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Predicting Turkish Preservice Elementary Teachers' Orientations to Teaching Science with Epistemological Beliefs, Learning Conceptions, and Learning Approaches in Science

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The present study investigated to what extent Turkish preservice elementary teachers' orientations to teaching science could be explained by their epistemological beliefs, conceptions of learning, and approaches to learning science. The sample included 157 Turkish preservice elementary teachers. The four instruments used in the study were School Physics Teachers' Conceptions of Teaching (Gao & Watkins, 2002), the Epistemic Belief Inventory (Schraw, Bendixen, & Dunkle, 2002), and the Conceptions of Learning Science and the Approaches to Learning Science questionnaires (Lee, Johanson, & Tsai, 2008). Step-wise multiple regression analyses indicated that the teacher-centered/moulding orientation to teaching science was mostly predicted by unfruitful learning approaches, naïve epistemological beliefs, and traditional learning conceptions in science. On the other hand, the student-centered/cultivating orientation to teaching science was mostly explained by constructivist learning conceptions in science. These findings suggest that epistemological beliefs, learning approaches, and learning conceptions are important factors in the genesis of conceptions of teaching science.

Keywords: epistemological beliefs, elementary preservice teachers, teaching conceptions, learning conceptions, learning approaches

INTRODUCTION

It has been widely recognized that a teacher's classroom teaching is difficult to change. According to Huibregtse, Korthagen, and Wubbels (1994), a modification in

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teachers' behavior requires insight into teachers' view of what constitutes a good teaching (i.e., in its basic form, their conceptions of teaching). Supportively, a large body of research in education has turned their attention to teachers' conceptions of teaching (Hewson & Hewson, 1987; van Beek, de Jong, Wubbels, & Minnaert, 2014). This growing interest in teaching conceptions might be related to the fact that the conceptions of teaching held by teachers might influence their classroom practices (Chen, Brown, Hattie, & Millward, 2012; Hermans, Tondeur, van Braak, & Valcke, 2008; Koballa, Glynn, Upson, & Coleman, 2005; Lotter, Harwood, & Bonner, 2007) and the way their students conceive and approach learning (Tikva, 2010; Kember & Gow, 1994; López-Íñiguez & Pozo, 2014).

Although teachers' conceptions of teaching play a crucial role in improving the quality of education (Gao & Watkins, 2002), much of teachers' conceptions of teaching were inconsistent with a constructivist approach to teaching that many reformers advocate (Prawat, 1992). In this respect, researchers (Hewson & Hewson, 1987; Taylor & Booth, 2015) argued that science teacher education programs should aim to develop appropriate conceptions of teaching, for example, student-centered conceptions. Therefore, this study aimed to investigate teaching conceptions of preservice teachers and uncover some factors that may contribute to the genesis of these conceptions.

Before we proceed, we must clarify what we mean by the terms 'conceptions of teaching' and 'orientations to teaching' and we must situate these terms within a broader context. We conceptualized teaching orientations and teaching conceptions based on the framework of Gao and Watkins (2002). Accordingly, we used teaching orientation when we talked about the term in the broadest sense and we used teaching conceptions when we wanted to refer to the different dimensions that constitute teaching orientations (Gao & Watkins, 2002). Gao and Watkins (2002) formulated teaching conceptions in a multiple level model with two higher-order teaching orientations and five lower level teaching conceptions. In Gao and Watkins' (2002) model, teacher-centered/content-based teaching orientation is labelled as 'mouding orientation' and it includes 'knowledge delivery' and 'exam preparation' teaching conceptions. Student-centered teaching orientation is labelled as 'cultivating orientation' and it includes 'ability development', 'attitude promotion', and 'conduct guidance' teaching conceptions.

Teaching orientations are seen as an important component of Pedagogical Content Knowledge and they are often used synonymously with beliefs and conceptions (Friedrichsen, van Driel, & Abell, 2011). It is clear that there is no clear distinction between teaching conceptions and teaching orientations in the literature. Magnusson et al. (1999) conceptualized Pedagogical Content Knowledge (PCK) as a compilation of five components: orientations to teaching science, knowledge of students' understanding of science, knowledge of curriculum, knowledge of instructional strategies, and knowledge of assessment of scientific literacy. In Magnusson et al. (1999) conceptualization of PCK, orientations to teaching science component influences teaching most compared to other components (Kind, 2016). Magnusson et al. (1999) reported nine possible science teaching orientations: academic rigor, didactic, guided inquiry, inquiry, conceptual change, project-based, discovery, activity-driven, and process. A close reading of definitions of these nine teaching orientations can help one to classify these nine orientations into two major categories: teacher-centered (academic rigor and didactic) and student-centered (guided-inquiry, inquiry, conceptual change, project-based, discovery, process and activity-driven). In this paper, we differentiated between teaching orientations and teaching conceptions. Similar to Gao and Watkins (2002), we used five lower level teaching conceptions to form two higher-order teaching orientations.

A great number of researchers have explored teachers' conceptions of teaching for more than three decades. These researchers followed two main research lines in their investigations. The first line of research was descriptive in nature and dates backs to the study of Fox (1983). For instance, Koballa, Graber, Coleman, and Kemp (2000) conducted a phenomenographic study to explore German pre-servive chemistry teachers' conceptions of teaching. They found that the preservice teachers held three different teaching conceptions: transferring knowledge, problem posing, and interacting with students. In another study, Tsai (2002) has found three different teaching conceptions held by Taiwanese science teachers: traditional, process, and constructivist. Based on his review of empirical studies that attempted to describe teaching conceptions, Kember (1997) proposed a multiple-level categorization model of teaching conceptions, in which there were two broad higher level orientations labelled teacher-centered/ content-orientated and student-centered/ learning-orientated teaching conceptions. In other studies with samples of Turkish preservice or inservice teachers, researchers (e.g., Sahin & Yilmaz, 2011; Al-Amoush, Usak, Erdogan, Markic, & Eilks, 2013) have also labelled conceptions of teaching as traditional vs. constructivist. Therefore, similar to Gao and Watkins (2002), we also believe that it is possible to conceptualize conceptions of teaching as teacher-centered/ content-orientated (also known as *moulding orientation*) vs. student-centered/ learning-orientated (also known as *cultivating orientation*).

In the second line of research, researchers have investigated how teachers' conceptions of teaching were related to their conceptions of learning (Antoniadou & Skoumios, 2013; Boulton-Lewis, Smith, McCrindle, Burnett, & Campbell, 2001; Huibregtse et al., 1994; Koballa et al., 2000; Prosser, Trigwell, & Taylor, 1994), their epistemological beliefs (Aypay, 2010, 2011; Bahcivan, 2014; Chan, 2004; Chan & Elliott, 2004; Cheng, Chan, Tang, & Cheng, 2009; Otting, Zwaal, Tempelaar, & Gijselaers, 2010), and their approaches to learning (Enwistle, McCune, & Hounsell, 2002; Enwistle & Tait, 1990; Huibregtse et al., 1994, Richardson, 2005; Stofflett & Stoddart, 1994). The present study aims to further this line of research by simultaneously examining the relations between teaching conceptions and the other three constructs, namely conceptions of learning, epistemological beliefs, and approaches to learning. In particular, this study investigated to what extent learning conceptions, epistemological beliefs, and learning approaches in science explain the variance in conceptions of teaching science.

LITERATURE REVIEW

The literature review includes three sections. Each section reviews the relevant literature about the relationship between conceptions of teaching and three different constructs: conceptions of learning, epistemological beliefs, and approaches to learning, respectively.

Conceptions of learning and conceptions of teaching

In its basic form, a conception of learning can be considered as one's view of what constitutes a good learning (Lee, Johanson, & Tsai, 2008). Previous research has generally accepted the existence of hierarchical trends of learning conception from the lower level of reproductive view of learning (i.e., learning as acquisition and accumulation of content) to the upper level of constructivist view of learning (i.e., learning as re-organizations of existing knowledge structures) (Tsai, 2004).

Consistent with Tsai (2004), this study also viewed conceptions of learning science as reproductive and constructivist learning conceptions.

A number of studies explored the relationships between conceptions of teaching and conceptions of learning (Antoniadou & Skoumios, 2013; Boulton-Lewis et al., 2001; Huibregtse et al., 1994; Koballa et al., 2000; Prosser et al., 1994). These studies yielded inconsistent results. While some researchers found that teachers' conceptions of teaching and conceptions of learning were aligned others found that teachers' conceptions of teaching and conceptions of learning might not be aligned. For example, Prosser, Trigwell, and Taylor (1994) found that teachers' conceptions of teaching and their conceptions of learning were aligned. They reported that teachers who discussed learning in terms of accumulating more information, perceived teaching as transmitting concepts of the discipline. Unlike Prosser et al. (1994), Huibregtse et al. (1994) found that teachers' conceptions of teaching and learning were incongruent with each other. They reported that several teachers seemed to support the idea that efficient learning was realized when teachers transmit knowledge even if they valued student-centered teaching. Some other researchers (Antoniadou & Skoumios, 2013; Boulton-Lewis et al., 2001; Koballa et al., 2000) obtained mixed results in terms of the relationship between teachers' conceptions of teaching and learning. For instance, Koballa et al. (2000) reported teachers' conceptions of chemistry teaching and learning are mostly congruent, but two teachers have incongruent chemistry teaching and learning conceptions because they viewed learning chemistry as the gaining knowledge from credible sources while viewing teaching of chemistry in terms of teacher's interactions with students. The research cited in this paragraph are based on the data from in-service teachers. In this paper, we are studying the relationship between preservice teachers' conceptions of teaching and conceptions of learning. We are not able to locate studies exploring the relationship between preservice teachers' conceptions of teaching and conceptions of learning. Therefore, this study can help us understand the nature of relationship between preservice teachers' conceptions of teaching and conceptions of learning.

Personal epistemological beliefs and conceptions of teaching

Personal epistemological beliefs refer to one's beliefs regarding the nature of knowledge and learning (Schommer, 1990). Previous studies reported that epistemological beliefs were related to the conceptions of teaching (Aypay, 2010, 2011; Bahcivan, 2014; Chan, 2004; Chan & Elliott, 2004; Cheng et al., 2009; Otting et al., 2010). More specifically, Aypay (2010, 2011) found significant relations among the dimensions of epistemological beliefs and the conceptions of teaching and learning. As preservice teachers questioned the authority or the expert knowledge (sophisticated or well-developed belief in the omniscient authority dimension), believed in the importance of effort in learning (sophisticated belief in the quick learning dimension), and believed in the uncertainty inherent to knowledge (sophisticated belief in the certain knowledge dimension); they adopted more the constructivist conception of teaching and learning (Aypay, 2010, 2011). On the other hand, as preservice teachers believed in certain and absolute knowledge (naïve or less-developed belief in the certain knowledge dimension), innate and fixed ability to learn (naive belief in the innate ability dimension), and interestingly, the importance of effort in learning (sophisticated belief in the quick learning dimension); they were more likely to hold the traditional conception of teaching and learning (Aypay, 2010, 2011).

Chan (2004) and Chan and Elliott (2004) found significant positive relationships between the traditional conception of teaching-learning and three epistemological belief dimensions: innate/fixed ability, authority/expert knowledge, and certainty of knowledge. In other words, teacher education students who agreed with the traditional conception of teaching-learning also agreed that learning capacity is innate or fixed, knowledge is derived from authority or experts and that knowledge is permanent and unchanged. On the other hand, the constructivist conception of teaching-learning was found to be negatively related to the epistemological belief dimension on learning effort/process. In other words, the Hong Kong teacher education students who hold constructivist conceptions are less likely to believe that knowledge is created through hard work and effort spent in drilling (Chan, 2004; Chan & Elliott, 2004).

The aforementioned research studies found significant relationships between four dimensions of epistemological beliefs and conceptions of teaching. These four epistemological beliefs dimensions included omniscient authority (OA), certain knowledge (CK), innate ability (IA), and quick learning (QL). Consistent with these previous studies (Aypay, 2010, 2011; Chan, 2004; Chan & Elliott, 2004; Cheng et al., 2009; Otting et al., 2010), the present study also examined how these four dimensions of epistemological beliefs were related to conception of teaching. All of the studies that are cited in this section conflated conceptions of teaching and conceptions of learning. In this study, we measured these seemingly related constructs separately.

Learning approaches and conceptions of teaching

Learning approaches can be conceived as the ways in which students themselves learn the subject matter (Lee et al., 2008). The previous research on learning approaches has generally expressed two major ways of experiencing learning situations: (a) *deep approaches* including deep motive on learning science (i.e., intrinsic interest) and deep strategy to learn science (i.e., maximize learning), and (b) *surface approaches* including surface motive on learning science (i.e., fear of failure) and surface strategy to learn science (i.e., rote learn) (Lee et al., 2008). Therefore, this study defined learning approaches consisting of two dimensions, deep and surface approaches to learning science.

A number of empirical studies (Enwistle et al., 2002; Enwistle & Tait, 1990; Huibregtse et al., 1994, Richardson, 2005; Stofflett & Stoddart, 1994) showed that conceptions of teaching might be influenced by approaches to learning. For instance, Enwistle and Tait (1990) found that students who adopt deep approaches to learning generally preferred the methods of teaching and assessing which was thought to promote understanding, while those with a surface approach generally preferred an environment which was likely to facilitate rote learning. Similary, Stofflett and Stoddart (1994) indicated that as preservice teachers themselves experienced learning in an active way, they are more likely plan lessons that foster students' active knowledge construction. Richardson (2005) also found strong correlations between students' approaches to studying that they adopt and their perceptions of the academic environment including but not limited to perceptions of good teaching, the provision of good feedback on student work, openness to students, and work load.

Previous studies established a close relationship between teaching conceptions and approaches to learning, teaching conceptions and learning conceptions, and teaching conceptions and epistemological beliefs, separately. Unfortunately, we were not able to locate studies that bring all of these variables in a particular study and evaluate such relations in the science-learning domain. Therefore, this study investigated the following research question: What is the relative contribution of dimensions of epistemological beliefs, learning approaches, and learning conceptions in science to explaining conceptions of teaching science?

METHOD

Sample

The sample of this study was comprised of 157 (110 female and 47 male) preservice elementary teachers at a public university in Turkey. Of these participants, 72 of them were enrolled in the elementary science education program, 77 of them were enrolled in the general elementary education program, and 8 of them did not report their program. The age of participants ranged from 18 to 24 years with a mean age of 21 years. The educational levels included 64 freshmen (41%), 30 sophomore (19%), 31 juniors (20%), and 27 seniors (17%). Five participants (3%) did not report their educational level.

The preservice teachers in the general elementary education program are prepared to teach Turkish, math, social studies, and science in grades 1-4. The preservice teachers in the elementary science education program are prepared to teach only science in grades 5-8. In this study, we wanted to cover full spectrum of elementary grades. Therefore, we purposefully included preservice teachers from both the general elementary education and the elementary science education programs who will teach science at the elementary grades. Preservice teachers in the general elementary education start their classroom practicum course in their sixth semester and preservice teachers in the elementary science education program start their classroom practicum course in their seventh semester at this particular university. Preservice teachers in both programs have their student teaching experience in their last two semesters. Participants were also chosen based on convenience because of the proximity of the University to the third author.

Instruments

We used four instruments in this study: School Physics Teachers' Conceptions of Teaching (SPTCT) questionnaire (Gao & Watkins, 2002), Conceptions of Learning Science (COLS) questionnaire (Lee et al., 2008), Approaches to Learning Science (ALS) questionnaire (Lee et al., 2008), and Epistemic Belief Inventory (EBI) (Schraw, Bendixen, & Dunkle, 2002).

We used three main criteria in selecting the instruments used in the study: (a) the instrument must be validated previously, (b) the instrument should be appropriate to use in the domain of science, and (c) the instrument should be applicable in a non-Western country. Some researchers argued that the influence of culture and subject area on the constructs under investigation should not be overlooked (e.g., Gao & Watkins, 2002; Lee et al., 2008; Tsai, 2004).

School physics teachers' conceptions of teaching (SPTCT) questionnaire

The 37-item SPTCT questionnaire developed by Gao and Watkins (2002) was translated into Turkish to measure the participating preservice teachers' conceptions of teaching. The original SPTCT was developed to measure Chinese science teachers' conceptions of teaching at Kember's (1997) multiple levels. Preservice teachers responded to the items on a 5-point Likert type scale, with gaining high score in a certain category showed stronger agreement in the corresponding category. In this questionnaire, Gao and Watkins (2002) identified five conceptions of teaching and two higher order orientations to teaching. The keywords and phrases describe the nature of teaching in the lower- and higher scales in the SPTCT are presented below with their representative items.

- *Knowledge Delivery* (KD): Teaching as delivering knowledge and skills (e.g., student learning means accepting knowledge from teachers).
- *Exam Preparation* (EP): Teaching as preparing for examinations and drilling students (e.g., you should spend most of your class time in drilling students with exam-type items).
- *Ability Development* (AD): Teaching as facilitating student learning (e.g., the role of a physics teacher is very similar to a tourist guide who leads students in the way of learning).
- *Attitude Promotion* (AP): Teaching as promoting and fostering good learning attitudes such as being active and independent in learning (e.g., I never miss any chance to encourage my students to learn actively).
- *Conduct Guidance* (CG): Teaching as facilitating and guiding good conduct (e.g., I never miss any chance to demonstrate how to be a nice person).
- *Moulding Orientation* (MO): The combination of KD and EP conceptions, which reflect teacher-centered/ content-orientated teaching (i.e., moulding students quantitatively and according to external demands).
- *Cultivating Orientation* (CU): The combination of AD, AP, and CG conceptions, which address student-centered/ learning-orientated teaching (i.e., cultivating students qualitatively).

In this study, we found that two higher order orientations to teaching had a good reliability, with a Cronbach's alpha of .73 for the *moulding orientation* and .85 for the *cultivating orientation* to teaching science.

Conceptions of learning science (COLS) questionnaire

To measure Turkish preservice elementary teachers' conceptions of learning science, we translated the instrument COLS developed by Lee et al. (2008) into Turkish. The original COLS questionnaire was developed based on the theoretical framework of Tsai (2004) to measure high school students' conceptions of learning science in Taiwan. The students rated their degree of agreement on a 5-point Likert type scale, anchored at 1 = strongly disagree, 2 = disagree, 3 = no opinion, 4 = agree, and 5 = strongly agree. Accordingly, students gaining higher scores in a certain category showed stronger agreement with the statements in the category regarding learning science. In their study, Lee et al. (2008) identified six factors in the COLS questionnaire. The descriptions of these six factors with their representative items are presented below.

- *Memorizing* (M): Learning science means memorizing definitions, laws, formulae, and special terms (e.g., learning science means memorizing the important concepts found in a science textbook).
- *Testing* (T): Learning science means being successful in science tests or examinations (e.g., learning science means getting high scores on examinations).
- *Calculate and Practice* (CP): Learning science means doing a series of calculations or practicing tutorial problems (e.g., learning science means knowing how to use the correct formulae when solving problems).
- *Increase of Knowledge* (IK): Learning science means the acquisition and accumulation of scientific knowledge (e.g., learning science helps me acquire more facts about nature).

- *Applying* (A): Learning science means the application of acquired scientific knowledge (e.g., learning science means learning how to apply knowledge and skills I already know to unknown problems).
- *Understanding and Seeing in a new way* (US): Learning science means constructing integrated and theoretically consistent knowledge structures in science and acquiring scientific knowledge for getting a new perspective to interpret natural phenomena (e.g., learning science means understanding the connection between scientific concepts; learning science means finding a better way to view natural phenomena or topics related to nature) (Lee et al., 2008).

In this study, we found that the reliability (Cronbach's alpha) coefficients for the above six factors were 0.74, 0.85, 0.71, 0.70, 0.70, 0.84, respectively; and the overall alpha was 0.89, suggesting that these factors had a good reliability in assessing the preservice teachers' conceptions of learning science.

Approaches to learning science (ALS) questionnaire

To measure the preservice teachers' approaches to learning science, the ALS questionnaire developed by Lee et al. (2008) was translated into Turkish by the researchers. Lee et al. (2008) developed the original 24-item ALS questionnaire by revising Kember, Biggs, and Leung's (2004) domain-general Revised Learning Process Questionnaire to encompass science learning in particular. For each item regarding approaches to learning science, students rated their degree of agreement on a 5-point Likert type scale, ranging from "always" (assigned a score of 5) to "never" (assigned a score of 1). The exploratory and confirmatory factor analyses showed four second-order factors in the ALS questionnaire: deep motive (DM), deep strategy (DS), surface motive (SM), and surface strategy (SS). The descriptions of these four factors with their representative items are presented below.

- *Deep Motive* (DM): Student holds deep motives (e.g., intrinsic interest, commitment to work) on learning science (e.g., I work hard at studying science because I find the material interesting).
- *Deep Strategy* (DS): Student uses deep strategies (e.g., relating ideas, understanding) to learn science (e.g., I try to find the relationship between the contents of what I have learned in science subjects).
- *Surface Motive* (SM): Student holds surface motives (e.g., aim for qualification, fear of failure) on learning science (e.g., I want to get a good achievement in science subject so that I can get a better job in the future).
- *Surface Strategy* (SS): Students uses surface strategies (e.g., minimizing the scope of study, memorization) to learn science (e.g., I see no point in learning science materials that are not likely to be on the examinations) (Lee et al., 2008).

In this study, we found that the reliability (Cronbach's alpha) coefficients for the above four factors were 0.82, 0.80, 0.61, 0.73, respectively. Note that the reliability coefficient of the surface motive factor was lower than 0.70, but the overall alpha was 0.85, suggesting that these factors had a good reliability in assessing the preservice teachers' approaches to learning science.

Epistemic belief inventory (EBI)

Turkish version of the EBI (Cam, Topcu, Sulun, Guven, & Arabacioglu, 2012) was used in this study to assess preservice elementary teachers' epistemological beliefs. The original 28-item EBI (Schraw et al., 2002) measured the five epistemological beliefs dimensions first hypothesized by Schommer (1990): Omniscient Authority, Certain Knowledge, Simple Knowledge, Innate Ability, and Quick Learning. Cam et al. (2012) adapted the 28-item EBI (Schraw et al., 2002) in Turkish context by reducing the number of dimensions and items. The adapted 15-item Turkish EBI taps four dimensions in the original EBI developed by Schraw et al. (2002). The descriptions of these four epistemological beliefs dimensions with their representative items are presented below from a naïve perspective.

- *Omniscient Authority* (OA): The knowledge is derived from authority (e.g., when someone in authority tells me what to do, I usually do it).
- *Certain Knowledge* (CK): The knowledge is certain (e.g., what is true today will be true tomorrow).
- *Innate Ability* (IA): The ability to learn is fixed at birth (e.g., some people just have a knack for learning and others don't).
- *Quick Learning* (QL): The acquisition of knowledge is quick or not at all (e.g., if you don't learn something quickly, you won't ever learn it).

The participants responded to each item on a 5-point Likert type scale, ranging from "strongly disagree" (=1) to "strongly agree" (=5). Accordingly, participants gaining a high score in a certain epistemological beliefs dimension hold a naïve epistemological belief in the corresponding dimension.

In this study, Cronbach's alpha reliability estimates for the OA, CK, IA, and QL epistemological belief dimensions were .39, .48, .67, and .57, respectively. Although these reliability estimates were less than optimal, they were typical of reliability estimates reported in psychometric studies of epistemological beliefs (Bath & Smith, 2009; Cam et al., 2012; Schommer, 1990; Schraw et al., 2002; Topcu, 2011; Yilmaz-Tuzun & Topcu, 2008).

DATA COLLECTION

Data collection was carried out at a public university in Turkey. After explaining the aim of the study briefly, the third author distributed the study questionnaires to the participants in their designated classrooms. The questionnaire were administered during class time and lasted about one and a half hour. After preservice teachers answered some demographic questions such as their program, age, and gender, they completed conceptions of teaching science (SPTCT), epistemological beliefs (EBI), conceptions of learning science (COLS), and approaches to learning science (ALS) questionnaires, respectively. Participation in this study was voluntary.

Data analysis

In the first part of data analysis, lower- and higher-order scale means of each questionnaire were calculated for every participant to be used for descriptive statistics and then multiple regressions. In the second part of data analysis, multiple regression analysis was conducted to better understand how the predictor variables (dimensions of epistemological beliefs, conceptions of learning science, and approaches to learning science) (See Table 1) might be associated with each orientation to teaching science (*moulding* and *cultivating*). To determine the best model, we used statistical stepwise regression strategy, in which a regression analysis is initiated with no variable, and each predictor variable is added to the equation one at a time to determine whether the predictor variable significantly contributes to the model (Tabachnick & Fidel, 2001).

RESULTS

The results of this study are presented in two parts. The first part included the analysis of descriptive statistics for the study variables. The second part presents the analysis of the two stepwise multiple regressions to explain how accurately the orientations to teaching science can be predicted from the dimensions of conceptions of learning science, approaches to learning science, and epistemological beliefs.

Table 1. The study variables

Teaching Orientations	Learning Conceptions	Epistemological Beliefs	Learning Approaches
Moulding (MO)	Memorizing (M)	Omniscient Authority (OA)	Deep Motive (DM)
Cultivating (CU)	Testing (T)	Certain Knowledge (CK)	Deep Strategy (DS)
	Calculate and Practice (CP)	Innate Ability (IA)	Surface Motive (SM)
	Increase of Knowledge (IK)	Quick Learning (QL)	Surface Strategy (SS)
	Applying (A)		
	Understanding & Seeing in a new way (US)		

The analysis of the descriptive statistics

Dependent variables

The *moulding* and *cultivating* orientations to teaching science, which comprised different conceptions of teaching science, were the dependent variables in this study. Therefore, we calculated means, standard deviations, and Cronbach's coefficient alphas for both five conceptions of teaching and two higher order orientations as seen in Table 2. Given that the mean score of each teaching orientation and its comprising conceptions was greater than 3.40, we can conclude that preservice elementary teachers on average responded positively both student- and teacher-centered conceptions of teaching science. However, they showed more support towards student-centered conceptions of teaching science because the mean scores of the three teaching conceptions comprising the *cultivating* teaching orientation (i.e., ability development, attitude promotion, and conduct guidance) were higher than the other two teaching conceptions comprising the *moulding orientation* to teaching science (i.e., knowledge delivery and exam preparation). Supportively, the analysis of the frequency distributions showed that more than 43 percent of the preservice teachers supported the *cultivating orientation* (45.2 %) and its three comprising conceptions (49 % for the AD, 65.4 % for the AP, and 43.2 % for the CG) in contrary to the *moulding orientation* to teaching science, which was supported by only 12.3 % of the preservice teachers.

Independent variables

Learning conceptions, learning approaches, and epistemological beliefs were the independent variables in this study. Means, standard deviations, and Cronbach's coefficient alphas for the scales of these variables are presented in Table 3.

Inspection of the means for the learning conceptions indicated that participants in this study overall supported the constructivist-orientated learning conceptions. Among 141 participants, 66.3% defined learning science as understanding and seeing in a new way, while only 10.6% viewed learning science as memorizing definitions, laws, formulae, and special terms. Examination of the means for the learning approaches revealed that the study participants overall reported that they more often use deep strategies such as relating ideas and understanding than surface strategies such as minimizing the scope of study and memorization to learn science.

Table 2. The descriptive statistics and Cronbach's Coefficient Alphas for the two teaching orientations and their comprising conceptions

Teaching Orientations and Conceptions	*N*	*Minimum*	*Maximum*	*M*	*SD*	*Alpha*
Moulding Orientation	155	2.50	4.59	3.49	0.47	.73*
Knowledge Delivery	155	2.00	4.50	3.40	0.54	.49***
Exam Preparation	155	2.30	4.80	3.58	0.52	.63***
Cultivating Orientation	155	2.44	4.93	3.87	0.47	.85*
Ability Development	155	2.14	5.00	3.85	0.52	.62***
Attitude Promotion	153	2.57	5.00	4.05	0.60	.78**
Conduct Guidance	155	2.20	4.80	3.71	0.52	.43***

* The Cronbach's alpha coefficients for the two higher-order orientations to teaching were acceptable.
** The Cronbach's alpha coefficient for the lower-order orientation to teaching was acceptable.
*** The Cronbach's alpha coefficients for the lower-order conceptions of teaching were low, but they were not included in the multiple regression models.

The number of participants who generally used deep strategies to learn science (39.1%) was almost four times greater than those who employed surface learning strategies in science (9.8%). Analysis of the means for the epistemological beliefs showed that participants in this study believed more in omniscient authority. For the epistemological beliefs dimensions of the quick learning, certain knowledge, and innate ability, more than half of the participants showed an overall disagreement (69.4%, 58%, and 50.3%, respectively). On the other hand, for the epistemological belief dimension of the omniscient authority, only 35.7 % of the participants reported their overall disagreement.

The analysis of multiple regressions

Stepwise multiple regressions were used to predict preservice elementary teachers' teaching orientations from their learning conceptions, learning approaches, and epistemological beliefs. In this analysis, the mean score of items for each conception of learning science (M, T, CP, IK, A, and US), approach to learning science (DM, DS, SM, and SS), and dimension of epistemological beliefs in science (OA, CK, QL, and IA) were used as a predictor, while the mean score of items for each orientation to teaching science (*moulding* and *cultivating*) as a criterion. Therefore, we conducted two stepwise multiple regressions in this study.

Before performing the two stepwise multiple regressions, the assumptions of multiple regression were checked. First, we checked the sample size. According to Green (1991), the simplest rules-of-thumb are $N \geq 50 + 8m$ (where N is the minimum ratio of number of subjects and m is the number of independent variables) for testing the multiple correlation and $N \geq 104 + m$ for testing the partial correlation. Given that there were 16 independent variables in this study and Green's (1991) rule-of-thumb for the multiple correlation overestimates the required sample when $m \geq 7$, we can think that this study with 157 subjects had enough data to provide reliable correlation estimates. Second, we checked the linearity assumption. The scatter plots showed that each relationship between the independent and dependent variables were linear. Third, we checked the normality assumption. The Q-Q-Plots indicated that all variables were normal. Fourth, we checked the multicollinearity through the correlation matrix, tolerance, and variance inflation factor (VIF). In the correlation matrix, Pearson's bivariate correlation coefficients among all independent variables were smaller than .08. The tolerance of all independent variables was above .40 while VIFs for all independent variables were below 3. The analysis of these three key criteria indicated

Table 3. The descriptive statistics and Cronbach's Coefficient Alphas for the independent variables

Independent Variables	N	Minimum	Maximum	M	SD	Alpha
Learning Conceptions						
Memorizing	141	1.00	5.00	2.57	1.01	.74*
Testing	141	1.00	5.00	2.54	0.97	.85*
Calculate and Practice	141	1.00	5.00	3.09	0.84	.71*
Increase of Knowledge	141	1.00	5.00	3.65	0.74	.70*
Applying	141	1.00	5.00	3.66	0.78	.70*
Understanding & Seeing in a new way	141	1.00	5.00	3.81	0.79	.84*
Learning Approaches						
Deep Motive	133	1.00	5.00	3.39	0.77	.82*
Deep Strategy	133	1.00	5.00	3.61	0.77	.80*
Surface Motive	133	1.00	4.80	3.18	0.77	.61**
Surface Strategy	133	1.00	4.80	2.77	0.87	.73*
Epistemological Beliefs						
Omniscient Authority	157	1.00	5.00	3.03	0.93	.39***
Certain Knowledge	157	1.00	4.75	2.80	0.73	.48***
Innate Ability	157	1.00	5.00	2.89	0.75	.67***
Quick Learning	157	1.00	4.67	2.52	0.85	.57***

* The Cronbach's alpha coefficients for the independent variable scales were acceptable.
** The Cronbach's alpha coefficient for the independent variable scale was a little low. Findings for the relevant scale should be interpreted with caution.
*** The Cronbach's alpha coefficients for the independent variable scales were low, but typical in the corresponding literature.

the absence of the multicollinearity. Fifth, we checked the homoscedasticity assumption. The scatterplots of the residuals (ZRESID) and predicted values (ZPRED) showed that the variance of the residuals was the same for all predicted scores. Finally, we tested the assumption of the independence of errors with the Durbin-Watson test. Since Durbin-Watson's d values were between 1.5 and 2.5 for the two multiple regression models, we have enough evidence that there were no auto-correlation in the data.

After ensuring the assumptions of sample size, linearity, normality, multicollinearity, homoscedasticity, and independence of errors were met, two stepwise multiple regressions were conducted and presented in the following two sections.

The multiple regression for the moulding orientation to teaching science

The correlations among the *moulding* orientation to teaching science, conceptions of learning science (memorizing, testing, calculate and practice, increase of knowledge, applying, and understanding and seeing in a new way), approaches to learn science (deep motive, deep strategy, surface motive, and surface strategy), and epistemological beliefs (omniscient authority, certain knowledge, innate ability, and quick learning) are presented in Table 4. As expected, the correlational analysis indicated that the *moulding* teaching orientation was significantly correlated with the conceptions of learning science, approaches to learn science, and epistemological beliefs. Some exceptions were the correlations among the *moulding* teaching orientation and applying learning conception and innate ability and quick learning epistemological beliefs.

A step-wise multiple regression was conducted to examine how accurately the conceptions of learning science, approaches to learn science, and epistemological beliefs predict the *moulding* orientation to teaching science. Table 5 shows unstandardized coefficients for the regression equation predicting preservice teachers' *moulding* orientation to teaching science. The multiple-regression analysis revealed that the calculate and practice scale (β = .30, $t(129)$ = 3.23, p < .01), omniscient authority scale (β = .18, $t(129)$ = 2.36, p < .05), and surface motive scale (β = .21, $t(129)$ = 2.24, p < .05) significantly contributed to the model. This model explained 26.6 % of the variability in the *moulding* orientation to teaching science, $F(3,129)$ = 16.94, p < .001. This finding indicated that as preservice teachers believed that source of scientific knowledge was omniscient authority, employed surface motives in learning science, and defined learning science as doing a series of calculations or practicing tutorial problems rather than memorizing definitions, formulas, and facts, they would be more likely to support the *moulding* orientation to teaching science.

The multiple regression for the cultivating orientation of teaching science

The correlations among the *cultivating orientation* to teaching science, conceptions of learning science (memorizing, testing, calculate and practice, increase of knowledge, applying, and understanding and seeing in a new way), approaches to learn science (deep motive, deep strategy, surface motive, and surface strategy), and epistemological beliefs (omniscient authority, certain knowledge, innate ability, and quick learning) are presented in Table 6. The correlation analysis revealed that the *cultivating orientation* to teaching science was significantly correlated with all conceptions of learning science and approaches to learn science. However, it was not significantly correlated with any of the epistemological beliefs.

The multiple regression analysis showed that only three conceptions of learning science were significant predictors of the model for the *cultivating orientation* to teaching science. Table 5 also shows unstandardized coefficients for the regression equation predicting preservice teachers' *cultivating orientation* to teaching science. The understanding and seeing scale (β = .47, $t(129)$ = 6.54, p < .001), memorizing scale (β = -.42, $t(129)$ = -4.79, p < .001), and calculate and practice scale (β = .34, $t(129)$ = 3.72, p < .001) together explained 43.3 % of the variance in the *cultivating* teaching orientation, $F(3,129)$ = 34.60, p< .001. This finding showed that preservice teachers would be more likely to support the *cultivating orientation* to teaching science when they viewed learning science as understanding and seeing natural phenomena in a new way and doing a series of calculations or practicing tutorial problems rather than memorizing definitions, laws, formulae, and special terms.

DISCUSSION AND IMPLICATIONS

The present study investigated to what extent Turkish preservice elementary teachers' orientations to teaching science could be explained by their epistemological beliefs, conceptions of learning, and approaches to learning science. Descriptive statistics showed that most of the preservice teachers seemed to respond positively to all categories of conceptions of teaching science. In other words, they supported not only student-orientated, but also teacher-orientated conceptions of teaching science. These findings are not unique to our study. Gao and Watkins (2002) also concluded that a teacher might have more than one or even conflicting conceptions of teaching. This study did not focus on exploring why preservice teachers had multiple conceptions of teaching science.

Table 4. Correlation matrix among the moulding orientation to teaching science, conceptions of learning science, approaches to learn science, and epistemological beliefs (N = 133)

Variable	MO	M	T	CP	IK	A	US	DM	DS	SM	SS	OA	CK	IA	QL
Moulding (MO)	-	.18**	.26**	.47*	.25**	.14	.26**	.24**	.21**	.43*	.25**	.30*	.23**	.14	.08
Memorizing (M)		-	.76*	.62*	.01	.01	.07	.15**	.06	.45*	.65*	.22**	.39*	.19**	.30*
Testing (T)			-	.71*	.02	-.03	-.05	.17**	.09	.56*	.70*	.29*	.42*	.31*	.37*
Calculate & Practice (CP)				-	.35*	.22**	.26**	.36*	.31*	.59*	.54*	.22**	.27**	.17**	.22**
Increase of Knowledge (IK)					-	.72*	.78*	.55*	.65*	.32*	-.04	.06	.02	-.13	-.05
Applying (A)						-	.79*	.55*	.66*	.28*	-.04	.10	.03	-.09	-.13
Understanding & Seeing in a new way (US)							-	.66*	.74*	.33*	-.11	.13	.01	-.16**	-.17**
Deep Motive (DM)								-	.72*	.41*	.08	.08	.16**	-.09	.01
Deep Strategy (DS)									-	.38*	-.01	.06	.08	-.12	-.08
Surface Motive (SM)										-	.45*	.23**	.28**	.06	.24**
Surface Strategy (SS)											-	.16**	.42*	.35*	.41*
Omniscient Authority (OA)												-	.38*	.22**	.08
Certain Knowledge (CK)													-	.34*	.47*
Innate Ability (IA)														-	.48*
Quick Learning (QL)															-

Note. *p < .001. **p < .05

Table 5. Summary of regression models with step-wise selection to predict the moulding and cultivating orientations to teaching science

Variable	B	*SE* B	Adjusted R^2
Regression Model for *Moulding*			.266
(Constant)	(2.28)	(.18)	
Calculate & Practice	.17	.05	
Omniscient Authority	.09	.04	
Surface Motive	.13	.06	
Regression Model for *Cultivating*			.433
(Constant)	(2.76)	(.17)	
Understanding & Seeing in a new way	.27	.04	
Memorizing	-.19	.04	
Calculate & Practice	.19	.05	

Note. B = Unstandardized regression coefficients.

However, this multiple conceptions of teaching science could be explained by teachers' having an 'espoused theory' and a 'theory-in-use' (Argyris & Schon, 1978; Argyris, Putnam, & McLain Smith, 1985; Jones, 2009; Li, Leung, & Kember, 2001) or by teachers' holding an 'ideal conception' and a 'working conception' (Samuelowicz & Bain, 1992). This suggests that teachers' stated conceptions of teaching science might be different from their actual conceptions.

We expected that preservice teachers' *moulding orientation* to teaching science would be explained by their epistemological beliefs, learning conceptions, and learning approaches. Among the four epistemological beliefs dimensions, two epistemological dimensions (omniscient authority and certain knowledge) were significantly and positively correlated with the *moulding orientation*. However, only omniscient authority made a significant contribution in explaining the *moulding orientation*. This positive correlation was in line with our initial expectation because underlying assumption of the *moulding orientation* is that authority figures such as teachers are in a position to shape students' learning. Consistent with Chan (2004) and Chan and Elliott (2004), our findings suggested that preservice teachers who believed that knowledge is derived from authority were more likely to hold *moulding orientation* to teaching science (teacher-centered/ content-orientated conceptions of teaching science).

In addition to omniscient authority, calculate and practice dimension of learning conceptions made a significant contribution in predicting the *moulding orientation* to teaching science. Preservice teachers who conceived learning science as doing a series of calculations or practicing tutorial problems were more likely to hold *moulding orientation* to teaching science. Memorizing dimension was also significantly and positively correlated with the *moulding orientation* to teaching science, but we did not include the memorizing learning conceptions in the regression analysis because the correlation between calculate and practice dimension and memorizing was high (.62).

Surface motive was the only dimension of approaches to learning science that made a significant contribution in explaining the *moulding orientation* to teaching science. Consistent with our expectation, we found that preservice teachers who were motivated to learn science for the sake of getting good grades or avoiding failure tended to adopt *moulding orientation*. Our findings seemed to support Enwistle and Tait (1990) who found that students with a surface approach to learning generally preferred an environment, which was likely to facilitate rote learning.

Table 6. Correlation Matrix among the Cultivating Orientation to Teaching Science, Conceptions of Learning Science, Approaches to Learn Science, and Epistemological Beliefs (N = 133)

Variable	CU	M	T	CP	IK	A	US	DM	DS	SM	SS	OA	CK	IA	QL
Cultivating (CU)	-	-.25**	-.17**	.20**	.50*	.47*	.59*	.43*	.46*	.19**	-.17**	.09	-.01	-.07	-.11
Memorizing (M)		-	.76*	.62*	.01	.01	-.07	.15**	.06	.45*	.65*	.22**	.39*	.19**	.30*
Testing (T)			-	.71*	.02	-.03	-.05	.17**	.09	.56*	.70*	.29*	.42*	.31*	.37*
Calculate & Practice (CP)				-	.35*	.22**	.26**	.36*	.31*	.59*	.54*	.22**	.27**	.17**	.22**
Increase of Knowledge (IK)					-	.72*	.78*	.55*	.65*	.32*	-.04	.06	.02	-.13	-.05
Applying (A)						-	.79*	.55*	.66*	.28*	-.04	.10	.03	-.09	-.13
Understanding & Seeing in a new way (US)							-	.66*	.74*	.33*	-.11	.13	.01	-.16**	-.17**
Deep Motive (DM)								-	.72*	.41*	.08	.08	.16**	-.09	.01
Deep Strategy (DS)									-	.38*	-.01	.06	.08	-.12	-.08
Surface Motive (SM)										-	.45*	.23**	.28**	.06	.24**
Surface Strategy (SS)											-	.16**	.42*	.35*	.41*
Omniscient Authority (OA)												-	.34*	.22**	.08
Certain Knowledge (CK)													-	.34*	.47*
Innate Ability (IA)														-	.48*
Quick Learning (QL)															-

Note. *p < .001. **p < .05.

We expected that preservice teachers' *cultivating orientation* to teaching science would be explained by their epistemological beliefs, learning conceptions, and learning approaches. However, only three dimensions of learning conceptions made a significant contribution in explaining the *cultivating orientation* to teaching science. As expected, the memorizing dimension of learning conceptions was negatively correlated, while the understanding and seeing dimension of learning conceptions was positively correlated with the *cultivating orientation* to teaching. We found that preservice teachers who believed learning science means memorizing definitions, laws, formulae, and special terms were less likely to gravitate towards *cultivating orientation* to teaching science. *Cultivating orientation* to teaching science is aligned with student-centered constructivist teaching principles. In the *cultivating orientation*, students are expected to construct their own knowledge with appropriate support from their teachers. In this respect, underlying assumptions of the memorizing learning conception and the *cultivating orientation* are not congruent with each other. We also found that preservice teachers who believed that learning science means constructing integrated and theoretically consistent knowledge structures in science and acquiring scientific knowledge for getting a new perspective to interpret natural phenomena were more likely to hold *cultivating orientation* to teaching science.

Contrary to our expectation, the calculate and practice dimension of learning conceptions was positively correlated with the *cultivating orientation* to teaching science. This means that preservice teachers who conceived learning science as doing a series of calculations or practicing tutorial problems were more likely to hold *cultivating orientation* to teaching science. This unexpected finding can be explained by certain contextual factors specific to Turkey. Even though Turkey has attempted to adopt constructivist curricula since 2005 (Kiroglu, 2008), the national high-stakes exams continued to determine the enacted curriculum. Student success in high-stakes exams in Turkey is heavily dependent upon practice and drill study approaches through which students answer multiple-choice exam questions in a limited amount of time. Therefore, Turkish preservice teachers regardless of their orientation to teaching science (*moulding* or *cultivating*) might perceive the calculate and practice dimension of learning conceptions positively. If the current assessment of student achievement via high-stakes exams continue, preservice teachers might have to compromise their constructivist teaching and learning conceptions that they developed in teacher education programs.

Overall, we can conclude that teacher-centered conceptions of teaching science were explained by unfruitful learning approaches, naïve epistemological beliefs, and traditional learning conceptions in science. On the other hand, student-centered conceptions of teaching science were mostly explained by conceptions of learning science, especially constructivist learning conceptions. These findings suggest that epistemological beliefs, learning approaches, and learning conceptions are important factors in the genesis of conceptions of teaching science. Given that teachers' inappropriate conceptions of teaching can be altered through a teacher education program (Hewson, Kerby, & Cook, 1995) or a professional development program (Calkins, Johnson, & Light, 2012), this study has implications for teacher educators in the design and development of teacher education programs. Teacher education programs should aim to develop sophisticated epistemological beliefs in preservice teachers by fostering learning through analysis and reflection rather than promoting blind adherence to the authority of the teacher and textbook. In addition, teacher education programs have to take their students' prior learning conceptions and approaches into consideration when providing instruction and student teaching experiences organized around contemporary constructivist teaching and learning models. Given that research on teaching conceptions has primarily been conducted in Western countries (Lingbiao & Watkins, 2001), this study which investigated the factors associated with teaching conceptions in a non-Western country makes a further contribution to our understanding of teachers' conceptions of science teaching and, thereby, inform us of how to improve existing pedagogical practices.

Limitations of the study

Every study has some limitations. There are four main limitations in our study. First, the data were obtained from preservice elementary teachers enrolled in one university located in southwest region of Turkey. Therefore, our findings may not be generalized to all preservice elementary teachers in Turkey. Second, reliability coefficients for some dimensions of epistemological beliefs and learning approaches were relatively low compared to dimensions of learning conceptions and orientations to teaching science that are used in the regression analysis. If we had higher reliability coefficients we would have more explanatory power in the regression analysis. Third, our findings are based on quantitative analysis of self-reported data. Future studies that employ mixed methods might provide further insights about the relationships among orientation to teaching, epistemological beliefs, conceptions of learning, and approaches to learning. Fourth, even though we reported reliability and validity information for the instruments used in this study they were all translated instruments.

REFERENCES

Al-Amoush, S., Usak, M., Erdogan, M., Markic, S., & Eilks, I. (2013). Pre-service and in-service teachers' beliefs about teaching and learning chemistry in Turkey. *European Journal of Teacher Education*, *36*(4), 464-479.

Antoniadou, P. & Skoumios, G. M. (2013). Primary teachers' conceptions about science teaching and learning. *The International Journal of Science in Society*, *4*, 69-82.

Argyris, C., Putnam, R., & McLain Smith, D. (1985). *Action science*. San Francisco: Jossey-Bass.

Argyris, C. & Schon, D. (1978). *Organisational learning: A theory-of-action perspective*. Reading, Massachusetts: Addison-Wesley.

Aypay, A. (2010). Teacher education student's epistemological beliefs and their conceptions about teaching and learning. *Procedia-Social and Behavioral Sciences*, *2*(2), 2599-2604.

Aypay, A. (2011). The adaptation of the teaching-learning conceptions questionnaire and its relationships with epistemological beliefs. *Educational Sciences: Theory and Practice*, *11*(1), 21-29.

Bahcivan, E. (2014). Examining relationships among Turkish preservice science teachers' conceptions of teaching and learning, scientific epistemological beliefs and science teaching efficacy beliefs. *Journal of Baltic Science Education*, *13*(6), 870-882.

Bath, D. M. & Smith, C. D. (2009). The relationship between epistemological beliefs and the propensity for lifelong learning. *Studies in Continuing Education*, *31*(2), 173-189.

Boulton-Lewis, G. M., Smith, D. J. H., McCrindle, A. R., Burnett, P. C., & Campbell, K. J. (2001). Secondary teachers' conceptions of teaching and learning. *Learning and Instruction*, *11*(1), 35-51.

Calkins, S., Johnson, N., & Light, G. (2012). Changing conceptions of teaching in medical faculty. *Medical Teacher*, *34*(11), 902-906.

Cam, A., Topcu, M. S., Sulun, Y., Guven, G., & Arabacioglu, S. (2012). Translation and validation of the Epistemic Belief Inventory with Turkish pre-service teachers. *Educational Research and Evaluation*, *18*(5), 441-458.

Chan, K. W. (2004). Preservice teachers' epistemological beliefs and conceptions about teaching and learning: Cultural implications for research in teacher education. *Australian Journal of Teacher Education*, *29*(1), 1-13.

Chan, K.W. & Elliott, R.G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education, 20,* 817-831.

Chen, J., Brown, G. T. L., Hattie, J. A. C., & Millward, P. (2012). Teachers' conceptions of excellent teaching and its relationships to self-reported teaching practices. *Teaching and Teacher Education*, *28*(7), 936-947.

Cheng, M. M., Chan, K. W., Tang, S. Y., & Cheng, A. Y. (2009). Pre-service teacher education students' epistemological beliefs and their conceptions of teaching. *Teaching and Teacher Education*, *25*(2), 319-327.

Entwistle, N., McCune, V., & Hounsell, J. (2002). *Approaches to studying and perceptions of university teaching-learning environments: Concepts, measures and preliminary findings* (Occasional Report1). Retrieved from Enhancing Teaching and Learning Environments in Undergraduate Courses Project website: http://www.ed.ac.uk/etl

Entwistle, N. & Tait, H. (1990). Approaches to learning, evaluations of teaching, and preferences for contrasting academic environments. *Higher Education*, *19*(2), 169-194.

Fox, D. (1983). Personal theories of teaching. *Studies in Higher Education*, *8*(2),151-163.

Friedrichsen, P., van Driel, J. H., & Abell, S. K. (2011). Taking a closer look at science teaching orientations. *Science Education*, *95*(2), 358-376.

Gao, L. & Watkins, D. A. (2002). Conceptions of teaching held by school science teachers in P.R. China: Identification and cross-cultural comparisons. *International Journal of Science Education*, *24*(1), 61-79.

Green, S. B. (1991). How many subjects does it take to do a regression analysis. *Multivariate Behavioral Research*, *26*(3), 499-510.

Hermans, R., Tondeur, J., van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers & Education*, *51*(4), 1499-1509.

Hewson, P. W. & Hewson, M. G. (1987). Science teachers' conceptions of teaching: Implications for teacher education. *International Journal of Science Education*, *9*(4), 425-440.

Hewson, P. W., Kerby, H.W., & Cook, P. A. (1995). Determining the conceptions of teaching science held by experienced high school science teachers. *Journal of Research in Science Teaching*, *32*(5), 503-520.

Huibregtse, I, Korthagen, F., & Wubbels, T. (1994). Physics teachers' conceptions of learning, teaching and professional development. *International Journal of Science Education*, *16*(5), 539-561.

Jones, A. (2009). Generic attributes as espoused theory: The importance of context. *Higher Education*, *58*(2), 175-191.

Kember, D. (1997). A reconceptualisation of the research into university academics' conceptions of teaching. *Learning and Instruction*, *7*(3), 255-275.

Kember, D., Biggs, J., & Leung, D. Y. P. (2004). Examining the multidimensionality of approaches to learning through the development of a revised version of the Learning Process Questionnaire. *British Journal of Educational Psychology*, *74*, 261-280.

Kember, D. & Gow, L. (1994). Orientations to teaching and their effect on the quality of student learning. *The Journal of Higher Education*, 65(1), 58-74.

Kind, V. (2016). Preservice science teachers' science teaching orientations and beliefs about science. *Science Education, 100*(1), 122-152.

Kiroglu, K. (2008). *Yeni ilköğretim programları (1-5. Sınıflar)* [New elementary curricula (1st-5th grades) (2nd. ed.). Ankara: Pegem A.

Koballa, T. R., Glynn, S. M., Upson, L., & Coleman, D. C. (2005). Conceptions of teaching science held by novice teachers in an alternative certification program. *Journal of Science Teacher Education*, *16*(4), 287-308.

Koballa Jr, T., Graber, W., Coleman, D. C., & Kemp, A. C. (2000). Prospective gymnasium teachers' conceptions of chemistry learning and teaching. *International Journal of Science Education*, *22*(2), 209-224.

Lee, M.-H., Johanson, R. E., & Tsai, C. C. (2008). Exploring Taiwanese high school students' conceptions of and approaches to learning science through a structural equation modeling analysis. *Science Education*, *92*(2), 191-220.

Li, N., Leung, D. Y., & Kember, D. (2001). Medium of instruction in Hong Kong universities: The mis-match between espoused theory and theory in use. *Higher Education Policy*, *14*(4), 293-312.

Lingbiao, G. & Watkins, D. (2001). Identifying and assessing the conceptions of teaching of secondary school physics teachers in China. *British Journal of Educational Psychology*, *71*, 443-469.

López-Íñiguez, G. & Pozo, J. I. (2014). The influence of teachers' conceptions on their students' learning: Children's understanding of sheet music. *British Journal of Educational Psychology*, *84*(2), 311-328.

Lotter, C., Harwood, W. S.,& Bonner, J. J. (2007). The influence of core teaching conceptions on teachers' use of inquiry teaching practices. *Journal of Research in Science Teaching*, *44*(9), 1318-1347.

Magnusson, S., Krajcik, J., Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds.), Examining pedagogical content knowledge (pp. 95-132). Dordrecht, The Netherlands: Kluwer.

Otting, H., Zwaal, W., Tempelaar, D., & Gijselaers, W. (2010). The structural relationship between students' epistemological beliefs and conceptions of teaching and learning. *Studies in Higher Education*, *35*(7), 741-760.

Prawat, R. S. (1992). Teachers' beliefs about teaching and learning: A constructivist perspective. *American Journal of Education*, *100*(3), 354-395.

Prosser, M., Trigwell, K., & Taylor, P. (1994). A phenomenographic study of academics' conceptions of science learning and teaching. *Learning and Instruction*, *4*, 217-231.

Richardson, J. T. (2005). Students' perceptions of academic quality and approaches to studying in distance education. *British Educational Research Journal*, *31*(1), 7-27.

Sahin, S. & Yilmaz, H. (2011). A confirmatory factor analysis of the teaching and learning conceptions questionnaire (TLCQ). *Journal of Instructional Psychology*, *38*(3), 194-200.

Samuelowicz, K. & Bain, J. D. (1992). Conceptions of teaching held by academic teachers. *Higher Education*, *24,* 93-111.

Schommer, M. (1990). The effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, *82*, 498-504.

Schraw, G., Bendixen, L. D., & Dunkle, M. E. (2002). Development and validation of the Epistemic Belief Inventory (EBI). In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 261-275). Mahwah, NJ: Erlbaum.

Stofflett, R. T. & Stoddart, T. (1994). The ability to understand and use conceptual change pedagogy as a function of prior content learning experience. *Journal of Research in Science Teaching, 31*(1), 31-51.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using Multivariate Statistics.* U.S.A: Pearson.

Taylor, D. L. & Booth, S. (2015). Secondary physical science teachers' conceptions of science teaching in a context of change. *International Journal of Science Education*, (ahead-of-print), 1-22.

Tikva, J. B. (2010). Socratic teaching is not teaching, but direct transmission is: Notes from 13 to 15-year olds' conceptions of teaching. *Teaching and Teacher Education*, *26*(3), 656-664.

Topcu, M. S. (2011). Turkish elementary student teachers' epistemological beliefs and moral reasoning. *European Journal of Teacher Education*, *34*(1), 99-125.

Tsai, C.-C. (2002). Nested epistemologies: Science teachers' beliefs of teaching, learning and science. *International Journal of Science Education*, *24*(8), 771-783.

Tsai, C.-C. (2004). Conceptions of learning science among high school students in Taiwan: A phenomenographic analysis. *International Journal of Science Education*, *26*, 1733-1750.

van Beek, J. A., de Jong, F. P. C. M., Wubbels, T., & Minnaert, A. E. M. G. (2014). Measuring teacher regulating activities concerning student learning in secondary education classrooms: Reliability and validity of student perceptions. *Studies in Educational Evaluation*, *43*, 206-213.

Yilmaz-Tuzun, O. & Topcu, M. S. (2008). Relationships among preservice science teachers' epistemological beliefs, epistemological world views, and self-efficacy beliefs. *International Journal of Science Education*, *30*(1), 65-85.

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