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Investigating Coherence between Preservice Science Teachers' Conceptions of Learning and Teaching Science: A Phenomenographic Study

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ABSTRACT

The purpose of this study has been twofold: 1) to determine Turkish preservice science teachers' (PSTs) conceptions of learning and teaching science and 2) to investigate the reasons of in/consistencies between conceptions. A phenomenography including 87 PSTs has been conducted. Data has been collected through an open ended instruments and semi structured interviews. Analyses have revealed that PSTs have five different conceptions of learning science and two different conceptions of teaching science. 67% of the sample has consistent conceptions. Additionally, PSTs' previous experiences have been found responsible not only for expected consistencies but also for inconsistencies. Implications have been presented considering the results.

Keywords: conceptions of learning science, conceptions of teaching science, preservice science teachers, science education, phenomenography

Fen Bilimleri Öğretmen Adaylarının Fen Öğrenme ve Öğretme Anlayışları Arasındaki Uyumun İncelenmesi: Bir Fenomenografi Çalışması

ÖZ

Bu çalışmanın iki amacı vardır: 1) fen bilimleri öğretmen adaylarının fen öğrenme ve öğretme anlayışlarının belirlenmesi ve 2) bu anlayışlar arasındaki uyum ve uyumsuzlukların sebeblerinin incelenmesi. 87 öğretmen adayını kapsayan bir fenomenografi çalışması gerçekleştirilmiştir. Çalışmada açık uçlu veri toplama araçları ve yarı yapılandırılmış görüşmeler yolu ile veri toplanmıştır. Analizler öğretmen adaylarının 5 farklı fen öğrenme anlayışı ve 2 farklı fen öğretme anlayışına sahip olduğunu göstermiştir. Örneklemin 67%'sinde bu anlayışlar arasında uyum olduğu gözlemlenmiştir. Bununla birlikte hem beklenilen uyumun hem de uyumsuzlukların sebebinin öğretmen adaylarının ön deneyimleri olduğu bulunmuştur. Çalışmanın bulguları doğrultusunda öneriler sunulmuştur.

Anahtar kelimeler: fen öğrenme anlayışı, fen öğretme anlayışı, fen bilimleri öğretmen adayları, fen eğitimi, fenomenografi

INTRODUCTION

Teacher is an indispensable part of a science learning environment since s/he has in/direct effect on students' comprehensive learning by adapting appropriate learning strategies and teaching methodologies (Abell, 2007). A plethora of

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studies have explored that (science) teachers' teaching approaches are consistent with their conceptions of learning and teaching (Chan, Tan & Khoo, 2007; Hewson & Kerby, 1993; Koballa, Glynn, Upson & Coleman, 2005). Studies have identified that these conceptions are nested (Koballa, Graber, Coleman & Kemp, 2000; Tsai, 2002), culture dependent (Chan et al. 2007; Tsai, 2004), domain-specific (Eren, 2009, Tsai, 2004) and relate to some other variables such as epistemological beliefs (Chan & Elliott, 2004; Otting, Zwaal, Tempelaar & Gijselaers, 2010) and self-efficacy beliefs (Author, in press; Eren, 2009).

Turkey has adopted contemporary curricula since 2005 (MoNE, 2006). New curricula give weight to constructivist learning and teaching approaches. In order to realize the curricular reforms, science teacher education programs in Turkey have also weighted to constructivist approaches. However, certain scholars have asserted that Turkish inservice (science) teachers are in need of qualified support (Isikoglu, Basturk & Karaca, 2009) and preservice science teachers have not internalized the teaching and learning approaches promoted by the reforms (Kılınç et al., 2013; Yilmaz-Tuzun & Topcu, 2008).

Preservice science teachers, most probably, have their own science learning/teaching conceptions based on their prior school experiences and observations (Richardson, 1996) since very beginning of their undergraduate education. As science teacher educators, we wish preservice teachers to construct certain contemporary conceptions of learning and teaching science. However, these preservice teachers have most probably traditional learning experiences. Is it literal to expect preservices to internalize these conceptions, even though their prior school experiences have traditional baselines? What are their current conceptions of learning/teaching conceptions? Are these science learning/teaching conceptions nested as some researchers argued? If yes/no, what are the reasons of these in/consistencies? This study was conducted to answer these questions. Underlying reasons of in/consistencies between preservices' conceptions of learning and teaching science, this study has a potential to produce feedback and suggestions for science teacher education programs.

Conceptions of Learning and Teaching Science

Chan and Elliott (2004) define teachers' conceptions of teaching and learning as "the beliefs held by teachers about their preferred ways of teaching and learning" (p.819). To Hewson and Hewson (1989) conception of teaching science refers to "the set of ideas, understandings, and interpretations of experience concerning the teacher and teaching" (p.194). In both definitions "conception" is being utilized to categorize individuals' salient set of ideas and beliefs.

Studies in this area can be divided into two different designs: descriptive and relational studies. In descriptive studies , a pioneering study revealing students' conceptions of learning has been conducted by Saljo (1979). Marton, Beaty and Dall'Alba (1993) have also conducted a phenomenographic study for the same purpose. Discourse analyzes in both studies have revealed similar conceptions.

Tsai (2004), to the best of my knowledge, is the first researcher, have conducted a phenomenographic study to uncover students' conceptions of learning science. Except for "preparing for tests" in Tsai's categories, all the researchers have revealed similar categories of conceptions of learning. In general by 'memorizing' researchers mean that memorizing laws, ideas, formulae, and knowledge etc. 'Increase of knowledge' refers to individuals' beliefs and ideas about conceptualizing learning as extension of cumulative knowledge that a person already has. 'Applying' is admitted as another conception of learning which relates to the applicability of received knowledge into practical situations. 'Understanding' seems as a more constructivist conceptions of learning (science) in comparison to the previous ones since such a conception abandons memorizing and includes a true understanding of science. Individuals have a conception of learning science, 'seeing in a new way', if they view science as getting a new way of interpreting natural phenomena (Tsai, 2004).

As I saw, the number of phenomenographic studies revealing (preservice) teachers' conceptions of teaching has been very limited. Koballa et al. (2000) have conducted such a study including nine preservice chemistry teachers and investigated three different conceptions of chemistry teaching: Transferring knowledge, posing problems and interacting. Tsai (2002) has also conducted a qualitative study and offered three different codes related to inservice teachers' conceptions of teaching science: traditional, process and constructivist. Finally, Chan and Elliott (2004) have developed a 30-item questionnaire measuring preservice teachers' conceptions of teaching and learning. This questionnaire has been widely used by the researchers and confirmed to retain two conceptions: traditional and constructivist.

Descriptive studies have also showed that individuals' conceptions of learning (science) are domain specific and culture dependent. Tsai (2004) have presented evidence that students' conceptions of learning science are domain-specific to some extent. For instance, 'calculating' does the mostly verbalized conception of learning science among art majors whereas 'understanding' is the one among science majors. Moreover, Eren (2009) has displayed that Turkish preservices' conceptions of learning and teaching changes in accordance to their study area. In addition to these findings, Tsai (2004) explains the reason for why he find out a higher number of conceptions of learning science than other researchers as the effect of cultural differences between eastern and western students. The scholars Chan, Tan and Khoo (2007) have found significant differences among Singaporean preservice teachers' conceptions of learning and teaching science in terms of their races.

The second type of design, relational studies, has been conducted for examining these conceptions' relations with certain cognitive or psychological constructs. Personal epistemology and self-efficacy beliefs are the prominent ones. Chan and Elliott (2004) have examined the relationships between preservice teachers' epistemological beliefs and conceptions of learning and teaching. They have

found that while fixed ability, expert and certainty knowledge dimensions of personal epistemology relates to traditional conceptions, learning effort dimension have relationship with constructivist conceptions. Otting et al. (2010) have also stated the similar results. Moreover, Eren (2009) has showed preservice teachers' self-efficacy beliefs predict their conceptions of learning and teaching. Finally, author (in press) have mentioned that preservice science teachers' conceptions of learning predict their science teaching efficacy beliefs.

As a different viewpoint, I believe that PSTs' conceptions of learning and teaching science may be linked to their pedagogical content knowledge (PCK) which can be admitted as a topic specific version of an amalgam including these conceptions. Because PCK mainly refers to the conceptions, ideas and beliefs of (preservice) teachers regarding how students learn and which forms of representations should be formed for appropriate teaching of a specific topic (Shulman, 1986; 1987). PSTs' PCK development is declared as a dynamic process (Cochran, DeRuiter & King, 1993; Wilson, Shulman & Richert, 1987) and has a direct effect on their classroom practices (Grossman, 1990; Magnusson, Krajcik & Borko, 1999) similar to learning and teaching conceptions (Hewson & Kerby, 1993; Koballa et al., 2005).

Significance of the Study

Besides all the aforementioned research attempts in international literature, I could have not encountered studies specifically focusing on the reasons of in/consistencies between (preservice science) teachers' conceptions of learning and teaching (science). Science educators admit that an individual's conception of science learning affect both his/her ways of what/how to learn (Tsai, 2004) and his/her conception of teaching (Hewson and Hewson, 1987; Koballa et al., 2000). Certain scholars (e.g. Koballa et al., 2000; Tsai, 2002) have also presented evidence about this expected consistency. That is, if a (preservice) science teacher has a constructivist/higher level of conception of learning science, s/he has also a constructivist conception of teaching science. The same scholars detected also inconsistencies (together with consistencies) between (preservice) science teachers' conceptions of learning and teaching science. Koballa et al. (2000) explain the reason behind this unexpected result as that some of preservice chemistry teachers have more than one learning conception. In another study, Koballa and Graber (2001) have evidenced that PSTs can have more than one conception of teaching science; one of them dominates their practices.

If we consider valuable contributions of certain researchers (e.g. Pajares, 1992; Rokeach, 1968) in belief literature, it is rational that a (preservice science) teacher's conception of learning forms his/her conception of teaching. Because, learning is a prior step in a teacher's life-span in comparison to teaching. Thus, structural in/consistencies between (preservice science) teachers' learning and teaching conceptions should be clarified by connecting their conceptions to their past experiences. From this point of view, still, the literature needs evidence to

elicit reasons of inconsistencies between preservice teachers' conceptions of learning and teaching.

Research Questions

Considering the purpose of this study I have three research questions:

1. What are the conceptions of learning and teaching science that Turkish PSTs have?
2. To what extent do these conceptions are consistent?
3. What are the reasons of consistencies and inconsistencies between Turkish PSTs' conceptions of learning and teaching science?

METHOD

Sample

I have selected the participants using convenience sampling procedures (Creswell, 2008). The sample have included 29 male and 58 female (a total of 87) preservice science teachers (PSTs) from two different university. Participants' mean age is 21.6 (Sd=1.52). All the participants were purposefully selected among senior year students; because, Turkish senior students have taken all the subject matter courses together with school practicum and they have almost been introduced to all types of educational courses. These courses and school practicum most probably get them to hold a more comprehensive conception of science teaching and learning than prior year PSTs.

In context of Turkey, students are placed into high schools in accordance to their national exam results. All Turkish students have to join in another exam at the end of their high school education to enter a university. All these exams have only multiple choice items. These national exams together with traditional curricula implemented in schools had forced students to memorize scientific formulae, definitions and knowledge instead of meaningful understanding (Küçük & Çepni, 2004). The curricula have been updated to include constructivist approach since 2005 for all educational levels in Turkey. The sample of this study includes traditionally educated PSTs. Teacher-centered lecturing was the common way of teaching in their learning context.

Data Collection

Data was collected in 2013-2014 academic year by two ways: written and oral communications. In written communications, which also included two following parts, participants were requested to answer: 1) what does "learning science" mean? Please explain with your own words. 2) what does "teaching science" mean? Please explain with your own words. The second one was asked two weeks later than administration of the first one. I aimed to prevent direct interventions between answers. In the first part of written communications, participants were also requested to mention their genders, ages, full names and their own evaluations regarding their previous educational experiences (primary, elementary and high school educations) on a two tied (traditional-constructivist)

9 point scale. I utilized their full names to match the papers in first and second parts. Completing the written responses took approximately 15 minutes for each administration. The major data of analyzing PSTs' conceptions of learning and teaching science was their written responses.

After finishing the coding and matching procedures, I invited nine students to conduct oral communications to my office at university. Four PSTs holding consistent conceptions of learning and teaching science, and five PSTs holding inconsistent conceptions were selected among the sample. In oral communications, the guiding interview questions stated below were directed:

- What is your definition of "learning science"?
- What is your definition of "teaching science"?
- Can you select a concept from the formal elementary school science curriculum and define your probable ways of teaching in the classroom?
- How do you define an individual who have learned science comprehensively?
- Do you think that your previous learning experiences affect your conceptions of learning and teaching science? How? Why?
- There are in/consistencies between your definitions of learning and teaching science. How do you explain the reasons of these in/consistencies?

Oral communications were realized individually and took approximately 25 minutes. All the oral communications were tape-recorded. Finally, I transcribed the records verbatim and coded for further analyses.

Data Analysis

In the analyses of written responses and verbatim transcripts, I conducted the phenomenography as the research method by which researchers do not only investigate participants' definitions but also make interpretations. Data can be collected through in-depth interviews and open-ended questions in phenomenography studies (Creswell, 2007).

The categories of conceptions presented by previous researchers and epistemological sophistication of participants' responses were the main drives in determination of the participants' conceptions. In categorization, I highlighted keywords and significant statements in written responses. Considering associative keywords and statements, I clustered the definitions. I compared each cluster (category) with previously presented categories to label. Two more science educators, informed about the purposes of the study, have re-clustered participants' definitions under my categories. The inter-rater reliability has been calculated over 90%. In analyzing verbatim transcripts of records, the in/consistencies between PSTs' conceptions were categorized in terms of underlying reasons.

RESULTS

Conceptions of Learning Science

The analyses have revealed that PSTs have five different conceptions of learning science. Following sub-sections present the explanations about these conceptions, respectively, from traditional to constructivist ones.

Increase of knowledge

In this category, learning science is admitted as an increase of cumulative knowledge that a person already has. Objectives of learning science are clarified as acquisition of physics, biology and chemistry related knowledge and addition of new knowledge to already known body of knowledge. Certain representative responses are presented below:

Learning science includes true understanding of knowledge included by physics, chemistry and biology.

Learning science is to reach a self-sufficiency related to body of knowledge in physics, chemistry and biology.

Learning science does not mean to be successful in exams. On the contrary, it means to be equipped with real knowledge of science in addition to what we already know.

In this category, learning science is not relating with understanding natural phenomena. The focus is on increasing the domain specific knowledge of science. Any of the participants may have not utilized "memorization" in their responses, because most probably memorization is being criticized by their lecturers during undergraduate education. Therefore, I prefer to label this category as increase of knowledge instead of memorization.

Understanding natural phenomena

In this category, learning science is accepted as understanding the natural phenomena. Participants focus on understanding the natural events and formations such as water cycle, the structures of human body and the universe as result of learning science. For instances, participants have responded that:

Learning science means to understand the life and nature. A science learned person understands what actually occurs in the environment.

Learning science is to understand the life for example grasping water cycle and behaviours of living beings, in short, to satisfy the curiosity about the universe.

Learning science is to understand the natural phenomena better than before. It is to support and step up perception regarding daily life events.

In this category, participants reduce science learning to understanding what actually occur in nature. Their responses offer another form of increase of knowledge since the increase of knowledge relates with understanding natural phenomena; however, this understanding does not provide practical solutions for their daily life. That is these participants have an assumption that there is relationship between scientific knowledge and natural phenomena. These PSTs do not deal with how scientific knowledge is justified.

Making science

Participants in this category define learning science as gaining the language and ways of science and being able to implement the steps that scientists use. Participants magnify the purposes of learning science as the development of curiosity and gaining the scientific process skills such as research and observation in order to design and implement laboratory experiments. Participants, for example, have responded that:

Learning science is to be able to make scientific research, observation and experiments.

Learning science is to be able to test hypothetical cause and effect relations scientifically in a laboratory.

Learning science is development of curiosity and being able to satisfy it in a laboratory medium.

Participants of this category do not relate learning science to understanding natural phenomena. Additionally, their science learning conception is not aimed to get a new perspective for daily life problems they encounter. They seem to learn the scientific method in order to implement them with the laboratory equipment. These results also indicate that these participants have a limited epistemological baseline.

Applying

In this category, learning science is defined as obtaining practical solutions for daily life. The participants do not admit science learning as only understanding the natural phenomena but also the unique way presenting solutions for daily/real-life problems. Preservice teachers, for example, have stated that:

Learning science is to conceptualize the scientific and technological knowledge and to implement them in daily life.

Learning science is to integrate scientific knowledge with real life events. Science presents the unique way to take things easy.

Learning science is not to memorize the physics, chemistry and biology related knowledge, contrarily, it is to conceptualize this knowledge and practicing them in daily life.

Learning science is being able to solve daily life problems scientifically. An individual, not preferring to implement scientific solutions in daily life, cannot be admitted as the one who have learned science.

These participants' definitions of learning science give some clues that they have a meaningful understanding of scientific knowledge. Because, they admit scientific approach as a way of problem solving. However, to the epistemological stance, admitting scientific approach as the unique way of problem solving points out a deficiency related to learning science.

Getting a new perspective

In this category, learning science is defined as the way of getting a new perspective. The participants admit science as a way of problem solving. They expect to structure new ways of problem solving by benefiting from scientific knowledge and methodologies. For instance, preservice teachers have stated that:

Learning science is to get an alternative way of solution for daily life problems.

Learning science is to understand real life and natural phenomena instead of memorizing theoretical knowledge. It is to deepen in interpreting and making sense of natural events.

Learning science is the development of creativity and critical thinking. It is to produce new ways of daily solutions; in short, it is to believe that there is always another way.

The main difference between the responders labeled as applying and getting a new perspective is that latter ones believe that they will gain a new perspective by learning science. According to them learning science is not the unique way of problem solving, but provides a medium for development of certain higher-order thinking skills. Therefore, these participants have provided the most qualified responses in accordance to the epistemological stance.

Conceptions of Teaching Science

I have labeled preservice teachers' conceptions of teaching science by two categories: traditional and constructivist. While presenting knowledge, explaining truth directly, providing information about world or anything else are utilized as descriptors of traditional conceptions of teaching science, helping students to make sense of anything, directing students into discussions, focusing on prior knowledge of learners and coaching are among the indicators of constructivist conceptions. Some preservice teachers holding traditional conceptions have stated that:

Teaching science is raising individuals' awareness by transferring knowledge which includes the parts of life and nature.

Teaching science is interpreting students' all questions and presenting solutions to them by a teacher who has qualified domain-specific knowledge.

Teaching science is teaching the subjects of physics, chemistry and biology. It is explaining the physical and biological world to develop students' desired behaviors.

Teaching science is to inform students about all the concepts involved by science. It is being able to explain these concepts and, if necessary, to utilize laboratory medium.

Traditional preservices seem to rely on teachers' amount of knowledge and try to explain concepts directly. The quotations presented above clarify that, according to traditional preservices, science is a comprehensive teaching subject involving many topics and knowledge, all of which should be presented to students. Another remarkable result is admission of science learning as the main goal of science teaching by these participants. According to them science is not a medium providing a learning environment for students to develop (some) thinking skills. On the other hand, some constructivist preservices have responded that:

Teaching science is to help students to make sense of life.

Teaching science is preparing a science learning environment in which students interact with each other and learn scientific concepts by discussing.

Teaching science is to provide students to discover life and natural phenomena by considering individual differences among them in a science learning environment in which teacher should make coaching.

Teaching science is guiding students to learn by experience considering their prior knowledge.

Definitions of constructivist preservices emphasize that science is a way of life and/or world-discovering in which students should be supported by coaching. Some of the definitions are focusing on such a learning environment by considering students' prior knowledge.

Consistency among Conceptions of Learning and Teaching Science

I have arranged participants' conceptions of learning from more traditional to more constructivist orientation: Increase of knowledge (IK), understanding natural phenomena (UNP), making science (MS), applying (A), and getting a

new perspective (GNP). Figure 1 and 2 presents the distribution of learning conceptions for two different teaching conceptions.

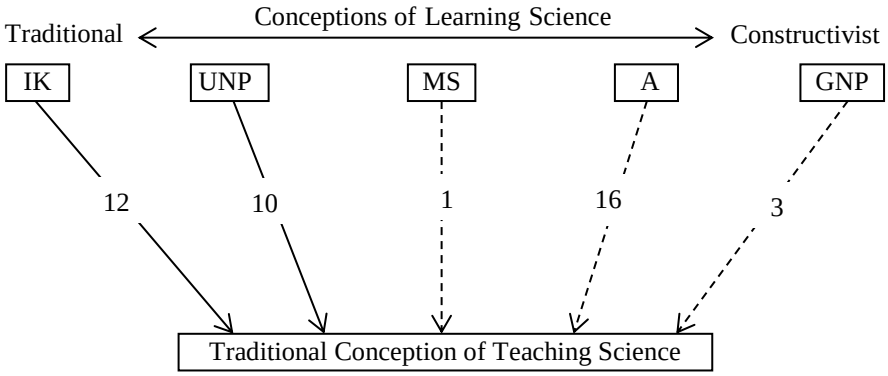

Figure 1. Distribution of conceptions of learning science for PSTs holding traditional conceptions of teaching
Note: Dotted lines shows inconsistent relations

Figure 1 shows that 42 preservices have traditional conceptions of teaching science. Among these 42 participants, there are 20 preservices whose conceptions of learning science present constructivist orientations. In other words, one participant for MS, 16 participants for A and three participants for GNP hold traditional conceptions of teaching science. On the other hand, consistency between PSTs' conceptions of learning and teaching science is 52% if participants hold traditional conceptions of teaching.

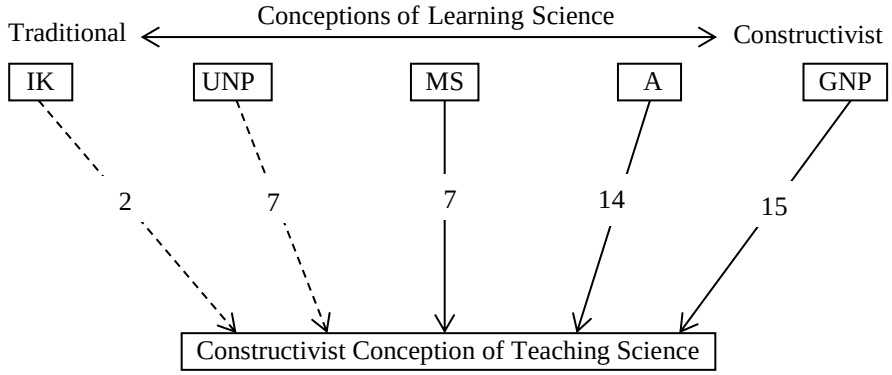

Figure 2. Distribution of conceptions of learning science for PSTs holding constructivist conceptions of teaching
Note: Dotted lines shows inconsistent relations

Figure 2 presents a better consistency between preservices' conceptions of learning and teaching science. There are 45 participants holding constructivist conceptions of teaching science. Nine preservices (2 for IK and 7 for UNP) have broken the perfect fit between learning and teaching science conceptions. 80% of the participants, holding constructivist conceptions of teaching science, have also constructivist conceptions of learning science.

When compared the results, it is possible to state that, for the participants who have constructivist conceptions of teaching science, consistency between learning and teaching science is higher than others. Furthermore, overall results show that there are 58 PSTs (67% of the sample) whose conceptions of learning and teaching science present consistency. Moreover, among all the conceptions of learning science applying needs further attention. Because, more than half of the participants, holding applying as their conceptions of learning, present a traditional teaching science conception, although applying has a constructivist nature. To sum up, based on the written communications I have specified five different conceptions of learning science and two types of conceptions of teaching science. When PSTs' conceptions of teaching science were traditional, I have observed 52% consistency with their learning conceptions. It has been 80%, if their teaching conceptions have been constructivist. Following section, considering oral communication data, presents underlying reasons of these in/consistencies.

Reasons of In/consistencies

I have invited nine PSTs to participate in-depth interviews which have been conducted to observe the underlying reasons of in/consistencies between their conceptions of learning and teaching science. Based on written responses, four PSTs holding consistent conceptions and five holding inconsistent conceptions have been chosen.

The main reason of consistency between PSTs' conceptions seems as their previous experiences which have firstly structured their learning conceptions. Then, their learning conceptions have directed their conceptions of teaching science. The interactions among these variables have presented differentiations for the participants holding consistently traditional or constructivist learning and teaching conceptions. Traditional PSTs were high-achievers in their elementary and secondary school science courses. Traditional approaches implemented in their formal education had assisted their success in nationwide multiple-choice exams. They believe that although small adaptations in these exams have been realized, traditional learning and teaching science conceptions still serve the purposes of elementary school education. When it comes to the constructivist PSTs, they have not good experiences with their previous educational processes. In their regular science courses (both in elementary and secondary education years) they had forced to memorize a body of knowledge, and year after year they had forgotten what they memorized. Such memories direct them to develop a constructivist conception of teaching science.

The PSTs, holding a constructivist conception of learning science, but traditional in teaching science, have been questioning the feasibility of implementing constructivist curricula in current context of schools in Turkey. Two of them stated that number of students in regular classrooms is still higher than what should be. According to them, within such number of students, it is impossible to implement constructivist teaching approaches. They validate this educational handicap with their observations in school practicum. During the school practicum they have interacted with inservice teachers who informed them in this direction.

Moreover, as expected, all the PSTs had traditional learning experiences in their previous education processes. Undergraduate education has seemed to introduce them with constructivist approaches. However, they have been slightly questioning why a few academic staff is still implementing traditional teaching ways in their regular classes. These inconsistencies between what academicians suggest and what they actually do have been damaging the PSTs' conceptions. For example, one of them (who has a traditional conception of learning science, but has constructivist conception of teaching science) believes that she can learn in traditional ways (since in some undergraduate courses she had been taught in traditional ways) but should attempt to implement constructivist ways of teaching science. By implementing constructivist teaching, she believes that number of students meaningfully comprehending science increases.

Another reason of why PSTs hold inconsistent conceptions of learning and teaching science is their limited knowledge related to science specific teaching ways. Choosing a concept and defining own ways of teaching that concept is indeed a difficult process for them. They have not been deciding the topics promptly. Even if they decide the concepts, they have been slogging in matching them with appropriate teaching ways. Their limited knowledge comes from observations during school practicum and educational courses in undergraduate education. To illustrate, one PST holding IK as conception of learning science stated that she can implement drama as the way of teaching science to all the science concepts. To her, in such a way, all the students can learn each concept of science actively. This participant had taken an elective course regarding implementation of drama in science teaching and believes that drama is the most appropriate way of teaching science. She presents a weakly-constructivist conception of teaching science, although traditional in learning.

CONCLUSIONS, DISCUSSIONS and IMPLEMENTATIONS

In this study, I have, firstly, uncovered Turkish PSTs' conceptions of learning and teaching science, and, secondly, investigated the reasons of in/consistencies between their conceptions. I have observed five different conceptions of learning science, labeled as IK, UNP, MS, A, and GNP, based on participants' written responses. Additionally, phenomenography has revealed that there are two

different conceptions of teaching science (traditional and constructivist) hold by PSTs.

Except for certain differentiations in nominations of conceptions, this study has presented diversity in PSTs' conceptions similar to previous studies. For example, GNP is labeled as seeing in a new way by Tsai (2004). I mainly have focused on the certain keywords utilized by the PSTs, this procedure seems to cause certain differentiations in nominations of science learning conceptions. Additionally, a few conceptions of learning (such as memorizing and testing) has not been observed, most probably because of discrepancy between the samples. In this study, I focused on PSTs' conceptions. Turkish PSTs are continuously being warned regarding negative effects of memorizing and traditional testing implementations on students' learning and assessment during training sessions. I hope that if the sample included elementary or high school students, I would find similar conceptions since the educational system in Turkey offers nationwide multiple choice exams to students for their further educational placements like Taiwanese context.

Results of this study display that 45 PSTs in the sample have constructivist conceptions of teaching science (see Figure 2). Among them 36 participants (41% of the overall sample) have also constructivist conceptions of learning science. This is quite distant to practicability of contemporary curricular adaptation efforts in Turkey. This problematic condition of teacher education system is also presented with previous studies (e.g. Kılınç et al., 2013; Yilmaz-Tuzun & Topcu, 2008). However, I believe that when PSTs' prior experiences are taken into consideration, 41% is not an ominous result.

PSTs' past experiences seems to affect their conceptions of learning and teaching science not only negatively but also positively. For the PSTs holding consistent traditional conceptions of learning and teaching science, their experiences have a negative effect. According to their self-explanations these participants had been high-achievers in previous science courses. They had shot the required points in national exams although been traditionally educated. Even though I warn them they have traditional conceptions, they believe that in current context of the country traditional conceptions and implementations in science education still fit the purpose. Certain researchers (e.g. Zembal-Saul, Starr & Krajcik, 1999) have already asserted that PSTs may have problems in considering learning needs of different students.

On the other hand, past experiences have positive effects on some PSTs' conceptions. PSTs holding consistently constructivist conceptions are questioning the aims and outputs of traditional approaches in science education. According to these participants traditional teaching is synonymous with getting students to memorize scientific body of knowledge. Even though they had successfully passed the national exams like their aforementioned friends, they found memorizing as troublesome. Because, memorizing had been not only

difficult but also an obligatory duty to just achieve the exams in their recent past. Fortunately, their past experiences make them hold a constructivist conception of learning science. Such a learning conception, then, seems to cause them holding a constructivist conception of teaching science.

Hewson and Hewson (1987) have argued that a (preservice) teacher's conception of teaching takes its roots from his/her conception of learning. This vision is also consistent with Pajares's (1992) claims that prior experiences of PSTs act as filters on their teaching behaviors. PSTs' prior experiences include their past learning experiences which generates their core beliefs (Rokeach, 1968). Tsai (2002) has also evidenced that inservice science teachers' conceptions of learning and teaching science are nested that is consistent with each other. Therefore, consistencies between PSTs' conceptions of learning and teaching science, found in this study, have remarkable evidence in the education literature.

When it comes to the reasons of inconsistencies, it is not so difficult to reveal them as I guess at the beginning of the study. Koballa et al. (2000; 2001) have evidenced that PSTs can have more than one conception of learning and teaching science and one of them may be dominating their practice and other conceptions. This plurality may be responsible for the inconsistencies. My observations are contradictory to these findings. Because, I have prompted each oral communication period by probing again the PSTs' conceptions. All the nine participants have put the same and unique conceptions consistent with their written responses into words. Additionally, by considering they may have more than one conceptions of teaching science I have asked the interviewees to clarify their teaching ways specifically on a concept. Their responses have been again matching with their written responses.

The first reason of inconsistency between PSTs' conceptions of learning and teaching science is their observations and experiences obtained during school practicum of their undergraduate education. Their observations regarding the classroom populations have negative effects on their conceptions of teaching science even if sometimes they have a constructivist conception of learning science. Some of them found practicability of constructivist teaching conceptions in current population of classrooms irrational. Additionally, their contact teachers at the formal elementary schools cannot already implement constructivist teaching orientations. Even if high population in regular classrooms may not be the unique reason of why their contact teachers can/do not implement what the current curricula expects from inservice teachers at formal schools, PSTs believe that implementing constructivist teaching mainly depends on this disadvantaged situation in regular classrooms.

Observed incoherencies between what academicians recommend and how they teach in courses seem as another reason of PSTs' inconsistencies. Simsek and Yildirim (2001) have argued that increasing number of pure science academicians in faculties of education in mid 1990s was one of the underlying

reasons of the reforms encountered in Turkish teacher training system at the end of the 1990s. This past faulty may cause such incoherencies which make out PSTs, for example, holding a traditional conception of learning science, but a constructivist conception of teaching.

Finally, PSTs' inadequacy in topic-specific science teaching method knowledge that is pedagogical content knowledge (PCK) seems also another reason of inconsistency between their conceptions. If we consider development of PCK is a dynamic process that needs processes such as observation, practice, and evaluating practice (Cochran et al., 1993; Wilson et al., 1987), the current status of PSTs in PCK is not surprising. PSTs' PCK quality has been evidently out of standards and this situation has been affecting their conceptions of teaching science unilaterally. In other words, if a PST has observed or experienced (during school practicum) or learned (in undergraduate courses) a science specific classroom implementation and believed that it is an effective way of teaching, s/he may hold a conception of teaching science in that way. Additionally, in such cases, their conceptions of learning science may not interact with their conceptions of teaching science.

Considering the results of this study, I can offer certain implementations for science education community. Whether consistent or inconsistent, PSTs' conceptions of learning and teaching science are feeding from their educational experiences. Considering this affect, I firstly suggest increasing intended experiences (in the way of curricular reforms) of PSTs during the teacher training education. PSTs need to be informed about science concept-specific classroom implementations. They can be directed into discussions about dis/advantages of these implementations. I believe that such discussions force PSTs to consider science learning contexts more comprehensively instead of focusing solely on their previous learning successes or difficulties. Science teaching method courses present a convenient medium for this purpose. Next, contact teachers (leaders of the PSTs during school practicum at elementary schools) should be examined closely by the supervisor academicians of PSTs whether their classroom implementations are consistent with the curricular adaptations. Collaborative studies between contact teachers and supervisors can assist PSTs in terms of encountering appropriate classroom implementations.

REFERENCES

Abell, S. K. (2007). Research on science teacher knowledge. In Abell, S.K., & Lederman, N.G., (Ed.), *Handbook of Research on Science Education* (pp. 1105-1149). London: Lawrence Erlbaum Associates Publishers.

Author. (in press). Preservice science teachers' conceptions of learning science and science teaching efficacy beliefs: is there a relationship?

Chan, K.W., & Elliott, R. G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education, 20*(8), 817-831.

Chan, K., Tan, J., & Khoo, A. (2007). Pre-service teachers' conceptions about teaching and learning: a closer look at Singapore cultural context. *Asia-Pasific Journal of Teacher Education, 35*(2), 181-195.

Cochran, K. F., DeRuiter, J. A., & King, R. A. (1993). Pedagogical content knowing: An integrative model for teacher preparation. *Journal of Teacher Education, 44*(4), 263-272.

Cresswell, J.W. (2008). Educational research: planning, conducting and evaluating quantitative and qualitative research. New Jersey: Pearson.

Creswell, J.W. (2007). Qualitative inquiry and research design. Choosing among five approaches. California: Sage Publications, Inc.

Eren, A. (2009). Examining the teacher efficacy and achievement goals as predictors of Turkish student teachers' conceptions about teaching and learning. *Australian Journal of Teacher Education, 34*(1), 69-87.

Grossman, P. L. (1990). The making of a teacher: Teacher knowledge and teacher education. London: Teachers College Press.

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

Hewson, P.W., & Hewson, M.G. (1989). Analysis and use of a task for identifying conceptions of teaching science. *Journal of Education for Teaching, 15*, 191-209.

Hewson, P.W., & Kerby, H.W. (1993). Conceptions of teaching science held by experienced high school science teachers. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Washington, DC. ERIC ED 364426.

Isikoglu, N., Basturk, R., & Karaca, F. (2009). Assessing in-service teachers' instructional beliefs about student-centered education: a Turkish perspective. *Teaching and Teacher Education, 25*(2), 350-356.

Kılınç, A., Kartal, T., Eroğlu, B., Demiral, Ü., Afacan, Ö., Polat, D., Demirci Güler, M.P., & Görgülü, Ö. (2013). Preservice science teachers' efficacy regarding a socioscientific issue: a belief system approach. *Research in Science Education*, *43*, 2455–2475.

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*, 287-308.

Koballa, T., & Graber, W. (2001, August). Prospective science teachers' conceptions of teaching and learning: A methodological reconsideration. In D. Psillos, P. Kariotoglou, V. Tselfes, G. Bisdikian, G. Fassoulopoulos, E. Hatzikraniotis, & M. Kallery (Ed.), *Proceedings of the 3rd International Conference on Science Education Research in the Knowledge* (Volume 1, pp. 115–117). Thessaloniki, Greece: European Science Education Research Association.

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

Küçük, M., & Çepni, S. (2004). Measurement and assessment for science education in the Turkish educational context: problems and reflections. *Asia-Pacific Forum on Science Learning and Teaching, 5*(3).

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.

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.

Marton, F., Dall'Alba, G., & Beaty, E. (1993). Conceptions of learning. *International Journal of Educational Research, 19*(3), 277-299.

MoNE. (2006). İlköğretim fen ve teknoloji dersi (6, 7 ve 8. sınıflar) öğretim programı. Ankara.

Otting, H., Zwall, 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.

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

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

Rokeach, M. (1968). Beliefs, attitudes, and values: a theory of organization and change. San Francisco: Jossey

Saljo, R. (1979). Learning in the learner's perspective: Some commonsense conceptions. Gothenburg, Sweden: Institute of Education, University of Gothenburg.

Shulman, L. S., (1987). Knowledge and teaching: foundations of the new reform, *Harvard Educational Review, 57*(1).

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Simsek, H., & Yildirim, A. (2001). The reform of pre-service teacher education in Turkey. In Ronald G. Sultana (Ed.), *Challenge and Change in the Euro-Mediterranean Region: Case Studies in Educational Innovation* (pp. 411-432). New York, NY: Peter Lang.

Tsai, C.-C. (2004). Conceptions of learning science among high school students in Taiwan: A phenomenographic analysis. *International Journal of Science Education, 26*(14), 1733-1750.

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

Wilson, S. M., Shulman, L. S., & Richert, A. E. (1987). '150 different ways' of knowing: Representations of knowledge in teaching. In Calderhead, J., (Ed.), *Exploring Teachers' Thinking*, London: Cassell.

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.

Zembal-Saul, C., Starr, M. L., & Krajcik, J. S. (1999). Constructing a framework for elementary science teaching using pedagogical content knowledge. In J. Gess-Newsome & N. G. Lederman (Ed.), *Examining pedagogical content knowledge* (pp.237-256). Dordrecht, The Netherlands: Kluwer.

GENİŞLETİLMİŞ ÖZET

Fen bilimleri öğretmenlerinin öğrenme ve öğretme anlayışlarının sınıf içi pratiklerini doğrudan etkilediği bilinmektedir. Alanyazında yer alan çalışmalar fen bilimleri öğretmenlerinin öğrenme anlayışlarının öğretme anlayışları ile uyumlu ve alan odaklı olduğunu, kültürel yapılardan etkilendiğini, epistemolojik inançlar ya da öğretim özyeterliği gibi eğitsel açıdan önemli olan birçok değişkenle ilişkili olduğunu göstermektedir. Ülkemizde 2005 yılından beri gerçekleştirilen fen bilimleri öğretim programlarındaki değişim hareketleri dikkate alınacak olursa yapılandırmacı öğrenme ve öğretme anlayışlarına sahip fen öğretmenlerinin yetiştirilmesine yönelik gereklilik daha iyi anlaşılacaktır. Üniversite eğitimlerinden önce geleneksel olduğu kabul edilen öğretim programları ile yetiştirilmiş olan fen bilimleri öğretmen adaylarımız acaba hangi fen öğrenme anlayışlarına sahip? Bu öğrenme anlayışları acaba fen öğretim anlayışlarını nasıl biçimlendirmiştir? Fen öğrenme ve öğretme anlayışları arasındaki uyum ya da uyumsuzlukların sebepleri nelerdir acaba? Çalışma kapsamında bu sorulara cevap aranacaktır.

Çalışmada nitel araştırma yöntemlerinden fenomenografi kullanılmıştır. Araştırmaya uygun örneklem yöntemi ile iki farklı üniversiteden 87 fen bilimleri öğretmen adayı katılmıştır. Lisans eğitimlerinin son yılını okuyan öğretmen adaylarının daha fazla ders aldıkları ve okul deneyimlerinin de daha fazla olmasından dolayı ön sınıflara göre daha içselleştirilmiş bir öğrenme ve öğretme anlayışına sahip oldukları düşünüldüğü için örneklemdeki bütün katılımcılar son sınıf öğrencileri arasından seçilmiştir. Yazılı ve sözlü iletişim olmak üzere iki farklı yolla veri toplanmıştır. Yazılı veri kendi içinde iki basamaktan oluşmaktadır. İlk olarak bütün katılımcılara "Sizce fen öğrenmek ne demektir? Kendi cümlelerinizle ifade ediniz." sorusu yöneltilmiştir. İki hafta sonra aynı katılımcılara "Sizce fen öğretmek ne demektir? Kendi cümlelerinizle ifade ediniz." sorusu yöneltilmiş ve katılımcıların bu iki soruya yazılı olarak cevap vermeleri istenmiştir. Katılımcılardan ilk uygulamada yaş ve cinsiyet gibi bazı özellikleri hakkında bilgi toplanmıştır. Bunun yanında her iki uygulamada da ad ve soyadı bilgisi istenmiştir. Katılımcıların cevaplarında öne çıkan tanım ifadeleri ya da önemli kelimeler dikkate alınarak kategoriler oluşturulduktan sonra bu kategoriler alanyazında yer alan öğrenme ve öğretme anlayışları ile karşılaştırılmıştır. Katılımcıların cevaplarının epistemolojik açıdan niteliği de kategorilendirmeler ve kodlamalar sırasında kullanılmıştır. Bununla birlikte iki farklı fen eğitimcisi çalışma hakkında bilgilendirilmiş ve katılımcıların cevaplarını araştırmacı tarafından bulunan kategorilere yerleştirmiştir. Bu uygulamada 90%'nin üzerinde puanlayıcı güvenirliğine ulaşılmıştır. Çalışmanın ikinci kısmında sözlü iletişim yolu ile veri toplanmıştır. Yazılı cevaplarına göre fen öğrenme ve öğretme anlayışları arasında uyum olduğu gözlenen dört katılımcı ile uyum olmadığı gözlenen beş katılımcı görüşmeye davet edilmiştir. Bu görüşmelerde katılımcıların fen öğrenme ve öğretme anlayışları tekrar sorgulanmış, sonrasında ise var olan uyum ya da uyumsuzlukların sebepleri yarı yapılandırılmış görüşme tekniği ile ortaya çıkarılmıştır.

Bulgular, katılımcıların beş farklı fen öğrenme anlayışına sahip olduğunu göstermektedir. Bu öğrenme anlayışları gelenekselden yapılandırmacı anlayışa doğru sırası ile *bilgi artışı, doğayı anlama, bilim yapma*, *uygulama* ve *yeni bir perspektif kazanma* şeklinde isimlendirilmiştir. Bununla birlikte 45 katılımcının yapılandırmacı fen öğretme anlayışına ve 42 katılımcının geleneksel fen öğretme anlayışına sahip olduğu gözlemlenmiştir. Ayrıca yapılandırmacı fen öğretim anlayışına sahip olan öğretmen adaylarının 80%'i aynı zamanda yapılandırmacı kabul edilebilecek bir fen öğrenme anlayışına sahip görünmektedir. Fen öğrenme ve öğretme anlayışları arasındaki bu uyum, geleneksel fen öğretme anlayışına sahip olan katılımcılar için 52%'ye düşmektedir. Bulguların tamamı dikkate alındığında fen bilimleri öğretmen adaylarının fen öğrenme ve öğretme anlayışları arasındaki uyumun 67% olduğu görülmektedir.

Yarı yapılandırılmış görüşmeler göstermektedir ki fen bilimleri öğretmen adaylarının öğrenme ve öğretme anlayışları arasındaki uyum ya da uyumsuzluğun sebebi öğretmen adaylarının fen öğrenme ya da öğretme ile ilişkilendirilebilecek ön deneyimleridir. Adaylarının öğrenme anlayışları, öğretme anlayışlarını yönlendirmekte ve bu çoğu zaman uyumlu bir anlayış çiftini karşımıza çıkarmaktadır. Genel olarak geleneksel bir fen öğrenme ve öğretme anlayışına aynı anda sahip olan katılımcılar üniversiteden önceki eğitim dönemlerinde fen derslerinde başarılı olduklarını ifade etmişlerdir. Ayrıca geleneksel öğrenme anlayışlarının kendilerine ulusal sınavlarda başarı getirdiğini ve bu durumun halen değişmediğini, dolayısıyla geleneksel bir öğretimin fen bilimleri öğrencilerini başarıya ulaştıracağını belirtmişlerdir. Öğrenme ve öğretme anlayışlarının her ikisi için de yapılandırmacı yaklaşıma sahip olan öğretmen adaylarında ise kendi ön öğrenme süreçlerine yönelik eleştirel bir bakış açısı ile karşılaşılmıştır. Öte yandan yapılandırmacı bir öğrenme anlayışına fakat geleneksel bir fen öğretme anlayışına sahip olan öğretmen adayları yapılandırmacı öğretimin kalabalık sınıf ortamına uymayacağını, bu durumu okul deneyimi derslerinde de gözlemlediklerini belirtmişlerdir. Ayrıca fen öğrenme ve öğretme anlayışları arasında uyumsuzluk gözlenen bazı öğretmen adayları akademisyenlerin de yapılandırmacı yaklaşımı tutarlı bir şekilde kullanmadıklarını ifade etmişlerdir.

Bu çalışma kapsamında bulunan fen öğrenme ve öğretme anlayışı kategorileri alanyazında yer alan kategoriler ile önemli ölçüde uyuşmaktadır. Ancak alanyazında bu tip araştırmalar genellikle öğrenme anlayışına odaklanmakta ve daha çok öğrenci örneklemlerine yönelik çalışmalar ile karşılaşılmaktadır. Bu çalışmanın öğretmen adaylarına odaklanmış olması bazı farklılıklara sebebiyet vermektedir. Fen bilimleri öğretmen adaylarının yaklaşık yarısının geleneksel bir fen öğretim anlayışını benimsiyor olmaları yeni fen öğretim programlarının uygulanabilirlikleri açısından düşündürücüdür. Ayrıca adayların fen öğrenme ve öğretme anlayışları arasındaki uyum ve uyumsuzlukların kendi deneyimlerinden kaynaklanıyor olması dikkate alınacak olursa, öğretmen yetiştiren kurumların öğretmen adaylarının istendik deneyimlerinin sıklığını artırması gerektiği görülmektedir.