction, and thus they are prone to favour a stricter approach towards instructional management. On the other hand, the participants of this study tended to focus on what the individuals do to change the environment in terms of student–teacher relationships, and thus, they were more flexible in managing students. In other words, they were less controlling in their beliefs regarding people management. These results are consistent with other studies in Turkey (Gencer and Cakiroglu 2007; Savran and Çakıroğlu 2003). Gencer and Cakiroglu (2007) argued that because the participants in their study were still students, they were more flexible and sensitive to student–teacher relationships compared to instructional management. They also emphasised that the student teachers were more experienced in instructional planning than in classroom management, which might lead to stricter beliefs about instructional management. These results are also valid for the participants in the present study. Actually, whilst Turkish students are expected to prepare science lesson plans and design instructional materials during many pedagogical courses, they only have an opportunity to manage a real primary science class one or two times during their teacher preparation courses.

With respect to teacher attitudes, it was found that preservice elementary teachers had positive attitudes towards science teaching. Whilst a significant difference between the two majors stands out, the magnitude is not large. This gives rise to the idea that preservice elementary and science teachers seem to hold similar attitudes towards science teaching, which is also supported by studies in Turkey (Turkmen 1999, 2002) as well as in other countries (Bonnstetter 1984). Positive attitudes of teachers have a positive effect on students' attitudes, thus promoting student academic achievement (Pigge and Marso 1997). Stollberg (1969) asserted that teachers with a neutral or negative attitude could either avoid the teaching of science or pass this negative attitude on to young students. Moreover, science teaching attitudes have also been found as a correlate of science teaching self-efficacy and outcome expectancy of preservice teachers (Sarikaya 2004; Tekkaya et al. (2002). Similarly, the present study reveals a moderate correlation between science teaching attitudes and STOE and a high correlation between science teaching attitudes and PSTE. This suggests that improving the attitudes of preservice teachers towards science teaching most likely improves their science teaching self-efficacy and outcome expectancy. Attitudes towards science teaching is also found to be correlated with the number of science teaching methodology courses taken by preservice elementary teachers in this study. Although the correlation coefficient is low, the number of methodology courses taken can be considered as one of the correlates of science teaching attitudes. Consistent with this finding, Turkmen (2007) reported that elementary science teaching method courses influenced attitudes towards science teaching. Therefore, increasing the number of science teaching methodology courses may promote positive attitudes towards science teaching, but as is known, attitudes are the result of the gradual collection of information during a longitudinal process, and it is difficult to maintain a positive attitude. Therefore, developing positive attitudes requires special attention not only during the student teacher's university years but also throughout the entire period of one's education and teaching career (Turkmen 2007).

According to the results of this study, students of both majors generally had positive self-efficacy beliefs on both the STOE and PSTE. Specifically, SEM had higher science teaching self-efficacy than EEM. Nevertheless, the magnitude of the difference is small. Furthermore, there was no significant difference between the groups with respect to outcome expectancy. A high score on PSTE suggests that greater science teaching self-efficacy beliefs are correlated to having positive beliefs about student outcomes, whilst a high score on the STOE corresponds to greater outcome expectancy related to the power of teaching and the ability to effectively address any negative effects outside the classroom. In other words, preservice teachers believed in their ability to teach science effectively and believed that students can learn science given effective instruction. The results of some other studies conducted in different years in Turkey also support the idea that Turkish preservice elementary teachers have positive science teaching efficacy beliefs (Gencer and Cakiroglu 2007; Savran and Çakıroğlu 2003; Tekkaya et al. 2004; Yılmaz and Huyugüzel-Çavaş 2008). In addition, Table 3 indicates that science teaching outcome expectancy for the participants appears significantly related to the number of science teaching methods courses taken. In science teaching methods courses, the student teachers had the opportunity to experience teaching science using hands-on activities and other student-centred teaching methods throughout their microteaching experience. This was simulated modelling, as suggested by Palmer (2006) as a source of self-efficacy. He proposed that "…extensive use of hands-on activities can enhance efficacy in two ways—firstly, by providing effective instructional strategies (cognitive pedagogical mastery), and secondly, by consolidating the science content understandings of the students themselves (cognitive content mastery)" (p. 349). The preservice teachers had just completed their motivation and content learning experience under simulated conditions, and as a result, they may believe that the same technique could also be influential in the primary classroom (Palmer 2006). Similarly, Gunning and Mensah (2011), in their case study, found that hands-on activities, discussions about teaching elementary science and science teaching opportunities provided by a microteaching assignment during a science teaching methods course improved the self-efficacy of preservice elementary teachers to teach science. Consequently, they suggest that "types of experiences offered within the course are valuable for preservice elementary teachers learning to teach science and increasing their self-efficacy to teach science" (p. 183).

The results from two different stepwise multiple regression analyses show that science teaching attitude is the only factor that predicts both PSTE and STOE. Among EEM, whilst both science concept knowledge and science teaching attitudes are the significant predictors of PSTE, science teaching attitude is, in fact, more influential. With respect to STOE, the only statistically significant predictor is science teaching attitude. Similarly, among SEM, science teaching attitude is the only predictor for both PSTE and STOE. Interestingly, as Table 3 displays, although PSTE correlates significantly with a number of variables studied, science teaching attitude is the major factor explaining the variance in PSTE. Similarly, whilst STOE also correlates significantly with participating in extracurricular science activities, the only factor explaining the variance in STOE is, again, science teaching attitude. In other words, when the effects of multiple variables are examined together, the variables other than science teaching efficacy lost their predictive validity, which shows that the interplay of the variables affects the variance in science teaching self-efficacy and outcome expectancy. This implies that science teaching attitude is much more significant in explaining the science teaching efficacy beliefs when all variables are analysed together. However, antecedent factors are also found to contribute significantly to science teaching attitude; thus, providing opportunities for extracurricular activities and increasing the number of science and science teaching methods courses may develop a positive science teaching attitude that may, in turn, increase science teacher efficacy. If a student teacher is acquainted with science and has taken several courses with success, he or she will most likely have a greater orientation towards science, which, in turn, results in positive attitudes towards the teaching of science and efficacy beliefs regarding science. Consistent with these findings, Ateaq (1995) claimed that the more science courses taken by preservice teachers, the more positive they feel about the teaching of science. Concordantly, Tarik (2000) revealed that prior science courses impact science teaching efficacy beliefs. In short, although the other variables such as participating in extracurricular activities, science concept knowledge and number of science teaching methods courses do not appear to predict science teaching efficacy beliefs directly, they are significantly correlated with science teaching attitude, which is the major predictor.

Studies about teacher self-efficacy are generally intended to inform teacher educators. The findings of these studies provide teacher educators with ways to enhance the self-efficacy and outcome expectancy of their student teachers, thereby allowing them to graduate students with an increased sense of teaching confidence that positively influences the quality of education in schools. Consistent with the extant studies in the literature, I suggest that more qualitative and longitudinal studies be conducted with preservice elementary and secondary science teachers to determine the predictors that influence science teaching self-efficacy.

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Appendix

Example items from ABCC Inventory

Instructional Management Subscale

I believe the teacher should direct the students' transition from one learning activity to another.
I believe that students need direction in how to work together.
I specify a set time for each learning activity and try to stay within my plans.
I believe class rules are important because they shape the student's behaviour and development.

People Management Subscale

I believe students should create their own daily routines as this fosters the development of responsibility.*
I believe students will be successful in school if allowed the freedom to pursue their own interests. *
When moving from one learning activity to another, I will allow students to progress at their own rate.*
Students in my classroom are free to use any materials they wish during the learning process.*
*Scoring reversed for these items

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