Van Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 2024; 21(2), s.425-449.

Van Yüzüncü Yıl University Journal of Education, 2024; 21(2), p.425-449. DOI:10.33711/yyuefd.1413428

Primary School Pre-service Teachers' Orientation towards Science Teaching

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Abstract: One of the challenges that primary school teachers have is teaching science lessons and their beliefs have an essential role in teaching science. Therefore, this study focuses on primary school pre-service teachers' orientation toward science teaching including beliefs about the purposes of science teaching, beliefs about science teaching and learning, and beliefs about the nature of science (NOS). Data were collected from seven pre-service primary teachers (PST) through semi-structured interviews to reveal their beliefs and analyzed by using deductive and inductive coding. The primary analysis showed PSTs focused on everyday coping, affective domain, and improving skills like social skills as beliefs about the purpose of science teaching. Teachers mainly had teacher-centered beliefs (e.g. traditional) and transitional beliefs. Also, they mainly held naïve NOS beliefs. Further analysis showed that the teachers having teacher-centered beliefs had teaching purposes like the correct explanation, solid foundation, and science process skills. These teachers also had naïve NOS understandings. The teacher having informed beliefs in the nature of science held student-centered beliefs and also focused on the structure of science as a teaching purpose, unlike other teachers. Discussions and implications are presented considering the beliefs forming teachers' orientation toward science teaching in primary schools.

Keywords: Beliefs about the nature of science, orientation towards science teaching, primary school pre-service teachers, purposes of teaching, teaching and learning beliefs.

Sınıf Öğretmen Adaylarının Fen Öğretimi Yönelimleri

Öz: Sınıf öğretmenlerinin en çok zorlandığı konulardan birisi fen öğretimidir ve öğretmen inanışları fen öğretim kalitesini etkilemektedir. Bu nedenle bu çalışmada sınıf öğretmenliği öğretmen adaylarının fen öğretim amaçları, feni öğretmeye ve öğrenmeye yönelik inanışları ve bilimin doğasına yönelik inanışlarını içeren fen öğretimine yönelik yönelimleri araştırılmıştır. Veriler 7 sınıf öğretmeni adayından yarı-yapılandırılmış görüşmeler aracılığıyla toplanmış, tümdengelimsel ve tümevarımsal yollarla analiz edilmiştir. Öğretmen adayları fen öğretim amacı olarak günlük hayatta bilgiyi kullanma, duyuşsal alan geliştirme ve beceri geliştirme amaçlarına odaklanmıştır. Fen öğrenmeye ve öğretimine yönelik inanış olarak ise öğretmen adayları genelde öğretmen merkezli inanışa sahip olmuştur ve bilimin doğası ile ilgili olarak genelde gelişmemiş inanışlara sahiptir. Sonuçlar ayrıca, öğretmen merkezli inanışa sahip olan öğretmen adaylarının doğru cevaba ulaşma, öğrencileri sonraki yıllara hazırlama ve bilimsel süreç becerilerini geliştirme gibi amaçlara sahip olduğunu göstermiştir. Bu öğretmen adaylarının ayrıca gelişmemiş bilimin doğası inanışlarına sahip olduğu görülmüştür. Gelişmiş bilimin doğası inanışlarına sahip olup öğrenci merkezli yaklaşım geliştiren öğretmen adayı ise bilimsel bilginin özelliklerini amaç edinen tek öğretmen adayı olmuştur. Çalışmanın sınıf öğretmenliği adaylarının fen öğretimi amaçları, fene yönelik

Geliş tarihi/Received: 02.01.2024 Kabul Tarihi/Accepted: 10.05.2024 Makale Türü: Araştırma Makalesi

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Atıf için/To cite: Şen, M. (2024). Sınıf öğretmen adaylarının fen öğretimi yönelimleri. *Van Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi*, *21*(2), 425-449. https://doi.org/ 10.33711/yyuefd.1413428

öğrenme ve öğretmeye ilişkin inanışları ve bilimin doğasına yönelik inanışları ile ilgili sonuçlarının fen öğretimi yönelimi alanına katkılar sunacağı düşünülmektedir ve konu ile ilgili önerilerde bulunulmuştur.

Anahtar kelimeler: Bilimin doğasına yönelik inanışlar, fen öğretim yönelimleri, öğretim amaçları, öğretme ve öğrenme inanışları, sınıf öğretmen adayları

Introduction

Orientations toward science teaching (OTS) are part of teachers' affective domain (e.g., beliefs) and affect teachers' quality of teaching (Chan & Hume, 2019). Historically, OTS has been defined in different ways. Firstly, Grossman (1990) identified OTS as conceptions of purposes of teaching subject matter. Using this definition, Magnusson et al. (1999) developed the term and explained that OTS is a teacher's ideas about the purpose of science at a particular grade level. Accordingly, OTS shows teachers' general views toward science teaching. Furthermore, Magnusson et al. (1999) claimed that teachers can have nine different OTS which are process, academic rigor, didactic, conceptual change, activity-driven, discovery, project based science, inquiry and guided inquiry. Then, Friedrichsen et al. (2011) analyzed previous research using Magnusson et al.'s views about OTS and detected some problems. Accordingly, previous research used different definitions for OTS and this made the term ambiguous. Likewise, complex belief systems forming OTS are overlooked when a teacher is categorized in one single OTS (e.g. didactic). At this point, Friedrichsen et al. (2011) claimed that teachers should not be labeled in a pre-determined list of categories. Instead of this, teachers' patterns in beliefs and interactions of multiple beliefs should be revealed and these revealed beliefs should be used to portray teachers' OTS profile. Based on these ideas, Friedrichsen et al. (2011) claimed that OTS is formed by complex belief systems including beliefs about the goals or purposes of science teaching, beliefs about science teaching and learning, and beliefs about the nature of science and these beliefs need to be captured to understand teachers' OTS. Although the nature of science beliefs were seen as views in previous research (Lederman et al., 2002), we accepted them as beliefs instead of views as they are part of multiple complex belief systems called OTS (Friedrichsen et al., 2011).

Literature Review

Orientation toward science teaching studies were conducted with pre-service teachers (PST) (e.g. Aydın et al., 2015), in-service teachers (e.g., Lankford, 2010), and university professors (e.g., Padilla & van Driel, 2011). Accordingly, Özden (2008) reported PSTs had constructivist views regarding OTS. In another study, PSTs reported the goal of teachers is to be guides for the development of student's critical thinking skills and inquiry. PSTs also reported that teachers should raise scientifically literate generations and students should understand how the world works after they get science courses (Avraamidou, 2013). In the same year, Brown et al. (2013) studied biology PSTs' OTS and reported that participants' OTS is teacher-centered, and PSTs thought that teaching is delivering the knowledge and learning is listening to the teacher. Aydın et al. (2015) studied chemistry PSTs' OTS and focused on their goals for science teaching. Researchers reported that participants held central and peripheral goals and they use central goals in their teaching, but they do not use their peripheral goals in their teaching. In another study held with chemistry PSTs; Demirdöğen and Uzuntiryaki-Kondakçı (2016) who aimed to improve participants' OTS for nature of science (NOS) teaching defined OTS as multidimensional beliefs and used Roberts' (1988, 2007) curriculum emphasis to understand participants' beliefs about the goals of science teaching. After the implementation, researchers reported participants gained richer OTS and they started to have the structure of science and science, technology, and decisions as goals of science teaching. In another study, Demirdöğen (2016) examined the interaction between middle school PSTs' OTS and teacher professional knowledge (i.e., Pedagogical Content Knowledge, PCK) components (e.g. assessment knowledge). The researcher found that if participants' NOS beliefs are not consistent with their goals, they do not teach NOS in their teaching. Likewise, the researcher reported that the goals show themselves differently in teaching. For example; if the goal of the teacher is to teach the content, all aspects of the teacher's professional knowledge interact with this goal. On the other hand, if the teacher's goal is to make students self-explainer, this goal is not reflected in teaching. The researcher also reported that beliefs about teaching and learning are consistent with beliefs about the goals of science teaching and beliefs about NOS. In another study, Cansız and Cansız (2022) studied middle school PSTs' beliefs about teaching and their teaching practices and reported that PSTs saw themselves as student-centered during interviews, but their teaching practice was teacher-centered.

There are also OTS studies held with in-service teachers. For example; Lee and Luft (2008) studied secondary science teachers' OTS and reported that the goals of teachers were to prepare students to meet daily life needs. In another study, Cohen and Yarden (2009) reported junior high school teachers had a duality in their orientation toward teaching cell topics. Accordingly, although teachers considered the cell topic is important and it should be taught, they reported the cell topic is difficult, and they postpone teaching the cell topic or they spend less time teaching that topic. Next, Friedrichsen et al. (2009) compared pre-service and two-year experience teachers and reported both groups had a didactic orientation towards science and their goal was to prepare students for high school. Similarly, Sickel (2012) examined beginning biology teachers' OTS focusing on their beliefs about learning and teaching, and reported that teacher-centered teachers focused on teaching content whereas the teacher having student-centered orientation focused on teaching discipline-specific abilities. In another study, Bakanay and Çakır (2022) focused on how high school in-service science teachers' OTS shape their history of science teaching. Researchers specifically examined participants' beliefs about teaching and learning and beliefs about NOS and reported that participants mainly had traditional, instructive, and transitional beliefs about teaching and learning. Participants' NOS beliefs also differed from each other and they held naïve, eclectic (e.g. conflicting views), and informed beliefs. Comparing beliefs about teaching and learning and beliefs about NOS, researchers formed three OTS profiles namely traditional OTS mentioning teacher-centered beliefs with naïve NOS beliefs, reformist OTS representing student-centered beliefs with informed NOS beliefs, and transitional OTS showing transitional characteristics (e.g. conflicting ideas for corresponding beliefs). Previous research was not only carried out to reveal pre-service and in-service teachers' OTS. For example; Padilla and van Driel (2011) focused on university professors teaching quantum chemistry and reported that the professors had didactic and academic rigor orientations because the professors thought that quantum topic is difficult and such a difficult topic can be taught through teacher explanation.

In addition to these studies, it is possible to infer some conclusions from the literature regarding teachers' orientation toward science teaching. First, orientation toward science can answer the teaching quality problem (Abell, 2008). Accordingly, previous research pointed out that teacher-centered or didactic orientation decreases the quality of teaching because teachers could not connect different dimensions of teaching including curriculum, instructional strategies, assessment, and students' understanding if they have the teacher-centered orientation, but teachers having student-centered OTS could connect different dimensions of teaching (e.g. instructional strategies and students' needs) and perform better teaching. (Aydın et al., 2015; Aydın & Boz, 2013; Park & Chen, 2012; Sickel, 2012). Second, previous research mainly focused on teachers' beliefs about the goals of science teaching and ignored other parts of OTS including beliefs about teaching and learning and beliefs about NOS when they examined teachers' OTS (Demirdöğen, 2016; Friedrichsen et al., 2011; Sickel, 2012). Third, even though OTS is resistant to change (Brown et al., 2013) as it is multiple sets of beliefs, it is possible to change teachers' OTS. Previous research provided evidence that teachers' OTS can improve through the use of a conceptual change approach (Demirdöğen et al., 2016), content representation tools (CoRes) (Williams et al., 2012), science education courses learned at the undergraduate level (Avraamidou, 2013), teaching experience (Arzi & White, 2007). Fourth, OTS is sensitive to the context and it can be negatively affected by these contexts. For example, Aydın et al. (2014) reported that teachers' ideal goals conflict with their working goals. Even though their OTS is reform-based, they can shift to didactic OTS because of contextual factors. Lastly, previous research compared the OTS of teachers working in different grade levels and disciplines (Kapyla et al., 2009; Markic & Eilks, 2012). Accordingly, Kapyla et al. (2009) compared primary school PSTs' OTS with biology PSTs and reported primary school teachers had constructivist OTS whereas biology teachers had didactic OTS. In another study, Markic and Eilks (2012) compared freshman PST teachers' beliefs from four domains (physics, chemistry, biology, and primary school) considering their beliefs about teaching and learning and reported that Primary school PSTs' beliefs were mostly consistent with modern educational theory, biology PSTs followed them, but physics and chemistry PSTs mostly held traditional beliefs. Therefore, it can be concluded that teachers' OTS can change from one discipline to another, and teachers' OTS might be more student-centered when teachers work in lower grade levels (e.g. primary school) where an advanced level of content knowledge is not necessary for teaching.

Significance of the Study

Previous OTS studies mainly focused on beliefs about the goals of science teaching and there are few studies considering OTS as a multiple set of belief systems including beliefs about teaching and learning and beliefs about the nature of science (Demirdöğen, 2016; Bakanay & Çakır, 2022). These studies focusing on multiple sets of beliefs were carried out with middle school PTSs and high school in-service teachers. However, OTS as multiple sets of beliefs has not been studied at the primary school level before. When we turn our agenda to the primary school level, we can see that primary school teachers have difficulty teaching science lessons (Appleton, 2003; Summers, 1994). As studying OTS has the potential to solve the problems for the quality of teaching (Abell, 2008), this study aims to reveal primary school PSTs' OTS as multiple sets of belief systems. When PSTs' OTS is revealed, some inferences can be made regarding their future science teaching, and identifying their OTS can be the first step for improving their future teaching. In this way, the current study can make a contribution to the field of science teaching at the primary school level.

Theoretical Framework

This study aims to examine primary school PSTs' orientation towards science teachers considering Friedrichsen et al.'s (2011) ideas. Therefore OTS is defined as multiple set of beliefs including beliefs about the goals or purposes of science teaching, beliefs about science teaching and learning, and beliefs about the nature of science in this study.

Beliefs about the purposes of science teaching part were framed considering Roberts' (1988, 2007) work on curriculum emphases. Accordingly, both curriculum and science teachers can have seven different purposes when teaching science. These seven purposes are everyday coping, the structure of science, science-technology, and decisions, scientific skills development, the correct explanation, self as explainer, and the solid foundation (Roberts, 1988). Roberts (1988) reported that none of these seven purposes is hierarchically better than others.

Beliefs about science teaching and learning part were taken from Luft and Roehrig's (2007) study. Accordingly, Luft and Roehrig (2007) defined five different teacher beliefs regarding teaching and learning after several interviews with teachers. These beliefs are traditional, instructive, transitional, responsive, and reform-based. While traditional and instructive beliefs are teacher-centered beliefs, responsive and reform-based beliefs are student-centered, and transitional belief is between the other two groups (Luft & Roehrig, 2007).

Lastly, beliefs about the nature of science were borrowed from Lederman et al. (2002) study. Accordingly, Lederman et al. (2002) defined a list of characteristics for scientific knowledge and seven of these characteristics are suitable to teach at the K-12 level. Therefore, this study specifically focuses on tentativeness, the empirical NOS, theory-laden NOS (subjectivity), creativity and imagination, the lack of a universal recipe-like method for doing science (scientific method myth), difference and the relationship between scientific theories and laws, social and cultural embeddedness of science (Lederman et al., 2002). Lederman et al. (2002) claimed that participants can hold informed or naïve beliefs about these NOS characteristics.

Research Question(s)

This study is descriptive in nature and aims to understand primary school PSTs' orientation toward science. Therefore, the main research question of this study is 'What is primary school pre-service teachers' orientation towards science teaching?'. As OTS is defined as the combination of three types of beliefs (e.g. Beliefs about the purposes of science teaching), the study seeks answers to the following research questions:

1. What are primary school pre-service teachers' beliefs about the purposes of science teaching?

2. What are primary school pre-service teachers' beliefs about science teaching and learning?

3. What are primary school pre-service teachers' beliefs about the nature of science (NOS)?

4. What are the interactions between different beliefs (e.g. beliefs about science teaching and learning) forming primary school pre-service teachers' orientation towards science teaching?

Methodology

Research Design

According to Merriam (2009), basic qualitative research deals with how people interpret their experiences, how they construct their world, and what meaning they attribute to their experiences. The overall purpose is to understand how people make sense of their lives and experiences (Merriam, 2009). In this study, the participants interpret and report their constructed belief systems. By doing this, this research aims to uncover these constructed beliefs forming PST's orientation towards science teaching. Therefore, this study is a basic qualitative research.

Research Context

This study was conducted in one of the private universities located in Ankara, Turkey. The education language of the university was English. The university offers a four-year-long primary education program. After completing this program, the pre-service teachers take their certification and become ready to work as a teacher in primary schools. Primary school teachers work at K-4 levels, they teach life science in K-2 and teach science at third and fourth-grade levels in Turkey.

In Turkey, high school students enroll in different programs when they pass to tenth-grade level. These programs are social science-focusing programs, math and social science-focusing programs, math and science-focusing programs, and language-focusing programs. Except for math and science-focusing program, other programs do not provide an advanced level of scientific knowledge to the students. Mainly, high school students completing math and social science programs are enrolled in primary school education departments of universities after they take the university entrance exam. Therefore, students enrolled in primary school education programs mainly do not have advanced scientific knowledge and skills.

Before the study, the participants took laboratory applications in science education and basic science in primary school courses. The study was carried out in the fall semester of 2022-2023 when participants were taking a science teaching method course at the same time.

Participants

Seven primary school pre-service teachers (PSTs) enrolled in a science teaching method course voluntarily participated in this study. As the study was conducted at the beginning of the semester, it is thought that the science teaching method course did not affect participants' OTS. If the study was conducted after this course, most probably the course would affect the results much more. PSTs did not get any incentive for their participation, and it was told that they can withdraw from the study at anytime they wanted. Pseudonyms were given to participants from PST1 to PST7. All participants' university grade level was junior (i.e., third year of university) and six of them were female except for PST2. Six of the participants graduated from their high schools' math and social science-focusing program and one of them (PST 1) graduated from the math and science-focusing program. Table 1 summarizes the characteristics of the participants:

Table 1

Characteristics of the Participants

PST#	Gender	High School Education
PST1	Female	Focuses on Math and Science
PST2	Male	Focuses on Math and Social Science
PST3	Female	Focuses on Math and Social Science
PST4	Female	Focuses on Math and Social Science
PST5	Female	Focuses on Math and Social Science
PST6	Female	Focuses on Math and Social Science
PST7	Female	Focuses on Math and Social Science

Data Collection

This study aims to understand primary school PSTs' beliefs (e.g. beliefs about the purposes of science teaching) forming their orientation towards science teaching. Luft and Roehrig (2007) reported that interviewing is a suitable method to capture teachers' beliefs; therefore, interviews were used to collect data. A total of 17 questions were asked to participants to reveal their OTS. As OTS included beliefs about the purposes of science teaching, beliefs about teaching and learning, and beliefs about the nature of science (Friedrichsen et al., 2011), the interview questions specifically addressed these beliefs. Accordingly, the first four questions were obtained from Friedrichsen et al. (2011) study to understand participants' beliefs about the purposes of science teaching (e.g., What are your goals when you teach science, when you teach science what do your students learn, and which skills do they develop?). The next three questions were asked to understand participants' beliefs about teaching and learning. These questions were obtained from Luft and Roehrig's (2007) study (e.g. What is the role of teacher in science lessons, what is the role of students in science lessons?). Lastly, Nature of Science C (V-NOS C) (Lederman et al., 2002) questions (10 questions) were asked to participants to understand their NOS beliefs. Interviews lasted nearly one hour for each participant. All interviews were recorded and transcribed for data analysis.

Data Analysis

At the beginning of the data analysis, transcriptions about beliefs about the purposes of science teaching part were deductively coded by two science education researchers having experience in qualitative data analysis considering the codes obtained from Roberts (1988, 2007). The definitions and explanations of seven curriculum emphases suggested by Roberts are presented in Table 2:

Table 2

Beliefs about the Purposes of Science Teaching (Roberts, 1988; 2007)

Curriculum Emphases (Belief about the Purposes of Science Teaching)	Definition	Example
Everyday Coping	Science is taught to improve students' understanding of daily life objects and events.	The teacher explains how chemical reactions occur in a car.
Structure of Science	Science is taught to teach characteristics of science like the relation between theory and evidence, and the self-correcting feature of science.	The teacher focuses on atom models, Avogadro's Hypothesis, and Atomic Theories.
Science Technology and Decisions	It integrates science and technology to solve a social problem.	The teacher focuses on the solution to the eutrophication problem and its impact on the public.
Scientific Skill Development	The aim is to improve students' science process skills (SPS). The focus is on the means of scientific inquiry.	The teacher teaches the classification of living organisms mentioning classifying SPS.
The Correct Explanation	The focus is to make students content experts in science. The focus is on the product of scientific inquiry (content knowledge).	The teacher just focuses on teaching correct knowledge and this knowledge is not discussed or questioned.
Self as Explainer	The focus is the explanation of the scientific phenomenon. It emphasizes the factors leading scientists to reach a conclusion. It is consistent with the history of science and the discussion of controversial issues having different explanations from different disciplines (e.g. science vs. religion).	The teacher teaches Kepler's ideas about the planetary model and refers to the contextual factors (his religious beliefs) that lead him to think in that way.
The Solid Foundation	The focus is to prepare students for the next units, years. This knowledge is helpful as students construct their advanced knowledge on it.	An elementary school teacher teaches the content to prepare students for secondary school.

When we analyzed the data, we found two more codes inductively for the participants' purposes of science teaching. These codes were 'affective domain' and 'other skills'. In the affective domain, participants focused on improving students' attitudes toward science (e.g. improving curiosity). Similarly, participants reported that they aimed to improve students' social, physical, and cognitive skills (e.g. reasoning skills) which were not listed in Roberts's (1988, 2007) curriculum emphases in some of their explanations. Such goals were coded as other skills. In conclusion, we coded participants' beliefs about the goals of science teaching using nine codes.

Next, we deductively coded transcriptions about beliefs about teaching and learning by using codes obtained from Luft and Roehrig (2007). Accordingly, we used five codes to reveal participants' beliefs about teaching and learning. Definitions and examples of each belief are presented in Table 3:

Table 3

Beliefs about Science Teaching and Learning (Luft & Roehrig, 2007)

Category	Definition	Example
Traditional	The teacher focuses on transmitting knowledge in the traditional category. This belief is teacher-centered.	The role of the teacher is to deliver knowledge. The teacher prepares PowerPoint. The teacher follows the textbook.
Instructive	The teacher applies the rules in class and aims to get students to have experiences without details. This belief is teacher-centered.	The teacher minimizes the disruptions and provides students with laboratory experiences. The teacher provides materials for students to learn. The teacher gives quizzes. The teacher asks students to follow laboratory instructions.
Transitional	The teacher aims to have a positive relationship with students and tries to be a guide for them.	The teacher conducts science lessons in a way that students enjoy it. The teacher encourages students to think about their ideas. The teacher also has relationships with students outside of the class.
Responsive	The teacher allows students to be active and independent learner and expect them to construct knowledge in cooperation. This belief is student-centered.	The teacher gives responsibility to students for their own learning. The teacher uses small groups where students make inquiries. The students discuss with each other and defend their claims. The students interact and they help each other.
Reform-Based	The teacher adjusts his/her teaching depending on students' needs. Therefore, the teacher observes students' experiences, notices their needs, and changes the instruction. This belief is student-centered.	The teacher let students have experiences in science so the teacher understands students' needs and modifies the instruction. The teacher considers ways that students learn best when s/he selects the instructional strategy. The teacher selects different strategies as students learn in different ways. Students' questions decide the next topics to be covered. The teacher considers whether the content is appropriate for the student's level.

Then, we coded the questions examining participants' nature of science beliefs. Lederman et al. (2002) shared naïve and informed beliefs for each NOS aspect (e.g. tentativeness) (see Table 4). Considering these beliefs, we coded each participant's beliefs about different NOS aspects and we reached four codes namely naïve belief, informed belief, no answer, and dualistic belief. A dualistic belief was used as code when participants held conflicting beliefs (e.g. including informed belief in one question and naïve belief in another question for the same NOS tenet) for the same NOS aspects.

Table 4

Beliefs about the Nature of Science (Lederman et al., 2002)

Nature of Science (NOS) Aspect	More Naïve Belief	More Informed Belief
Tentativeness	Scientific knowledge is certain. There are right and wrong answers in science. Law is a proven theory.	When new evidence emerges or the same data is interpreted in different ways, scientific knowledge changes. Negative evidence can refute a theory or law. We are never certain about a scientific idea.
The Empirical NOS	Science is straightforward and does not allow individual views. Science is concerned with facts that are proven.	Scientific knowledge depends on observation that is filtered by theoretical frameworks. There is no objective truth. Scientific claims are based on observational, personal, and social influences.
Theory-Laden NOS	Scientists can have different ideas on the same evidence as some evidence is missing. Scientists may not witness the event, so they may have different ideas. Scientists are objective so they cannot reach different results for the same evidence.	Scientists can interpret the same data differently because of their different backgrounds and education. Scientists are human and they think and learn differently from each other, therefore, they may interpret the same data differently.
Creative and Imaginative NOS	Scientists use their imagination in data collection, but they do not use it after data collection. The next part is objective.	Scientific knowledge depends on both logic and creativity. Creativity is used to find new ideas, we can also use creativity when we explain the observations.
The lack of a universal recipe-like method for doing science	Science includes an exact method when we follow it, we reach the right answer.	There is no single and correct way to follow when scientific knowledge is produced. The product of scientific inquiry is also not a certain right answer. Experimentation and falsification are not the only ways to produce scientific knowledge.
Difference and the Relationship between scientific theories and laws	Laws start as theory and when theories are proved, they transform into laws. Scientific theories can change, but laws do not.	Laws are descriptions and show the quantitative relationship between variables. Scientific theories are consistent with observations and they suggest new explanations and models. Using theories, we ask new questions and find new hypotheses, so theories improve our knowledge pool. Laws and theories are different entities and do not transform each other. Both laws and theories can change.
Social and cultural embeddedness of science	Science is about facts, so it is not affected by society. Science should not be affected by social values. Atom is the atom in different countries, so scientific knowledge is universal.	All factors in society and culture affect the acceptance of scientific ideas. Science culture including rules of practice and evidence affects the formation and interpretation of scientific knowledge. Scientists are the product of their culture, so they reflect their culture in their work.

These three analyses answered the first three research questions. In other words, we found some clues about participants' beliefs forming their OTS. However, these beliefs might interact with each other, and interactions of these beliefs might provide further information regarding participants' OTS. Therefore, we compared the same participant's different beliefs with each other and then, we compared different participants' beliefs with one another. This constant comparison allowed us to reach some findings about the interaction of these different beliefs. These findings were used as the answer to the fourth research question.

Trustworthiness and Ethics

We used investigator triangulation to increase the trustworthiness of the study. Accordingly, we coded the first participant's transcription together and calibrated the data analysis process. In this process, we explained our coding to each other. When we coded the data differently, we discussed the reasons and tried to persuade each other. At the end of calibration, we analyzed the data separately and compared the results. Inter-rater agreement was calculated as 85 %. Moreover, the differences in data analysis were also discussed and dissolved.

Prior to the study, ethical permission documents were prepared and presented to the university's ethical committee, and ethical permissions were taken from this committee. Furthermore, volunteer PSTs were selected as participants, and no one physically or psychologically got damaged. Participants' rights were protected and their data were not shared with a third person except for researchers. Lastly, participants were allowed to withdraw from the study whenever they asked.

Findings

This study aims to understand primary school PSTs' OTS considering three different beliefs (e.g. beliefs about the purposes of science teaching) and their possible interactions. Therefore, the findings are presented in four parts.

Findings for Beliefs about the Purpose of Science Teaching

Table 5 summarizes the results of the beliefs about the purpose of science teaching;

Table 5

Findings for Beliefs about the Purposes of Science Teaching

PST#	Everyday Coping	Structure of Science	STS	SPS	Correct Explanation	Self as Explainer	Solid Foundation	Affective Domain	Other Skills
PST1	X			X	X			X	X
PST2						X		X	X
PST3	X			X			X	X	X
PST4	X					X		X	X
PST5	X							X	X
PST6	X	X				X		X	
PST7	X				X			X	

Accordingly, findings for beliefs about the purposes of science teaching showed that all participants had affective domain goals which means they want to improve students' affective characteristics (e.g. attitudes, enjoyment, appreciation, curiosity). Other two goals that primary school PSTs generally had were everyday coping and improving other skills (e.g. cooperation skills, reasoning skills). Accordingly, participants aimed to get students to use the scientific knowledge learned in class in daily life (i.e., everyday coping) and they aimed to improve social, physical, and cognitive skills through science lessons (i.e., improving other skills). Three of the participants, on the other hand, focused on self as an explainer goal and they aimed to get students to try on the scientific explanation of the phenomenon and their reasons. Five of the goals were either rarely used (e.g. structure of science) or not used (e.g., science technology, and society/ decisions) by the participants. The following excerpts provide examples of participants' beliefs about different purposes of science teaching (Table 6).

Table 6

Excerpts for Beliefs about the Purposes of Science Teaching

Purpose	Excerpt
Everyday Coping	I expect students to understand and interpret natural events in their environment. I wish them to connect science and daily life events (PST1).
Structure of Science	I do not expect students to memorize the formulas. I want them to understand the logic of scientific law and explain it in their own words (PST6).
Science Technology and Decisions (STS)	-
Scientific Skill Development (SPS)	When students learn science, they understand science process skills, and how scientific inquiry and practices are done (PST3).
The Correct Explanation	I can use hands-on activities in science. Such activities can enhance their self-efficacy, they can do better and they can understand the content in detail (PST7).

Self as Explainer	I want my students to make inquiries in science lessons. You turn the switch on, why did you do that? Because we want the lamp on. I want students to think about the relationship between turning the switch on and the current passing through the circuit (PST2).
The Solid Foundation	The knowledge they learn in primary school will be pre-requisite knowledge for the following years (PST3).
Affective Domain	I can use educational games in my lesson. For example; they can match sense organs and corresponding objects in a game. When they open the different cards, they can match a picture visualizing the smell of food and another picture showing the nose as a sense organ. Such activities can improve their interest in science (PST4).
Other skills (Social, physical, cognitive skills)	When they engage in a science activity as a group, they collaborate with each other. Such activities improve their cooperation skills (PST5).

Findings for Beliefs about the Teaching and Learning

Table 7 presents participating teachers' beliefs about teaching and learning;

Table 7

Findings for Beliefs about Science Teaching and Learning

PST#	Traditional	Instructive	Transitional	Responsive	Reform-Based
PST1	X	X			
PST2		X			
PST3		X	X		
PST4	X	X			
PST5			X	X	
PST6			X	X	X
PST7	X	X	X		

As seen from Table 7, three general conclusions can be drawn about participants' beliefs about teaching and learning. First, PSTs mainly preferred teacher-centered beliefs which are traditional and instructive. Similarly, they held transitional beliefs that are between teacher-centered and student-centered beliefs. Second, participants mainly did not hold student-centered beliefs which were responsive and reform-based beliefs. Only two participants had student-centered beliefs. Third, participants having teacher-centered beliefs did not have student-centered beliefs, and the same is also true for the reverse. Table 8 provides further information about participants' beliefs about science teaching and learning:

Table 8

Excerpts for Beliefs about Science Teaching and Learning

Belief Category	Excerpt
Traditional	The role of a teacher is director. As science lesson is difficult, the teacher presents the knowledge by decreasing the number of topics, using various teaching methods, and connecting different ideas (PST7).
Instructive	The students try to learn new knowledge by applying the directions of the teacher (PST1).
Transitional	When you directly transmit the knowledge, students' curiosity is lost. Therefore, as a teacher, I want to teach the lesson in a way that students enjoy (PST5).
Responsive	I think that a teacher should benefit from peer learning. Everyone should be active, students should talk with their teacher and tell their ideas to peers (PST6).
Reform-Based	I am going to prepare portfolios. I need to take notes about their actions and deficiencies. I should have a folder for each student and answer their specific needs (PST6).

Findings for Beliefs about the Nature of Science

Participants' beliefs about seven tenets of the nature of science are presented in Table 9:

Table 9

Findings about Beliefs about the Nature of Science

PST#	Tentativeness	Empirical NOS	Theory-laden (Subjectivity)	Creativity and Imagination	Recipe Like Method	Theory & Law	Social and Cultural NOS
PST1	I	N	I	N	I	N	D
PST2	D	N	N	I	I	N	D
PST3	I	D	NR	N	N	NR	N
PST4	N	N	N	N	NR	N	N
PST5	I	I	N	N	N	N	N
PST6	I	D	I	I	I	I	I
PST7	I	N	NR	N	I	N	N

I = Informed, N= Naïve, NR= No Response, D= Dualistic

According to Table 9, two general assertions can be made about participants' beliefs about the nature of science. First, participants' naïve beliefs are generally more than their informed beliefs; therefore, it can be asserted that participants mainly did not have developed NOS beliefs. Second, participants mainly held informed beliefs in the tentativeness aspect of NOS and the universal recipe-like method for doing science (i.e., scientific method myth), but they held naïve beliefs in the rest of the NOS tenets. Table 10 presents specific information about participants' differing beliefs in seven different NOS aspects.

Findings for Possible Interactions between Different Beliefs Forming OTS

After examining participants' different beliefs, we specifically looked for some interactions between these beliefs. The possible interactions might provide a further understanding of their OTS. In this analysis, firstly we compared the results about beliefs about the purposes of science teaching and beliefs about teaching and learning. The findings showed that there is no direct interaction between these two beliefs. Even though PSTs' beliefs about teaching and learning change, their beliefs about the purposes of science teaching are mainly stable. For example; PSTs had everyday coping and affective domain goals in both teacher-centered and student-centered beliefs. On the other hand, we found some minor differences in PSTs' beliefs about the purposes of science teaching when their beliefs about teaching and learning changed. Accordingly, some of the PSTs having teacher-centered beliefs had purposes which are correct explanation, solid foundation, and, science process skills, but PSTs having student-centered beliefs did not have such purposes. On the other hand, one of the PST having student-centered beliefs focused on the structure of science as a purpose while the other six PSTs did not focus on the structure of science as a purpose. In conclusion, it might be claimed that correct explanation, solid foundation, and science process skills goals can be linked to teacher-centered beliefs whereas the structure of science can be related to student-centered beliefs.

Next, we looked for the interaction between beliefs about the purposes of science teaching and beliefs about the nature of science. The findings showed that the participant having the most informed NOS beliefs (PST6) had purposes which are everyday coping, the structure of science, self-as explainer, and affective domain. On the other hand, PST4 held the most naïve NOS beliefs and this participant had everyday coping, self-as explainer, affective domain, and other skills as purposes.

In the end, we compared participants' beliefs about teaching and learning with their NOS beliefs. The PST having the most informed NOS (PST6) beliefs held student-centered beliefs and the PST having the most naïve NOS (PST4) held teacher-centered beliefs.

Van Yüzüncü Yıl University Journal of Education, 2024; 21(2), p.425-449. DOI:10.33711/yyuefd.1413428

Table 10

Excerpts for Beliefs about the Nature of Science

NOS Aspect	Excerpt
Tentativeness (Informed)	Everything can change and nothing is absolute, this is also true for science. We learned from the science teaching method course that if something is certain, it becomes dogma (PST1).
Tentativeness (Naïve)	Scientists are certain about the definition of species. As they observe similar organisms breed, they reach absolute evidence and define the species term (PST4).
Tentativeness (Dualistic)	Scientific knowledge changes when we have different ideas or technological advances. Our knowledge about the speed of light may change after 50 years (Informed)… Scientists are certain about the definition of species because we do not need further detail about this definition. We are sure about this definition, this is not something like space (Naïve) (PST2).
Empirical (Informed)	Scientific experiments include observations and thinking. If you think something, you can externalize it through experiments (PST5).
Empirical (Naïve)	Science is more tangible compared with philosophy. We can match scientific data with real-world objects and events… Scientists conducted experiments to discover positive and negative particles of an atom (PST1).
Empirical (Dualistic)	By making observations, scientists define the species, but they are not sure. There are many factors affecting their observations and these factors can change the observations which also change the results coming from observations (Informed)… Science is about proven facts… Experimentation is always necessary and when we repeat an experiment, we should get the same result for each trial (Naïve) (PST3).
Theory Laden (Informed)	Scientists interpret the evidence differently. Scientists are human beings like us, they follow their own perspectives and they try to find evidence supporting their ideas (Informed) (PST6).
Theory Laden (Naïve)	Scientific knowledge can be proved, so scientists’ beliefs should not affect scientific knowledge (PST2).
Creativity (Informed)	Scientists use their creativity in all phases of scientific inquiry. Creativity starts the scientific inquiry. When you collect and analyze the data, the image in your mind is processed. We reflect our imaginations on the evidence we used for the report (PST6).
Creativity (Naïve)	Scientists do not use their creativity in their research because their work should be based on facts (PST4).
Recipe Like Method (Informed)	In science, experiment is not the unique way to construct knowledge. Scientists are curious about nature and they find different ways to reach knowledge. For example, they use the magnifier to better understand small organisms without conducting any experiments (PST2).
Recipe Like Method (Naïve)	The scientific method has consecutive stages which are making hypotheses, observations, collecting data, and reaching the results (PST3).
Theory and Law (Informed)	During the course, I took some notes. Accordingly, theories are explanations of observable phenomena. On the other hand, laws are general descriptions of observations. Before the course, I thought theories transform into laws when they are proven (PST6).
Theory and Law (Naïve)	Laws are more valid than theories as laws are proven. We accept the laws, but not theories (PST7).
Socio-cultural (Informed)	Science is affected by society. Let’s think about the Soviet and USA conflict. Soviet Russia sent astronauts to space and then the USA interested in space research. Wars, conflicts, and such things improve science. The conflicts among countries direct the development of scientific research. Therefore, everything is affected by socio-cultural context (PST6).
Socio-cultural (Naïve)	When scientists produce the knowledge, they learn the system. For example; gravity existed in the past and it exists today. Therefore, science is universal and not affected by society (PST5).
Socio-cultural (Dualistic)	Scientific knowledge is universal. When something is invented in the USA, it is also used in other countries (Naïve)… Beliefs and ethical values can affect science. For example; we discussed the cloning of Dolly in the science method course. People interpret the issue depending on their own ideas. Their ideas, therefore, can affect science (Informed), but science should be universal. I do not know.

Discussion

According to the findings of this study, primary school PSTs mainly used three goals which are affective domain, everyday coping, and development of other skills (e.g., social skills). Other goals such as STS were not preferred by PSTs. Similar to this finding, Cutter-Mackenzie and Smith (2003) reported that primary school teachers both had a lack of content knowledge and thought content knowledge is not essential at the primary school level; therefore, teachers claimed that improving students' skills and their attitudes toward science is more important than content in primary school level. If we think that our participants had no background in science because of their high school and university experiences (e.g. lack of science courses taken in these grade levels), the results of this study are consistent with Cutter-Mackenzie and Smith's (2003) explanations. Furthermore, pre-service teachers' lack of emphasis on science-related goals such as the structure of science, STS, and SPS also supported the idea that participants are not familiar with both science and its product (e.g., scientific knowledge).

Next, the study showed that participants mainly held teacher-centered beliefs for beliefs about teaching and learning. This finding was interesting because the university program offers student-centered courses. It is possible that the lack of science courses and PSTs' lack of content knowledge becomes an obstacle for them to have student-centered beliefs. This result is consistent with Appleton and Kindt's (1999) explanations about beginning elementary teachers' position. Accordingly, these teachers do not have a sufficient level of content knowledge and their self-efficacy level is low. Therefore, teachers having a lack of content knowledge and self-efficacy tend to control classroom events and prefer teacher-centered instructions.

The study also showed that primary school PSTs had naïve NOS beliefs in general. This result is consistent with previous research (Akerson et al., 2006; Garcia-Carmona, 2022; Garcia-Carmona & Acevedo-Diaz; 2016a). It is not surprising that PSTs having an insufficient science background (e.g. lack of knowledge and skills in science) have naïve NOS beliefs. Accordingly, Jüttner et al. (2013) reported that content knowledge includes declarative knowledge (i.e., explaining facts and theories), and procedural knowledge (e.g., how scientific process works). Participants' NOS beliefs seem to be directly linked with procedural knowledge because this procedural knowledge shows how that knowledge is produced. If people have informed NOS beliefs, most probably they are aware of how scientific knowledge is produced. For example; an informed belief for the distinction between scientific theories and laws addresses that theory and law are different entities and they do not transform to each other. This informed belief also assists that person to understand that scientists use theories to frame and solve their problems, use laws to formulate their observations, and so on. People having such subtle knowledge are probably more successful to understand the construction of scientific knowledge. At this point, Traianou (2006) discussed whether a primary school teacher should know declarative knowledge or procedural knowledge. According to the small range-constructivists, primary school teachers lack scientific qualifications and they do not know the knowledge found in the curriculum. Therefore, simple facts (declarative knowledge) should be presented to these teachers and they are supposed to reach higher-order knowledge using these simple facts. On the other hand, big ideas-constructivists claim that primary school teachers should know procedural understanding including scientific principles, and how scientists work and then these teachers construct the new knowledge on this procedural understanding (Traianou, 2006). Whether we support small range-constructivists or big-idea constructivists, our participants had lack declarative and procedural understanding due to their limited factual knowledge and naïve NOS beliefs, and so they are not ready to construct new knowledge and improve their understanding of science.

Primary school pre-service teachers' naïve NOS beliefs can also be related to their education including undergraduate and previous levels. For example; they might learn scientific method myth in their middle school years. Likewise, their teachers might taught these naïve ideas like 'theories transform to scientific laws when they are proved'. It should be also noted that these students mainly graduated from math and social science high schools where limited science courses are offered. When they did not get enough science courses in high schools, participants may not correct their naïve ideas gained in middle school years. Similarly, participants took only two science courses in their undergraduate level before participating in this study. Accordingly, their naïve beliefs about NOS were not eliminated in these courses. Therefore, both quality of undergraduate courses and the number of science courses need to increase in terms of opportunities used to improve primary school pre-service teachers' NOS beliefs.

Another focus of the study was the interactions between different beliefs. We compared participants' different beliefs and we found that the PST having informed NOS and student-centered beliefs specifically reported the structure of science as a belief about the purpose of science teaching, but other participants including the one having student-centered beliefs with naïve NOS beliefs did not focus on the structure of science. Roberts (1988) defined the structure of science as characteristics of science like the relation between the theory and evidence. In other words, the structure of science is directly related to teachers' goals of teaching the Nature of Science. For the structure of science, therefore, we can claim that having informed NOS belief is more important than having student-centered beliefs to have goals like teaching this goal (e.g. the structure of science). On the other hand, we did not find any participant having both teacher-centered beliefs and informed NOS beliefs. In this point, student-centered beliefs might be facilitators to teach NOS (e.g. the structure of science), but they are not sufficient alone to have such goals, and informed NOS beliefs are pre-requisite to have such goals. The close relationship between the nature of science and student-centered beliefs was also emphasized in previous research (Henze et al., 2008). Accordingly, Henze et al. (2008) reported if teachers do not have informed beliefs about the nature of models, they focus on only one model and they do not consider students' needs (i.e., teacher-centered beliefs). On the other hand, the teachers with informed beliefs about the nature of the models aim to teach different models in their teaching (i.e., the structure of science as purpose) considering students' needs (i.e., student-centered beliefs). Supporting our findings regarding the relationship between NOS beliefs and the structure of science as purpose, Demirdöğen and Uzun Uzuntiryaki-Kondakçı (2016) reported that PST chemistry teachers had richer OTS and structure of science as beliefs about the purpose of science teaching after a treatment focusing on understanding NOS aspects and their teaching.

In this study, participants having teacher-centered beliefs held naïve NOS beliefs, and only these participants focused on goals like the correct explanation, solid foundation, and science process skills as part of their beliefs about the purposes of science teaching. In line with this, Sickel (2012) reported that teacher-centered beginning biology teachers did not consider students' needs and focused on transmitting content knowledge and content goals. As it is understood, participants' focus on content and their little attention to students' needs limit their beliefs about the purpose of science teaching only with the content-related goals such as correctly explaining the content (i.e., correct explanation), teaching the content to connect them to higher grade levels' content knowledge (i.e., solid foundation), and using the content knowledge for the scientific inquiry (i.e., science process skills).

Implications

This study has some implications for research and practice. Accordingly, the study showed that primary school PSTs did not emphasize some science education goals. For example, none of the participants referred to science-technology and decisions (i.e., STS) goals as their beliefs about the purpose of science teaching. Such purposes can enrich their potential science lessons when they become in-service teachers in primary schools. Therefore, science education courses emphasizing such contents (e.g., STS) can be offered by primary education departments. In this way, primary school PSTs can gain such purposes to be taught in their future classes.

Similarly, participants mainly held teacher-centered beliefs even though their undergraduate courses were prepared considering student-centered instructions. It is possible that PSTs cannot have student-centered beliefs for science teaching and learning because they either could not connect their student-centered courses which were not directly related to science or the lack of science education courses made them unfamiliar with science; therefore, they tended to have teacher-centered beliefs to be safe in their future science teaching. As a solution to this problem, student-centered science education courses which can be models for PSTs' student-centered science instruction can be offered by primary education programs. Furthermore, the suggested courses can use a conceptual change approach or learning cycle to replace PSTs' teacher-centered beliefs with student-centered beliefs. For example; Demirdöğen et al. (2016) reported conceptual change approach is helpful to improve participants' OTS.

The study also showed that participants mainly held naïve NOS beliefs. Explicit NOS instruction, NOS-embedded argumentation and inquiry activities, and courses addressing NOS teaching can be prepared and offered by primary school education programs. In this way, primary school PSTs can improve their NOS beliefs.

This study also has implications for researchers. Examination of the interactions between different beliefs showed that 'the structure of science' as a belief about the purpose of science teaching can be an indicator of rich OTS that is important for high-quality teaching because this goal (i.e., the structure of science) was used only by the PST having both informed NOS and student-centered beliefs. Previous research reported that informed NOS beliefs (Demirdöğen et al., 2016) and student-centered beliefs (Sickel, 2012) bring about high-quality teaching. Therefore, researchers studying OTS considering multiple sets of beliefs can first look at whether their participants focus on the structure of science as the purpose of science teaching. Such first impressions might facilitate researchers' understanding of the participants' complex belief systems (i.e., OTS) before detailed and subtle analysis.

Limitations

The study has two main limitations. The first one is the generalization issue as in the other qualitative research. The study included seven primary-school PSTs, so the findings cannot be generalized to all PSTs. However, pre-service science teachers, in-service primary school teachers having similar characteristics to the participants, and primary school education programs can benefit from the study's findings. The thick description of the context, detailed explanation of the data collection and analysis processes, and the explanation of the findings can be helpful for the ones seeking the benefits from this study.

Another limitation is the use of only one data collection tool. In this study, the interviews were used to collect data and understand participants' OTS formed by different beliefs. In order to avoid this limitation, data were analyzed by two researchers independently and more than one time to understand whether our interpretations were consistent. Furthermore, we did not analyze individual questions. Instead, our approach was holistic and we analyzed the whole data set together to get further information about participants' beliefs. In addition to this, Luft and Roehrig (2007) reported that conducting interviews is sufficient to understand teachers' beliefs. For example, if observations are combined with interviews, we understand belief translation into practice (Luft & Roehrig, 2007). However, the aim of the study was to understand multiple beliefs (i.e., OTS), not the translation of the beliefs into practice; therefore, observations were not used. Likewise, the use of card-sorting activity (Friedrichsen & Dana, 2003) or content representation tools (Williams et al., 2012) was not appropriate to understand participants' OTS in this study because these tools were not framed by the views that see OTS as multiple sets of beliefs. For example; we cannot understand participants' beliefs about the nature of science by using these tools. In conclusion, the only tool used to understand participants' OTS formed by multiple beliefs was the interview.

Ethics Committee Permission Information: This research was carried out with the permission of TED University Human Research Ethics Committee with the decision dated 14/04/2023 numbered 2023/08.

Conflict of Interest Information: The author declares that there is no conflict of interest with any institution or person within the scope of the study.

Statement of Contribution Rate: The study has one author and the author conducted the study alone.

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Geniş Özet

Problem Durumu

Fen öğretimi yönelimi öğretimin kalitesini belirleyen temel etmenlerden birisidir (Chan & Hume, 2019). Bu çalışmada fen öğretimi yönelimi Friedrichsen vd. (2011) ile uyumlu bir şekilde 3 boyutta tanımlanmıştır. Buna göre öğretmenlerin fen öğretim yönelimi fen öğretimi amaçlarına yönelik inanışlar, fen öğrenme ve öğretimine yönelik inanışlar ve bilimin doğasına yönelik inanışlardan oluşmaktadır.

Alan yazında yapılan çalışmalar fen öğretimi yönelimi ile ilgili olarak şu çıkarımları yapmamızı sağlamaktadır: fen öğretimi yönelimi yapan çalışmalar öğretimin kalitesi ile ilgili bizlere bilgi vermektedir (Abell, 2008), önceki fen öğretimi yönelimi çalışmaları genel olarak fen öğretimine yönelik amaçlarla ilgili inanışlara odaklanmıştır (Demirdöğen, 2016), fen öğretimi yönelimini değiştirmek zor olsa da bu yönelimler değiştirilebilmektedir (Demirdöğen vd., 2016), fen öğretimi yönelimi bağlama karşı hassastır ve olumsuz yönde etkilenebilir (Aydın vd., 2014), son olarak fen öğretimi yönelimi disiplinden disipline değişebilmektedir (Kapyla vd., 2009).

Bu çalışmayı önemli kılan birkaç nokta bulunmaktadır. Buna göre fen öğretimi yönelimini 3 boyutta ele alan çalışma sayısı azdır ve söz konusu çalışma her 3 boyut hakkında da bilgi vermektedir. Benzer şekilde, sınıf öğretmenliği öğretmen adayları ile yapılan fen öğretimi yönelimi çalışma sayısı yok denecek kadar azdır. Mevcut çalışma gelecekte fen öğretiminin temellerini atacak olan öğretmen adaylarının fen yönelimleri hakkında bilgi verecektir.

Çalışmanın kavramsal çerçevesinin fen öğretimi amaçları ile ilgili inanışları Roberts (1988)'ın öğretim programı vurgularından, fen öğretimi öğrenme ve öğretimi ile ilgili inanışlar Luft ve Roehrig (2007)'in öğretmen inanışlarından ve bilimin doğasına yönelik inanışlar Lederman vd. (2002)'den alınmıştır. Bu çalışmada 4 temel soruya cevap aranmıştır. Bu sorular şu şekildedir; sınıf öğretmenliği öğretmen adaylarının fen öğretimine yönelik inanışları nedir, sınıf öğretmenliği öğretmen adaylarının fen öğretimi ve öğrenimine yönelik inanışları nedir, sınıf öğretmenliği öğretmen adaylarının bilimin doğasına yönelik inanışları nedir ve bu inanışlar arasında nasıl bir etkileşim vardır?

Yöntem

Bu çalışma temel nitel bir araştırmadır. Çalışmaya Ankara ilinde özel bir üniversitede öğretim gören 7 sınıf öğretmenliği bölümü öğretmen adayı katılmıştır. Veriler yarı yapılandırılmış görüşme soruları aracılığı ile toplanmış ve toplam 17 soru katılımcılara sorulmuştur. Elde edilen veriler daha sonra transkript edilmiş, tümdengelimsel ve tümevarımsal kodlarla kodlanmıştır. Bu şekilde ilk 3 araştırma sorusuna cevap aranmış ve elde edilen bulguların karşılaştırılması ile ilgili inanışlar arasındaki etkileşimler araştırılarak dördüncü araştırma sorusuna cevap aranmıştır.

Bulgular

Çalışmadan elde edilen sonuçlara göre, katılımcıların fen öğretimi amaçlarına yönelik inanışları katılımcıların duyuşsal amaçlara sahip olduğunu göstermektedir. Katılımcıların amaçladığı diğer iki amaç ise öğrencilerinin elde ettiği bilgileri günlük hayatta kullanmaları ve beceri gelişimidir.

Fen öğretimi ve öğrenimi ile ilgili olarak ise katılımcılar genel olarak öğretmen merkezli ve geleneksel öğretim yaklaşımını benimsemişlerdir. Ayrıca çalışmaya katılan öğretmen adaylarından hiçbiri hem öğretmen merkezli hem de öğrenci merkezli yaklaşıma sahip değildir.

Bilimin doğasına yönelik inanışlarda ise katılımcıların bilimin doğası boyutları ile ilgili genel olarak gelişmemiş inanışlara sahip olduğu söylenebilir. Katılımcıların gelişmiş olan inanışları ise bilimsel bilginin değişebilir yapısı ve bilimde tek bir doğru yöntemin olmamasıdır.

Farklı inanışların etkileşimi ile ilgili olarak ise öğretmen merkezli inanışa sahip öğretmenlerin fen öğretimi amacı olarak öğrenciyi sonraki yıllara hazırlamak, konuyu öğretmek ve bilimsel süreç becerilerine odaklanmak gibi amaçlara sahip olduğu görülmüştür. Öğrenci merkezli öğretmenin ise bilimsel bilginin özelliklerini öğretmeyi amaçladığı gözlemlenmiştir. Bilimsel bilginin özellikleri amacının ayrıca gelişmiş bilimin doğası inanışları ile de uyumlu olduğu görülmüştür. Fene yönelik öğrenme ve öğretme inanışları ile bilimsel bilgiye yönelik inanışlar arasında ise doğrudan bir etkileşim gözlemlenmemiştir.

Sonuç ve Tartışma

Sonuç olarak, Cutter-Mackenzie ve Smith (2003)'in de bahsettiği gibi sınıf öğretmenliği öğretmen adayları ilkokul düzeyinde üst düzey bir fen bilgisine sahip olmadıkları için duyuşsal amaçlara sahip olmuş olabilirler. Ayrıca, katılımcılar fen ile ilgili fenin özellikleri, fen toplum çevre gibi amaçları çok fazla amaçlamamışlardır. Bu durumda katılımcıların fen öğretimine çok aşina olmadıklarını göstermektedir. Çalışmada yer alan öğretmen adayları ayrıca genel olarak öğretmen merkezli yaklaşıma sahiptir. Bu durum öğretmen adaylarının gelişmemiş fen bilgisi ile ilgili olabilir. Buna göre, öğretmen adaylarının fen bilgisi düşük olduğundan öz yeterliliği de düşük olabilir ve kendilerini tehlikeye atmamak için öğretmen merkezli görüşlere sahip olup otoriter bir şekilde kendilerinin sorgulanmasının önüne geçmek istemiş olabilirler (Appleton ve Kindt, 1999). Benzer şekilde, fen geçmişi olmayan öğretmen adaylarının bilimin doğasına yönelik inanışlarının gelişmemiş olduğu söylenebilir ve bu bulgu önceki çalışmalarla uyumludur (ör; Akerson vd., 2006). Çalışmadan elde edilen bir amacın diğerlerinin önüne geçtiği gözlemlenmiştir. Buna göre bilimsel bilginin özellikleri amacına sahip öğretmen adayı hem öğrenci merkezli yaklaşıma sahiptir hem de bilimin doğasına yönelik inanışları yüksektir. Bu istendik bir durum olduğu için araştırmacılar öncelikli olarak katılımcıların bu inanışa sahip olup olmadığına bakabilirler bu şekilde ilgili katılımcıların inanışları hakkında genel bir fikir sahibi olunabilir.

Bu çalışmada fene yönelik amaçlar (ör; bilim toplum ilişkisi) vurgulanmadığı için sınıf öğretmenliği programlarında bu amaçlara yer verilmesi önerilmektedir. Örneğin, fen toplum çevre dersleri seçmeli olarak verilebilir. Daha fazla fen dersi verilerek öğretmen adaylarının fen bilgisi artırılabilir. Bu sayede öğrenci merkezli öğretim yapmak isteyen öğretmen adayları eksik bilgilerinden dolayı öğretmen merkezli öğretime geçmek zorunda kalmazlar. Benzer şekilde araştırma ve sorgulama tabanlı öğrenme yöntemleri ile öğretmen adaylarının bilimin doğasına yönelik inanışları geliştirilebilir. Son olarak bu çalışma nitel bir çalışma olduğu için çalışma sonucu genellenemez fakat çalışma bağlamına benzer durumda olan öğretmen adayları çalışmadan faydalanabilir.