International Journal of Environmental & Science Education, 2014, **9**(4), 429-442

Turkish Preservice Elementary Science Teachers' Conceptions of Learning Science and Science Teaching Efficacy Beliefs: Is There a Relationship?

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Received 1 November 2013; accepted 23 July 2014, doi: 10.12973/ijese.2014.226a

This study has been conducted to investigate conceptions of learning science (COLS) and personal science teaching efficacy belief (PSTE) of Turkish preservice elementary science teachers (PSTs) and to explore the relationship between these variables. Two instruments COLS questionnaire and PSTE subscale of Science Teaching Efficacy Beliefs Instrument (STEBI-B) have been administered to 379 PSTs from seven different universities. Descriptive analyses have pointed out that PSTs have higher level of COLS and moderately higher level of PSTE. The results obtained from the structural equation model have revealed that the conceptions 'testing', 'calculate and practice', 'increase of knowledge', 'applying' and 'understanding and seeing in a new way' have significantly predicted PSTE. We have assumed that lower level of conceptions 'memorizing', 'testing', and 'calculate and practice' predict PSTE by negative coefficients while higher level of conceptions 'increase of knowledge', 'applying' and 'understanding and seeing in a new way' predict by positive coefficients. However, 'calculating and practicing' has positively predicted and 'applying' has negatively predicted PSTE. Considering the results, adaptation of inquiry- and argumentation-based learning and teaching environments in science teacher education, creating opportunities to develop PSTs' pedagogical skills about knowledge transfer and application, and utilization of diagnostic tools to pursue PSTs' development of COLS have been suggested.

Keywords: Preservice elementary science teachers, conceptions of learning science, personal science teaching efficacy belief, structural equation modeling

INTRODUCTION

Beliefs are certain predispositions to the action (Rokeach, 1968). They are affective, loosely bounded, evaluative and episodic (Abelson, 1979). Korthagen (2004) has considered that 'beliefs' are the most important parameter in teacher education literature. Even though existing literature displays confusing results about the relationships between teacher's beliefs and practice (Fives & Buehl, 2012), there is sufficient evidence (e.g., Pajares, 1992) to argue that teacher's beliefs are crucial in the estimation of teaching practices in real classrooms. At this point, we have investigated the relationships between two important beliefs (conceptions of learning and teaching efficacy) of preservice elementary science teachers (PSTs) in the context of science education in order to estimate possible roles of these beliefs in their future practices. In addition, we have considered that this awareness based on pre-existing

ISSN: 1306-3065

beliefs of PSTs might provide knowledge on which science teacher educators can build better teacher education programs and opportunities.

People develop conceptions about the nature of their learning. These conceptions are crucial in a range of learning and teaching experiences (e.g., Tsai, Ho, Liang & Lin, 2011). Memorizing, increase of knowledge, applying and acquisition of facts are several conceptions of learning that the researchers have uncovered. Certain scholars have classified these conceptions as traditional and constructivist. In addition, recent research has showed that these conceptions have relationships with learning efficacy (e.g., Tsai et al., 2011), epistemological beliefs (e.g., Chan & Elliot, 2004), approaches to learning (e.g., Lee, Johanson & Tsai, 2008) and teaching orientation (Koballa, Graber, Coleman & Kemp, 2000).

Teaching efficacy beliefs are another psychometric factor influencing teaching experience and learning environments (Gibson & Dembo, 1984). These beliefs represent teachers' considerations about their competence in management of student learning (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998). Teacher educators frequently investigate them in order to estimate teacher behaviors and classroom implementations since these beliefs are an important predictor of teaching practices (Ramey-Gassert, Shroyer & Staver, 1996).

As science teacher educators, we have focused on conceptions of learning science and science teaching efficacy beliefs and the relationships between them. Our basic assumption is that a science teacher teaches science in a way s/he learns it. We have considered that PSTs' conceptions of 'learning' science have a potential to influence their science 'teaching' efficacy. We test this assumption in a group of Turkish PSTs. Turkey has updated elementary school science curricula two times since 2005, by adopting contemporary perspectives based on constructivism. Constructivist pedagogies have been given much importance in teacher education departments. Policy makers invested much money for education of PSTs and precollege students in direction of constructivism-based curricula. In this regard, examining PSTs' conceptions has crucial importance. Considering Turkey has experienced constructivism-based curricula for about ten years, we can argue that current PSTs have been exposed to traditional approaches as students at pre-college level, but exposed to constructivist approaches as teacher candidates at university level. In other words, they have learned science thorough traditional pedagogies, but they are asked to learn teaching science using constructivist pedagogies. Policy makers and teacher educators expect PSTs to hold constructivist conceptions of learning and teaching science. Currently, we do not know what types of conceptions do PSTs have developed about learning science. Do they feel efficient in science teaching? Do their conceptions of learning science (COLS) inform their science teaching efficacy? Do they hold strong science teaching efficacy beliefs based on constructivist COLS that they have developed during their college education? We strive to answer these queries in the present study. We believe that the results of such a study have a potential to inform both learning environments and teaching pedagogies provided in science teacher education programs.

THEORETICAL FRAMEWORK

Conceptions of Learning Science

Pajares (1992) states that 'belief' and 'conception' are used interchangeably by educational psychologists. Chan and Elliott (2004), in this respect, define (preservice) teachers' conceptions of teaching and learning as "the beliefs held by teachers about their preferred ways of teaching and learning" (p.819). Considering this definition, in this study, conceptions of learning science (COLS) refers to the individuals' salient set of ideas and beliefs regarding learning science.

Looking at the research about COLS, we can argue that researchers belong to one of two traditions. In first tradition, they have strived to understand the nature of conceptions of learning, using classifications and typologies. In second tradition, their goal is to scrutinize the relationships between COLS and learning and teaching variables. In first tradition, a pioneering work about the conceptions of learning was conducted by Saljo in 1979. He (1979) has asked 90 college students the meaning of learning. After he has categorized the data, he has stated that individuals have had five different conceptions of learning: (1) *increase of knowledge,* (2) *memorizing,* (3) *the acquisition of facts, procedures etc. which could be retained and/or utilized in practice,* (4) *abstraction of meaning,* (5) *interpretative process aiming at an understanding of reality*. Marton, Dall'Alba, and Beaty (1993) have modified the categorization of Saljo (1979) and added a new conception of learning: *personal change*. In addition, Tsai (2004) has explored high school students' COLS and he has found seven labels: (1) *memorizing,* (2) *preparing for tests,* (3) *calculating and practicing tutorial problems,* (4) *increase of knowledge,* (5) *applying,* (6) *understanding and* (7) *seeing in a new way*. Based on the work of Tsai (2004), Lee et al. (2008) have created an instrument COLS questionnaire to explore high school students' COLS. According to the results, they have classified students' COLS under six categories. This categorization was almost the same as the categorization of Tsai (2004). However, they have combined the categories "understanding" and "seeing in a new way" into a unique dimension, which differs from Tsai's (2004) categorization.

'Traditional' vs. 'constructivist' conceptions is another type of classification of learners' or (preservice) teachers' conceptions of learning in current literature. To illustrate Chan and Elliot (2004) uncover (preservice) teachers' traditional conceptions of learning as "absorption of transferred knowledge from experts to novices" (p.821). Constructivist conception of learning, on the other hand, refers to the creation and acquisition of knowledge by the learner through reasoning and justification (Chan & Elliot, 2004, p.821) which is consistent with what Baviskar, Hartle and Whitney (2009) have mentioned about constructivist learning. Baviskar et al. (2009) have stressed that constructivism is a theory of learning but not of teaching. These scholars argued that to the constructivist theory of learning, an individual learns if s/he connects knowledge to a comprehensive construct of facts, concepts, experiences, values and emotions. In other words, individuals learn if they overcome the incongruities between new coming knowledge and their prior knowledge and apply the new construct to novel situations according to the theory of constructivism. Same classification offered by Tsai et al. (2011) for conceptions of learning science was used in this study. We have labeled 'memorizing', 'testing', and 'calculate and practice' as traditional (lower level of) conceptions of learning. Additionally, 'increase of knowledge', 'applying', and 'understanding and seeing in new way' have been labeled as constructivist (higher level of) conceptions of learning.

In a similar research study, Al-Amoush, Usak, Erdogan, Markic and Eilks (2013) have investigated Turkish pre- and in-service teachers' conceptions of learning and teaching chemistry. The researchers have categorized participants' conceptions as traditional vs. modern beliefs similar to the aforementioned categorization of 'traditional' vs. 'constructivist'. They have found that Turkish pre- and in-service chemistry teachers' conceptions about education are constructivist in comparison to their conceptions of learning and teaching chemistry. Based on the results, Al-Amoush et al. (2013) have claimed that Turkish preservice chemistry teachers have a potential to teach chemistry with traditional ways in their future. In a following research attempt, Al-Amoush, Markic, Usak, Erdogan, and Eilks (2014) have repeated the study with a cross-cultural sample of teachers from Turkey, Germany and Jordan. The results of Turkish participants are same as in their previous study. Considering the results of such a cross-cultural study, Al-Amoush et al. (2014) have argued that traditional conceptions that Turkish participants hold may be formed by cultural traditions which influence interdependency among students, teachers and/or parents.

In second tradition, Lee et al. (2008) examined the relationship between students' COLS and approaches to learning science. They have found that traditional conceptions of learning science (memorizing, testing, calculating and practicing) are positively related to surface approaches to learning science. In addition, constructivist conceptions of learning science (increase of knowledge, applying, understanding and seeing in a new way) have predicted deep approaches to learning science. Furthermore, Otting, Zwall, Tempelaar and Gijselaers (2010) explored the link between students' epistemological beliefs and conceptions of teaching and learning. They have found that as students believe that learning requires considerable effort, they consider that teaching and learning should be based on constructivist aspects. They have also concluded that there is a positive relationship between 'certainty of knowledge' and the traditional conception of teaching and learning. In another research, Chiou, Lee and Tsai (2013) have investigated the relationship among epistemic views, conceptions of learning and approaches to learning physics. They have found that students' conceptions of learning physics predict students' approaches to learning physics and their epistemic views. Finally, Koballa et al. (2000) have investigated the interrelations between preservice teachers' conceptions of learning chemistry and conceptions about teaching chemistry. They have argued that conceptions of learning have been influential in the development of conceptions of teaching.

Teachers' Self-Efficacy Beliefs

Self-efficacy beliefs refer to perceived beliefs, judgments or capabilities of a person about performing actions at designated levels (Bandura, 1977). Pajares (2002) has stated that self-efficacy beliefs present people an instrumental mechanism for achieving and exercising their goals over their environment. According to Bandura (1982) self-efficacy judgments of people have four main sources: enactive attainments, vicarious experience, verbal persuasion and physiological state. Enactive attainments have the most influential effect on self-efficacy. They are based on mastery experiences resulting by success or failure. People experience certain situations vicariously by observing models. They compare their competences with these models. Verbal persuasion is discourses performed by others to make people to believe that they have necessary capabilities for achieving desired performance. In addition, physiological state includes people's reactions about their performances such as anxiety, happiness and anger (Bandura, 1982).

Teacher self-efficacy refers to the beliefs of teachers about their abilities related to managing students' learning (Gibson & Dembo, 1984). Consistent with Bandura's social cognitive theory, researchers have found two separate dimensions of teacher self-efficacy: personal teaching efficacy and outcome expectancy (Tschannen-Moran et al., 1998). According to Ashton, Webb and Doda (1983) personal teaching efficacy includes both teaching efficacy and personal efficacy. While teaching efficacy refers to teachers' beliefs about the link between teaching and learning, personal efficacy refers to teachers' beliefs about their own effectiveness. According to Bandura (1986), outcome expectancy refers to individuals' beliefs related to achieving a specific task leading to a desirable outcome.

There are many studies inquiring self-efficacy beliefs about teaching science (Bleicher & Lindgren, 2005). These studies have identified that science teachers with high sense of efficacy work harder and persist longer even when students are difficult to teach and possess a strong motivation to help their students learn (Ramey-Gassert et al., 1996).

Science Teaching Efficacy Beliefs Instrument Form B (STEBI-B) has been developed by Enochs and Riggs (1990) for assessment of preservice elementary teachers' science teaching efficacy. This instrument is composed of two dimensions: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). Mulholland, Dorman and Odgers (2004) have reported that preservice teachers' PSTE scores positively relates to number of science subjects that preservice teachers studied at secondary school and their enrollment in science teaching courses whereas STOE scores do not relate to the same variables.

A Model for the Relationships between Conceptions of Learning Science and Science Teaching Efficacy Beliefs

Pajares (1992) stated that prior experiences of teacher candidates acted as filters and intuitive screens on their teaching behaviors. These prior experiences include teachers' own studentship learning experiences generating their core beliefs (Rokeach, 1968). Preservice teachers learn about the world as a student before they start to teach, so one can possibly expect that variables of learning have a potential to (positively or negatively) predict the variables related to teaching. Moreover, Tsai (2002) explored the relationship among science teachers' beliefs about teaching, learning and nature of science. He argued that teachers' beliefs of learning science were closely related to their beliefs of teaching science. In this regard, we have assumed that PSTs' COLS may predict their science teaching efficacy (see Figure 1).

In order to test our assumption, we have benefited from two sources: Lee's and colleagues' (2008) COLS questionnaire and Enochs' and Riggs' (1990) science teaching efficacy scale. Tsai (2004) has first uncovered COLS of high school students, using a phenomenographic approach. He and his colleagues have then developed questionnaire items representing each conception in a subsequent study (Lee et al., 2008). In this study, Lee et al. (2008) have found six factors based on their exploratory factor analysis (EFA) results: memorizing, testing, calculating and practicing, increase of knowledge, applying and understanding and seeing in a new way. Brief explanations for each conception have been given below:

- Memorizing (M): Learning science includes memorizing definitions, formulae, and laws etc.
- Testing (T): Learning science means being successful in the exams and science tests.
- Calculating and practicing (CP): Learning science is closely related to practicing tutorial problems.

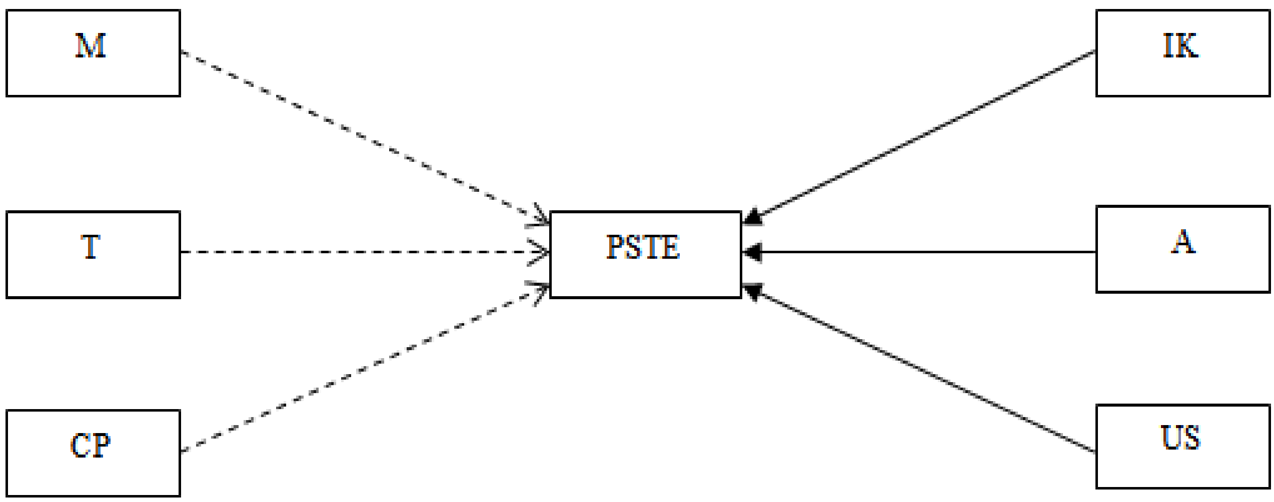

Figure 1. The model of the study. The dotted lines show the negative relationships while the solid lines present the positive ones.

- Increase of knowledge (IK): Learning science means the acquisition and accumulation of scientific knowledge.
- Applying (A): Learning science includes application of acquired scientific knowledge.
- Understanding and seeing in a new way (US): Learning science includes understanding as the major feature of learning science and acquiring scientific knowledge for obtaining a new way to interpret natural phenomena (Lee et al., 2008).

For eliciting science teaching efficacy beliefs, we have utilized a frequently used questionnaire developed by Enochs and Riggs (1990). Certain scholars (Bandura, 2006; Cakiroglu, Capa-Aydin & Woolfolk Hoy, 2012) suggest that PSTE is a sufficient dimension to measure teaching efficacy beliefs since it focus mainly on personal competences. Therefore, we have decided to only use PSTE in the present study.

Tsai and his colleagues (2011) have studied with high school students to explore the relationships among their epistemological beliefs, COLS and self-efficacy of learning science. They have found that absolutist epistemic beliefs have relationships with lower level of conceptions of learning (M, T and CP). In addition, sophisticated epistemic beliefs have predicted higher level of conceptions (IK, A and US). Higher level of COLS has positively related to learning science efficacy beliefs; besides, lower level of COLS have negatively related to learning science efficacy.

Considering the fact that current Turkish PSTs are exposed to constructivist learning environments at college levels, we expect them to develop constructivist COLS such as increase of knowledge, applying and understanding and seeing in a new way. In addition, taking into account the fact that PSTs transfer their conceptions of learning through their teaching approaches (Tsai, 2002), we estimate that they will feel efficient in creating learning environments (science teaching efficacy) that are similar to ones that they have experienced (during their college education). Therefore, bearing Tsai's and his colleagues work (2011) in mind, we assume that lower level of COLS will negatively predict PSTE, whereas higher level of conceptions will positively be related to PSTE. Figure 1 displays these assumptions and estimations.

Research Purpose and Research Questions

The purpose of this study is to investigate relationship between Turkish PSTs' COLS and PSTE. The research questions are:

- What types of COLS do Turkish PSTs have?
- What is the nature of Turkish PSTs' PSTE?
- Are there any relationship between Turkish PSTs' COLS and PSTE?

METHOD

Sample

The sample of the present study included 124 male and 255 female Turkish PSTs, ranging from 21-27 years. We selected participants using convenience sampling procedures (Creswell, 2008). We chose Science Teacher Education departments of seven Turkish universities from different regions of Turkey. Moreover, we purposefully selected last year participants since they had taken many subject matter and pedagogy courses. We believe that their beliefs related to learning and teaching science might be formed more coherently than prior year groups.

The participants of this study will be elementary school science teachers at the end of their education period. In elementary school science teacher education system of Turkey, high school students are placed into universities based on their national exam scores. During their teacher education period, students take subject-matter, general pedagogy and science-specific teaching methodology courses. Additionally, PSTs make school observations and teaching practice during their education. In Turkey, almost all of the universities implement the same curriculum in science teacher education departments.

Instruments

We used two instruments: Conceptions of Learning Science (COLS) questionnaire (Lee et al., 2008) and PSTE dimension of Science Teaching Efficacy Beliefs Instrument Form B (STEBI-B) (Enochs & Riggs, 1990).

Conceptions of learning science (COLS) questionnaire. Original COLS questionnaire includes 31 items with six conception themes. The questionnaire had a five-point Likert mode. Items of the questionnaire were anchored at 1 = strongly disagree, 2 = disagree, 3 = no opinion, 4 = agree, and 5 = strongly agree. We adapted this questionnaire into Turkish by adopting back-translation procedures and conducting exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) (see Bahcivan & Kapucu, 2014). Back-translation procedures have been carried out by a researcher in Turkish Language Department and one another in English language Department. Due to a few minor semantic incongruities, these researchers have slightly changed several items. For example, last item of memorizing "Learning science means memorizing scientific symbols, scientific concepts, and facts" had been back translated into English as "Learning science means memorizing scientific symbols, concepts, and facts". Such incongruities between original and translated items have been resolved. Bahcivan and Kapucu (2014) have provided more details about adaptation of this instrument.

Science teaching efficacy beliefs instrument (STEBI-B). This instrument is made up of two dimensions: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). The former corresponds to PSTs' beliefs about their own teaching abilities whereas the latter refers to PSTs' beliefs about expected outcomes to science teaching. These dimensions include 13 and 10 items respectively. PSTE dimension has been used in the present study. The questionnaire had a five-point Likert mode as COLS. Items of the questionnaire were anchored at 1 = strongly disagree, 2 = disagree, 3 = no opinion, 4 = agree, and 5 = strongly agree.

STEBI-B was previously translated into Turkish by Tekkaya, Cakiroglu and Ozkan (2004). The researchers have validated the instrument and reported the Cronbach alphas as 0.84 and 0.76 respectively for PSTE and STOE dimensions. We have administered the previously translated and validated PSTE items. STOE has not been utilized as a second dimension. Wagler and Wagler (2013) draw attention to improper validation processes in adaptations of STEBI-B. PSTE has been utilized in many research studies (e.g. Bursal, 2010) with Turkish samples and validated with factor analyses as a unique dimension. In this study, we have also conducted CFA on participants' PSTE scores.

Data Collection

We have combined aforementioned two instruments in a unique questionnaire form which is preceded by a cover sheet probing certain personal information such as gender and university name. We have distributed the questionnaires to the PSTs during their regular classrooms. Participants are allowed enough time to response. PSTs have participated in the study voluntarily. Completion of the questionnaires took approximately 20 minutes.

Data Analyses

We have used both descriptive and inferential analyses in the present study. As descriptive analyses we have used mean and standard deviation scores. EFA, CFA and structural equation modeling (SEM) have constituted inferential analyses. These analyses have been conducted on SPSS and AMOS programs. EFA and CFA have been used for validation of Turkish COLS questionnaire. Since STEBI-B has been adapted into Turkish previously only CFA has been performed for adaptation of STEBI-B. In addition, we have used Structural equation modeling (SEM) in examining fit of the proposed model in Figure 1.

RESULTS

Adaptation and Validation of Questionnaires

COLS questionnaire. The data has been divided into two parts. 160 participants have been included in EFA and remaining 219 have been utilized in CFA. Based on the EFA (n=160) results, we have excluded Item 20 and 21 from the dataset since they are loaded on first and second factor which are not consistent with these items structures. All the other items are loaded on the intended factors with a factor loading value larger than 0.40. As a result, six factors have been retained with 29 items in the final version of COLS questionnaire. This factorial structure has explained 63.27 % of variance. Moreover, Cronbach alpha coefficients for the factors are 0.84, 0.81, 0.80, 0.82, 0.79, and 0.90 respectively.

As a second step of validation, we have conducted CFA (n=219) on the first-order model of COLS items. All the factor loadings have presented measurement errors that are smaller than 0.20. A chi-square (χ^2) value for per degree of freedom is 2.78. We have found other fit indices, CFI, GFI, TLI, and RMSEA, as 0.91, 0.87, 0.90, and

0.06 respectively. These fit indices have indicated a reasonable fit and confirmed the structure of COLS questionnaire (Byrne, 2010).

STEBI-B (PSTE) questionnaire. We have conducted CFA (n=379) on first-order model of the PSTE in the STEBI-B items. CFA has resulted that all measurement errors are smaller than 0.20. A chi-square ($\chi 2$) value for per degree of freedom is 1.97. We have found fit indices such as CFI, GFI, TLI, and RMSEA, as 0.92, 0.93, 0.88, and 0.06 respectively. These values of fit indices have pointed out a reasonable fit and verified the structure of the PSTE in the STEBI-B. In addition, the Cronbach alpha coefficient of PSTE is 0.82.

Conceptions of Learning Science

As we mentioned before, we have administered COLS questionnaire to PSTs. Figure 2 shows the mean scores of PSTs in COLS questionnaire.

According to Figure 2, we can argue that PSTs have presented higher levels of COLS. They have considerably agreed the items under the factors such as understanding and seeing in a new way, applying and increase of knowledge. As expected, lower levels of COLS that stems from traditional learning environments are not common

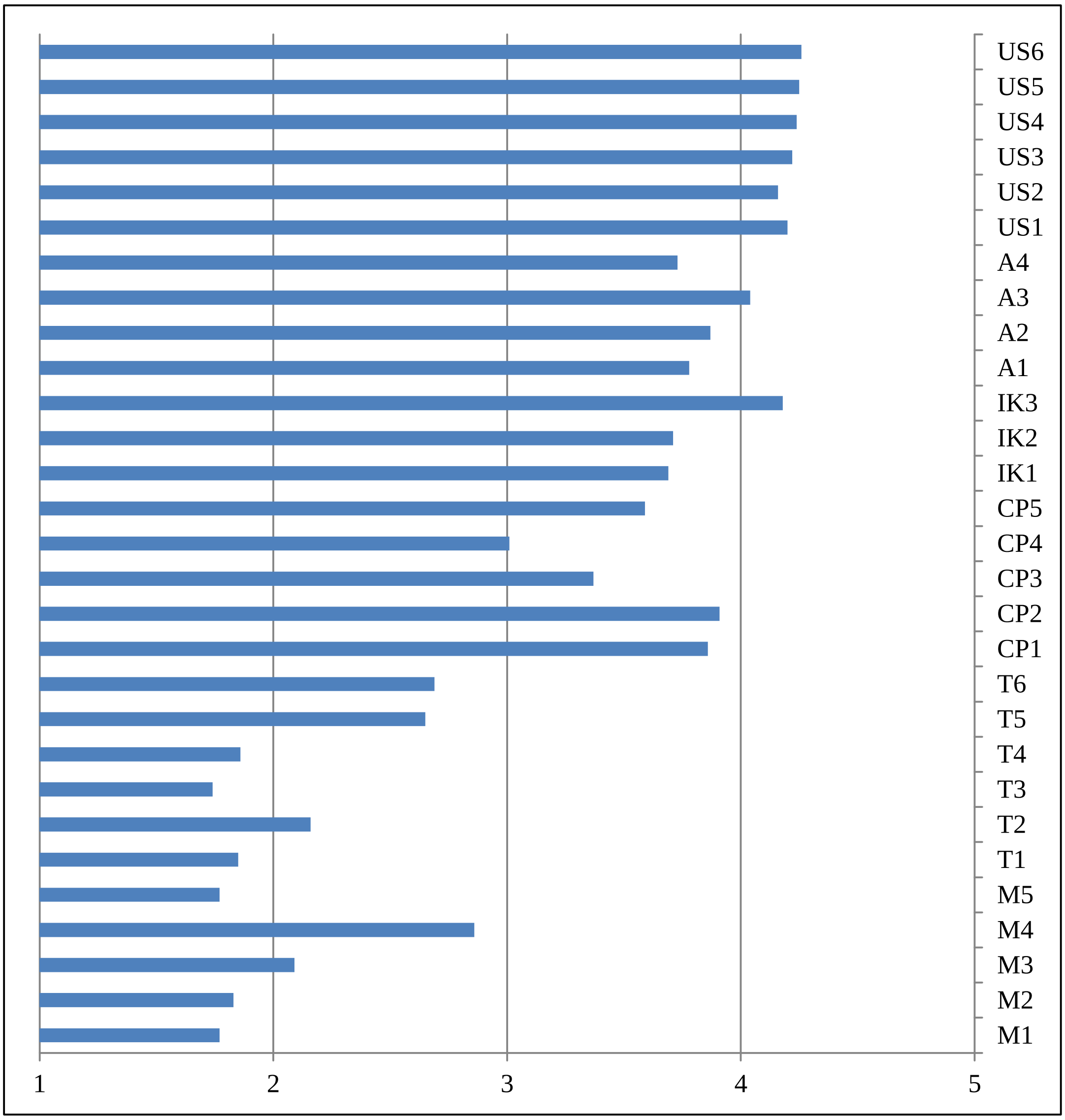

Figure 2. Means diagram showing COLS of PSTs.

among PSTs. However, we can argue that 'calculate and practice', which is a low level of conception, is crucial to certain PSTs considering its score over midpoint (3).

Science Teaching Efficacy Beliefs

In addition to COLS questionnaire, we have administered STEBI-B (PSTE) questionnaire to PSTs. Table 1 presents their mean scores (M), standard deviation of scores (SD), and range of scores (R). Looking at the scores for teaching efficacy items, we can argue that PSTs have possessed moderately high level of science teaching efficacy. In other words, their scores on PSTE items are, in general, over midpoint (3). They believe that they can efficiently teach science in general. Helping students with learning problems, presenting tolerance for students' queries and maintaining classroom experiments are the competences with high scores. Contrarily, the items such as teaching conceptions about science, owning essential skills to teach science and feeling confident during assessments by inspectors have produced low scores.

Table 1 . *PSTs' mean scores, standard deviation of scores, and range of scores*

	Item	M	SD	R
PSTE	When teaching science, I will usually welcome student questions	3,96	0,88	1-5
	I will continually find better ways to teach science	3,88	0,79	1-5
	I will typically be able to answer students' science questions	3,85	0,74	1-5
	I understand science concepts well enough to be effective in teaching elementary science	3,71	0,77	1-5
	I know the steps necessary to teach science concepts effectively	3,69	0,74	1-5
	Given a choice, I will not invite the principal to evaluate my science teaching	2,73	1,20	1-5
	I wonder if I will have the necessary skills to teach science	2,25	0,88	2-5
	I do not know what to do to turn students on to science	2,19	0,96	1-5
	I will find it difficult to explain to students why science experiments work	2,19	0,87	1-5
	When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better	2,01	0,81	1-5
	I will not be very effective in monitoring science experiments	1,96	0,94	1-5
	Even if I try very hard, I will not teach science as well as I will most subjects	1,82	0,86	1-5
	I will generally teach science ineffectively	1,77	0,84	1-5

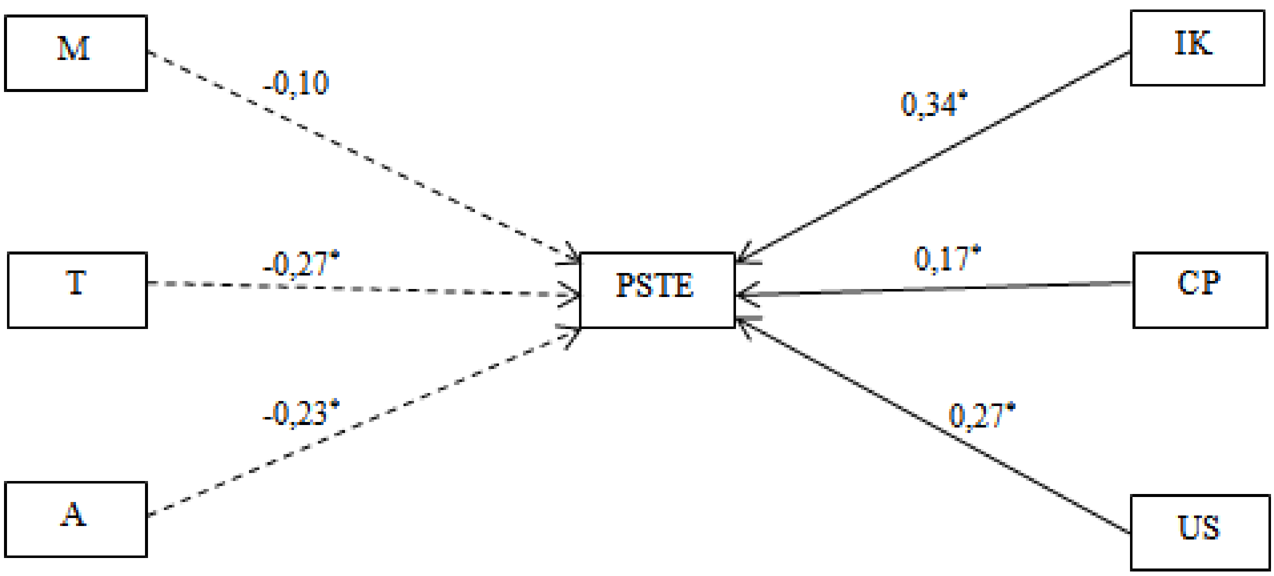

Figure 3. The path coefficients of the structured model (*p<0.05).

Table 2. *Factor loadings (FL), measurement errors (ME) and significance (p) of items in SEM Model*

	Item	FL	ME	p
M	M1	0,84	0,07	< .001
	M2	0,90	0,07	< .001
	M3	0,79	0,08	< .001
	M4	0,40	0,08	< .001
	M5	0,68	-	-
T	T1	0,63	0,07	< .001
	T2	0,54	0,07	< .001
	T3	0,57	0,07	< .001
	T4	0,71	0,07	< .001
	T5	0,66	-	-
	T6	0,71	0,09	< .001
CP	CP1	0,61	0,07	< .001
	CP2	0,65	0,07	< .001
	CP3	0,65	0,09	< .001
	CP4	0,63	0,09	< .001
	CP5	0,71	-	-
IK	IK1	0,64	-	-
	IK2	0,65	0,13	< .001
	IK3	0,67	0,16	< .001
A	A1	0,74	0,15	< .001
	A2	0,90	0,18	< .001
	A3	0,65	0,14	< .001
	A4	0,49	-	-
US	US1	0,71	0,05	< .001
	US2	0,77	0,05	< .001
	US3	0,80	0,05	< .001
	US4	0,82	0,05	< .001
	US5	0,78	0,05	< .001
	US6	0,82	-	-
PSTE	Item1	0,46	-	-
	Item2	0,58	0,18	< .001
	Item3	0,44	0,14	< .001
	Item4	0,64	0,20	< .001
	Item5	0,51	0,17	< .001
	Item6	0,47	0,15	< .001
	Item7	0,55	0,18	< .001
	Item8	0,47	0,14	< .001
	Item9	0,58	0,18	< .001
	Item10	0,48	0,20	< .001
	Item11	0,69	0,19	< .001
	Item12	0,62	0,19	< .001
	Item13	0,55	0,20	< .001

The Relationships between Conceptions of Learning Science and Science Teaching Efficacy Beliefs

We have conducted SEM analysis on the proposed model in Figure 1 to elicit the relationships between COLS and PSTE. Figure 3 displays the structural model with path coefficients and Table 2 presents the factor loadings, measurements errors and significance of item loadings on the model. According to Table 2, all the factor loadings are significant. In addition, the model presented a reasonable model fit (A chi-square for per degree of freedom=2.20, CFI=0.88, GFI=0.83, TLI=0.85, RMSEA=0.05).

Apart from 'memorization', all of the COLS have significantly predicted PSTE. In our estimations, we have assumed that lower level of conceptions will predict teaching efficacy by negative coefficients. In addition, higher levels of conceptions will predict PSTE positively. However, a few results in Figure 3 are opposite to our estimations. For instance, 'calculate and practice' that is a low level of conception has predicted teaching efficacy positively. Furthermore, 'applying', a high level of conception, has negatively predicted teaching efficacy.

DISCUSSION AND IMPLICATIONS

We have investigated COLS of Turkish PSTs, science teaching efficacy beliefs and the relationships between them. We have utilized COLS questionnaire and STEBI-B (the dimension PSTE) questionnaire frequently used by researchers in our study. These questionnaires have presented reasonable reliability and validity scores.

In terms of COLS, the present study has shown that PSTs particularly hold higher levels of COLS. The conceptions such as 'understanding and seeing in a new way', 'increase of knowledge' and 'applying' are crucial for learning science. When it comes to lower level of conceptions, apart from 'calculate and practice', PSTs are less likely to hold these conceptions. This picture signals an intriguing combination in Turkish context. Even though Lee et al. (2008) believe that 'increase of knowledge' is a higher level of conception because it is negatively related to surface learning approaches, we consider that this assumption is limited in our context. In addition, Lee et al. (2008) did not find any significant relationship between deep learning approaches and 'increase of knowledge'. We argue that 'increase of knowledge' is based on a limited epistemological background for learning science. Learning unknown knowledge structures may not give any strong sense about the nature of learning. We thus believe that this conception could be understood in a structured way pinpointing traditional learning approaches. Should we recalibrate our focus with this new perspective, we can argue that Turkish PSTs have developed conceptions of learning based on both traditional and innovative/constructivist classroom environments. Belo, van Driel, van Veen, and Verloop (2014) criticize adaptations of such dichotomies (e.g., traditional vs. constructivist or teacher-centered vs. student-centered) into belief-related studies. According to these scholars, focusing on dichotomies prevent researchers to investigate interrelated nature of teacher beliefs whose goal is to achieve 'appropriate' teaching practice. However, based on the results of this study, we believe that adapting such dichotomies still produce substantial interpretations of (preservice) teachers' beliefs and conceptions. We believe that traditional environments in Turkey produce strong conceptions such as 'calculate and practice' and 'increase of knowledge', whereas certain prominent conceptions such as 'applying' and 'understanding and seeing in a new way' are developed in constructivist environments. In addition, PSTs' learning approaches are not based on 'memorizing' and 'testing' that are other components of traditional learning environments. Perhaps PSTs are exposed to both traditional and constructivist pedagogies during their schooling. Considering many Turkish science teachers struggle to use innovative approaches suggested in curricular reform documents (e.g., Kilinc et al., 2012), perhaps PSTs' teachers at precollege level emphasized calculations and memorization of formulae in science classes. In addition, they may encounter complex learning environments such as group works, project assignments and so on at college level. Teacher educators in pedagogy courses also try to vaccinate constructivist philosophies at theoretical and practical levels in pedagogy courses.

When compared with previous studies investigating Turkish preservice teachers' conceptions of learning science (e.g., Al-Amoush et al., 2013; Al-Amoush et al., 2014) we have found partly consistent results. The probability of holding constructivist conceptions of learning science among Turkish PSTs is higher than the aforementioned studies. In their studies, Al-Amoush et al. (2013) and Al-Amoush et al. (2014) have indicated that Turkish preservice teachers have a tendency to hold constructivist conceptions about education; however, these conceptions have converted into traditional ones when they are asked to focus on chemistry. In this study we have not investigated participants' conceptions of teaching science. Preservice teachers' conceptions of teaching seem to narrowing their conceptions of learning science. Al-Amoush et al. (2013) have already argued that preservice teachers actually hold more learner-centered learning conceptions but their beliefs about practicability of such conceptions in a science learning environment delimit their learning science conceptions. In addition, the differences between research methods (qualitative vs. quantitative), instruments and sample inclusiveness may cause such inconsistencies.

Regarding science teaching efficacy beliefs, our results are consistent with Turkish and international literature. Perhaps because they have positive mastery experiences in science teaching methods courses and teaching practicum in real classrooms as well as they experience science teaching vicariously in same courses (e.g., Kilinc et al., in press), they develop moderately high teaching efficacy beliefs. However, due to the nature of STEBI-B questionnaire, we cannot produce further arguments (Cakiroglu, et al., 2012). STEBI-B includes limited number of items about teaching competences. However, considering that teachers use a range of competences in teaching science, all science teaching efficacy scales include such limitations. We believe that STEBI-B is a strong instrument for eliciting a general belief about confidence to teach science. In addition, the relationships between conceptions of learning and teaching efficacy beliefs may signal *in what direction* PSTs will use their teaching efficacy (creating traditional learning environments vs. designing innovative/constructivist classroom environments).

We have for the first time strived to elicit the relationships between COLS and science teaching efficacy beliefs. Our main assumption is that a teacher teaches science in a way s/he learns it. In addition, we believe that conceptions of learning may work as a core belief under teaching efficacy beliefs (Rokeach, 1968). Therefore, in our SEM model, COLS predict PSTE. The results of SEM analysis confirm our basic assumption. The conceptions such as 'calculation and practice', 'increase of knowledge' and 'understanding and seeing in a new way' have positively predicted PSTE, whereas 'testing' and 'applying' are negative predictors. Perhaps PSTs are exposed to a range of calculations and problem solving practices rather than inquiry-based and/or hands-on environments. They are likely to create such environments in their teaching practices. In addition, they believe that they could learn once their knowledge level enhances by incoming information. We believe that a peer, a member of family and news in the media may work as knowledge-increaser since all of these unplanned sources present unknown knowledge structures to people. In addition, raising awareness about scientific topics is a common goal for science teachers though this goal is frequently used without further reasoning. Therefore, we argue that traditional science classrooms whose members are PSTs may produce such conception as 'increase of knowledge'. As in other knowledge channels such as peers, family members and media, science teachers in these environments prefer only conveying the information without allowing students to make up their own mind. Therefore, we estimate that PSTs are likely to create weak learning environments wherein teachers work as knowledge-conveyer whose main goal is to increase the knowledge of students. When it comes to the relationships between 'understanding and seeing in a new way' and teaching efficacy, we believe that PSTs have a desire to design creative learning environment. However, we feel concerned as to whether they know the components of such environments and pedagogical skills they need to build such environments. In addition, applying is a negative predictor of teaching efficacy. We believe that this result completes the picture above. Perhaps PSTs have not found appropriate opportunities to apply the knowledge in new situations. They are likely to create similar learning environments where scientific knowledge is taught in a structured way without transferring it into new situations. Finally, it is encouraging to see that PSTs are able to understand that learning science does not only mean being successful in science tests.

The participants of this study had been traditionally educated during their elementary and secondary schooling, because the constructivist reforms have been adapted since 2005 in Turkey. Considering most of PSTs have developed certain higher level of conceptions of learning (applying and understanding and seeing in a new way) and are less likely to hold lower level of conceptions (testing and memorizing), it seems that constructivist reform activities in Turkish science education have been successful to some extent. However, there are still signs of traditional teaching applications such as teaching science as calculations and mathematical problem-solving. The question at this point is 'to what extent do PSTs transfer these conceptions of learning to their teaching beliefs and practices?' Perhaps they will not build their courses on memorization and testing. Understanding and seeing in a new way may be a crucial component of their teaching. These three teaching orientations are essential components of constructivist approach that Turkey has tried to infuse for about a decade. However, PSTs are willing to try to increase scientific knowledge of students by a calculation-based lecturing. First implication of the present study may be conceived on this result. Calculation and problem-solving are certain processes of making science; however, science is more than these two aspects. Scholars suggest that science teaching should include inquiry and argumentation since these processes are vital for a complete scientific understanding (Osborne, Erduran & Simon, 2004; Kuhn, 1993). Therefore, for a belief change, inquiry- and argumentation-based learning and teaching environments should be created in science teacher education, so PSTs find opportunities to see that measurements and calculations take a small place in science.

Positive relation of PSTs' 'calculation and practice' related conception on their PSTE scores may be getting its roots from existence of national student placement exams in Turkey. PSTs in the sample seem not to conceptualize learning science as 'testing', but they most probably aware of the positive effect of 'calculation and practice' on students' exam scores. At this point, we offer that policy makers and science educators in Turkey should find out ways to eliminate traditional approaches of students' selections for and placements into schools. Such elimination supplements the previous reforms in school curricula and teacher education system.

In addition, PSTs are not likely to incorporate application of knowledge into new situations though they have developed such learning conception. Perhaps they do not know how to create such learning environments. At this point, another implication may be creating opportunities to develop pedagogical skills about knowledge transfer and application. The relationships between science, technology and society may particularly be emphasized so PSTs experience how to transfer knowledge from its production area to its application field.

Next, we believe that science educators and teacher educators can use conceptions of learning in order to estimate future teachers' teaching pedagogies. Questionnaires and other diagnostic tools can be used to pursue the development of conceptions of learning in order to understand when and how an intervention should be conducted. For instance, if these tools are administered in the beginning of science teacher education, science educators may develop teaching programs and modules in order to enhance higher conceptions and eliminate lower ones. Such interventions may lead to efficient science teaching suggested by curricular reforms in many countries.

Finally, when some researchers' (e.g., Eick & Reed, 2002; Murphy, Delli & Edwards, 2004; Pajares, 1992) ideas concerning belief change is considered, it can be expected that preservice teachers may be influenced by their future colleagues in a negative or positive manner. For example, when they begin to teach as inservice teachers, their colleagues following traditional learning activities can force them to imitate these traditional learning activities. Observing such behaviors can be inevitable for Turkish science teachers because the experienced science teachers in Turkey were not educated with constructivist learning approaches in their primary, elementary and high school years like PSTs of this study. The curricula emphasizing constructivist approaches has been implemented in Turkey for last decade. Therefore, results of this study do not guarantee that PSTs' future implementations will be dominated by their COLS. For the following researchers, we offer to conduct such (especially longitudinal) studies, through this way we ensure about the effect of PSTs' COLS on their classroom practices.

ACKNOWLEDGEMENT

We would like to thank Assoc. Prof. Ahmet Kılınç for his valuable contribution about reviewing the paper and making suggestions.

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Please cite as: Bahcivan, E., & Kapucu, S. (2014). Turkish preservice elementary science teachers' conceptions of learning science and science teaching efficacy beliefs: Is there a relationship? *International Journal of Environmental and Science Education*, 9(4), 429-442. doi: doi: 10.12973/ijese.2014.226a