A Multiple Case Study: Turkish Physics Teachers' Teaching Beliefs Related to the National High School Physics Curriculum

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Abstract

In the present Turkish High School Physics Curriculum (THSPC), it was explicitly stated that physics teachers should use various teaching methods and techniques such as 5E, 7E, cooperative learning, inquiry-based learning, and problem solving in their instructional practices. Although the use of multiple methods and techniques has been suggested by the national physics curriculum, it is probable that teachers do not teach by using various instructional methods and techniques. Some factors, especially their beliefs about how to teach physics according to the THSPC, can affect their use of various teaching methods and techniques. Identifying teachers' teaching beliefs related to the THSPC and investigating the reflection of these beliefs in their instructional practices can contribute to effective implementation of the THSPC. In this regard, the purpose of this study was to identify physics teachers' beliefs about how to teach physics according to the THSPC and to investigate the extent of reflection of these beliefs in their teaching. Four teachers from different schools participated in this study. Data was collected through interviews, open-ended questionnaire and classroom observations. According to the data results, all physics teachers believed that they could teach physics according to the THSPC by giving examples from daily life, and creating a discussion environment. In addition, the classroom observations showed that they generally used these two teaching techniques in their instructional practices.

Keywords: Physics Education, Teaching Beliefs, Turkish High School Physics Curriculum

Introduction

Rapid changes in technology and science force educators to change the traditional purposes of education (Hurd, 1998). The aim of the traditional education was transferring knowledge from teachers to students without their active involvement in learning (McDermott, 1993). Educators and teachers considered the students as passive recipient of the knowledge. They ignored their active participation to learning. However, contemporary view in education gives importance to students' construction of knowledge now (Hinrichsen & Jarret, 1999). Therefore, traditional instructions have some deficiencies in terms of overcoming certain conceptual difficulties and making connections between concepts and the real world. In fact, students learn best when they relate their knowledge to their daily life and when they are intellectually active (Hake, 1998; McDermott, 1991, 1993).

These disadvantages of traditional education make educators leave the traditional learning approaches in the curricula (Parker, 2001). Science curriculum developers begin to emphasize process skills such as making observations and measurements, articulating hypothesis, and designing and carrying out experiments (Duschl, Schweingruber & Shouse, 2007). In this regard, science curriculum developers around the world now incorporate these views into the curricula.

Similarly, physics curriculum developers in Turkey prepared new physics curricula for each grade level by considering the educational developments in the world and rapid changes in science and technology (Ministry of National Education [MoNE], 2007). Firstly, new Grade 9 Turkish High School Physics Curriculum (THSPC) was put into practice in 2008-2009 education-year in Turkey. In the following years, consecutively, new curricula for the 10th, 11th and 12th grades were also put into practice. In these curricula, curriculum developers emphasized active involvement in learning, real-life context-based approach and students' attainment of some skills such as problem solving skills (PSS), physics-technology-society-environment objectives (PTSEO) and information and communication skills (ICS) (MoNE, 2007).

Although curricula were well prepared, their implementation is affected by teachers (Kelly, 2009; Ogborn, 2002). Especially, teachers' beliefs are one of the factors that affect the implementation of curricula (Anderson, 1996; Briscoe, 1991; Cheung & Wong, 2002; Grossman & Stodolsky, 1995; Kelly, 2009; Keys & Bryan, 2001). Teachers' beliefs and decisions about the curricula can prevent curriculum reforms to reach their aims (Kelly, 2009). For instance, teachers' beliefs related to suggested instructional strategies and their defined roles and responsibilities in the curricula (Levin & He, 2008) which might not necessarily be in accordance with their beliefs about teaching. Therefore, curriculum reforms can be shaped and changed by teachers' beliefs (Cheung & Wong, 2002; Keys & Bryan, 2001).

Additionally, according to Pajares (1992) beliefs have a serious influence on shaping teachers' behaviors in the classroom. They affect teachers' perceptions and judgments thereby affecting their instructional practices (Pajares, 1992). Moreover, beliefs provide basis for attitudes, which, in turn, affect actions and intensions of individuals (Fishbein & Ajzen, 2010). In this regard, understanding teachers' beliefs is crucial before evaluating teachers' instructional practices and their thought process (Zheng, 2009). For example, while some teachers believe in constructivist perspective regarding students' active involvement in teaching and learning (Beck, Czerniak, & Lumpe, 2000), some can believe in traditional perspective emphasizing transmission of knowledge from teacher to students (Roehrig, Kruse & Kern, 2007). Although it is expected from teachers to leave their traditional instruction, many teachers believe that science is best taught by transferring knowledge from teacher to students (BouJaoude, 2000; Porlán & Martín, 2004; Tsai, 2002).

Physics curriculum developers in Turkey argue that they prepared a curriculum by taking into account needs and realities of Turkey. They conducted some studies to have the views of teachers, students, families, school administrations and Ministry of National Education about the curricula which will be prepared (MoNE, 2007). However, how much attention was given to teachers' beliefs is still questionable even after the preparation of the THSPC. In light of the discussions set out in the previous paragraphs, it is clear that teachers' beliefs about curriculum can affect their instructional practices in the classroom (Kindberg, 1999; Roehrig et al., 2007; Saez & Carretore, 2002).

Moreover, physics curriculum developers gave importance to students' active involvement in learning in the present THSPC, and therefore, they suggest teachers use

teaching methods making students active in learning such as inquiry based learning, problem based learning, cooperative learning, and 5E, 7E (MoNE, 2007). However, teachers' teaching beliefs can be an obstacle for teaching according to these methods. They can teach according to what they believed instead of teaching according to the THSPC. This can cause students to attain small number of skills indicated in the THSPC. Identifying the teaching beliefs of physics teachers related to the THSPC can have invaluable contribution to the revision and development of the curriculum. Therefore, some research questions were formulated as follows;

1. What beliefs do physics teachers have about how to teach physics according to the Turkish High School Physics Curriculum?

2. To what extent are physics teachers' beliefs about how to teach physics according to the Turkish High School Physics Curriculum reflected in their instructional practices?

Related Literature

In reviewing the literature, the studies related to the physics curricula in Turkey and teachers' teaching beliefs were taken into account. Firstly, we presented the studies related to the THSPC.

Balta and Eryılmaz (2011) investigated physics teachers' views about the changes in the present physics curriculum and in-service needs related to topics added to physics curriculum. Like them, Ergin, Şafak and İrgenç (2011), and Baybars and Kocakülah (2010) investigated physics teachers' views on the present physics curriculum. Physics teachers' views about the changes in the present physics curriculum were generally positive (Balta & Eryılmaz, 2011; Ergin et al., 2011). However, physics teachers had some difficulties in teaching physics according to the present physics curriculum (Baybars & Kocakülah, 2010; Ergin et al., 2011). For example, limited lesson hours (Baybars & Kocakülah, 2010; Ergin et al., 2011) and inadequacy of physical facilities (Baybars & Kocakülah, 2010) were the obstacles to teach physics according to the present curriculum.

Marulcu and Doğan (2010) investigated physics teachers' and students' views about the physics curriculum which was implemented before 2008 and physics course books which were used before 2008. They found that many of the participants thought that lesson hours were limited for teaching physics according to the curriculum. In addition, they thought that course books and physics curriculum were up-dated.

The study conducted by Akay (2009) explored whether the physics curriculum implemented before 2008 had expected properties in terms of total quality. The data results obtained from the open-ended questionnaire showed that objectives in the curriculum were not attainable by students due to some reasons. Participants thought that physical and technological facilities in the schools were not sufficient to teach physics effectively.

Some studies were conducted about the relationship between teachers' teaching beliefs and their practices in the classroom. For example, a study which was conducted with 37 Taiwanese science teachers showed that many of the teachers had a traditional or transmission belief about the nature of science, learning science and teaching science (Tsai, 2002). The researcher categorized teachers' beliefs of teaching science as 'traditional;' 'process;' and 'constructivist'. For example, traditional teachers believed in the transmission of knowledge in teaching. Process teachers gave more importance to the scientific processes or problem solving procedures in teaching. Constructivist teachers believed in the construction of knowledge with the assistance of teachers in teaching (Tsai, 2002). In his study, Tsai (2002) found that only six teachers had constructivist beliefs about teaching science. On the other

hand, 21 teachers believed that science was best taught by transferring knowledge from teacher to students (Tsai, 2002).

Another categorization of teachers' beliefs about science teaching was made by Porlán and Martín (2004). Researchers studied with 265 in-service and pre-service teachers from different areas to describe their conceptions of teaching and learning science. Teachers' beliefs about science teaching were defined as 'traditional;' 'technical;' and 'alternative' in their study. Teachers who have traditional beliefs believed teaching as a transmission of content like in the study of Tsai (2002). It was found that in-service teachers mainly had a traditional and pre-service teachers had a technical view of teaching.

Olafson and Schraw (2006) investigated the relationship between elementary teachers' teaching beliefs and instructional practices. Like other studies (e.g., Porlán & Martín, 2004; Tsai, 2002), Olafson and Schraw (2006) classified teachers' beliefs. Teachers' beliefs were classified under three constructs 'realist;' 'contextualist;' and 'relativist'. Many of the participants indicated their position as a contextualist and they stated that their instructional practices were consistent with this position. Few participants who have relativist view were found in their study.

In addition to these classifications for beliefs, Uzuntiryaki, Boz, Kirbulut, and Bektaş (2010) classified pre-service teachers' teaching beliefs as 'weak;' 'moderate;' and 'strong' conceptions of constructivism. They investigated eight pre-service chemistry teachers' beliefs about constructivism and effects of these beliefs on their teaching practices. Researchers concluded that teachers' practice and their beliefs were not consistent. Although participants indicated constructivist ideas in interviews, their instructional practices were not aligned with constructivism.

Another study about effects of teaching beliefs on teaching was conducted by Hashweh (1996) with 35 science teachers. He compared constructivist teachers' and empristic teachers' teaching strategies to handle alternative conceptions of students. It was found that constructivist teachers were stricter than empristic teachers in evaluating student responses consisting of some alternative conceptions. In addition, they were more successful in identifying students' alternative conceptions. Constructivist teachers had richer information of teaching strategies than empristic teachers.

Mellado (1998) investigated four primary and secondary pre-service science teachers' conceptions and beliefs about science teaching and learning. They found that many of the participants thought that university education little affected their learning about teaching. Their ideas about teaching were mostly shaped by their previous teachers' actions. They tried to behave like their previous teachers who followed a traditional instruction which included asking questions to students and explaining events. In addition, although many of the participants had a view of constructivism toward teaching, inconsistency in their responses to questionnaire and interview was found. For example, participants agreed on many of the items in the questionnaire, however, their actions in the classroom resembled more traditional teaching models contrary to their ideas about teaching.

Simmons et al. (1999) conducted a large-scale research project with beginning math/science teachers to investigate their beliefs, perceptions and classroom performances about their teaching philosophies and content pedagogical skills. Although undergraduate programs' aim was to make teachers adopt a student centered approach in their teaching practices, their practices were not aligned with their beliefs found in interviews similar to findings of Mellado (1998) and Uzuntiryaki et al. (2010). They behaved like their previous teachers and they used teacher centered approaches in the classroom.

BouJaoude (2000) used metaphors and open-ended questions to assess pre-service science teachers' teaching beliefs before the education programme which was designed for changing teachers' beliefs. Researcher found that, before the education programme started, 75% of pre-service teachers had a transmission view of teaching, which includes: 'transmitting knowledge to students', 'thinking students as blank slates' and 'seeing students as passive learners'. Only 1% of pre-service teachers had a constructivist view of teaching before the programme started; however, number of teachers who believe in constructivist view of teaching increased after the programme.

A case study which was conducted by Levitt (2002) with 16 elementary teachers showed that many of the participants believed that the teaching and learning of science should be student centered. In addition, consistency between educational reforms and teachers' beliefs about teaching and learning were examined in this study. It was found that some of the teachers' beliefs were aligned with educational reforms but there were still some gaps between teachers' beliefs and the principles of reform.

Haney, Lumpe, Czerniak and Egan (2002) examined the relationship between six elementary teachers' personal agency beliefs about teaching science and their ability to effectively implement science instruction. They found that few teachers had positive capability and context beliefs. These participants tended to design lessons according to incorporated inquiry, described planning, prior knowledge and experiences of students, equality issues, available and appropriate resources, daily life examples and collaborative approaches.

The study which was conducted by Yerrick and Hoving (2003) to investigate pre-service science teachers' beliefs about science teaching and learning showed that pre-service science teachers conducted their lesson by lecturing, asking only a few questions to students and thinking science knowledge as fixed and actual. Moreover, many of the participants did not value inquiry science processes.

Boiadjieva, Tafrova-Grigorova, Hollenbeck, and Kirova (2009) examined Bulgarian secondary science teachers' pedagogical philosophies by using interview techniques. They found that participants believed that students learned by doing best. In addition, they believed that the best learning occurs when students engage in hands-on activities, listen and read. According to participants, students should be self-motivated and good listeners. They also indicated that making students to attain problem solving skills, and using individual and multiple learning styles were crucial in teaching. Researchers concluded that most participants had constructivist and inquiry beliefs according to conducted interviews.

Chai, Teo, and Lee (2010) investigated the relationship among 718 pre-service teachers' learning beliefs, epistemological beliefs and pedagogical beliefs. They tried to model teachers' beliefs by comparing and matching them with each other. Researchers found that pre-service teachers who believed in 'innate ability' also believed in 'traditional teaching'. In addition, pre-service teachers who believed in 'learning effort and process' also believed in 'constructivist teaching'. The constructs 'certainty of knowledge' and 'authority/expert knowledge' did not significantly affect 'constructivist teaching' negatively. They did not also affect significantly 'traditionalist teaching' positively in their study.

It is obvious that teachers' actions in the classroom are affected by their teaching beliefs (Nespor, 1987; Pajares, 1992). There is a strong relationship between their teaching beliefs and their practice in the classroom (Haney et al., 2002; Haney & McArthur, 2002; Hashweh, 1996; Mellado, 1998; Olafson & Schraw, 2006; Porlán & Martín, 2004; Simmons et al., 1999; Tsai, 2002; Uzuntiryaki et al., 2010; Yerrick & Hoving, 2003). For example, although some teachers believed in transmitting knowledge to students and they practiced their lessons

according to their traditional beliefs (BouJaoude, 2000; Porlán & Martín, 2004; Simmons et al., 1999; Tsai, 2002; Yerrick & Hoving, 2003), some teachers believed in student centered learning (Boiadjieva et al., 2009; Levitt, 2002).

Methodology

According to Pajeres (1992), the most effective way to understand teachers' beliefs is interviewing with individuals and observing their actions. Fishbein and Ajzen (2010) also support his ideas and suggest researchers use open-ended questionnaire or interview to identify teachers' beliefs. In this regard, we used qualitative research design to investigate four in-service physics teachers' teaching beliefs related to the THSPC and reflection of these beliefs in their instructional practices. This study included interview with participants, classroom observations, and administration of an open-ended questionnaire to participants.

Instead of studying with one case teacher, we studied with four case teachers from different schools for more valid results and replication aims. According to Merriam (1998), using multiple case designs in educational studies enhances the external validity or generalizability of findings. However, using single cases makes generalizability difficult. Therefore, multiple case study designs can be preferred for replication aims. Same procedures can be replicated for each case to generalize cases with each other (Yin, 2003). In the following section, we described the criteria for selecting four case teachers.

Selection of the Cases

Stake (1995) argues that the first criterion for choosing a case is the concern to maximize what we can learn. Choosing 'information-rich cases' is a critical issue before starting data collection (Merriam, 1998). Therefore, the first author interviewed with seven physics teachers who worked in the Eastern Anatolia region of Turkey before selecting case teachers among them. We chose four teachers who could provide us rich information. Therefore, we selected cases purposefully to reach more data.

Secondly, we considered school types of teachers. We thought that teachers in different types of schools could have different beliefs. We selected two teachers, who worked in Anatolian High Schools, having generally low-achieving students, and one case teacher, who worked in Anatolian Teacher High School and one case teacher who worked in Science High School, having generally high-achieving students

The final criterion in the selection of cases was whether participating teachers in this study teach physics according to the THSPC. All of them indicated that they tried to teach physics according to the THSPC before data collection began. However, they indicated that they sometimes did not teach physics according to the THSPC due to some physical and technological deficiencies.

In addition, each school had only one physics teacher. Therefore, same teacher entered all physics lessons in each school. For example, one physics teacher had to enter all grades which were 9th, 10th, 11th and 12th. However, teachers were observed in the lessons of Grade 9. Grade 9 THSPC was put into practice in 2008. Therefore, some teachers had two years of teaching experience in the implementation of the THSPC when the data collection began. We considered observing teachers in the lessons of Grade 9 as an advantage on the assumption of teachers' more familiarity to Grade 9 THSPC when compared with Grade 10 and Grade 11 THSPC. We believed that we could reach more valid results by observing them in Grade 9. In addition, we chose the units 'nature of physics' and 'energy' because these units included many of the skill objectives in the THSPC which were expected from teachers to help students attain.

We referred to teachers throughout this study with pseudonyms. The following is a presentation of a detailed account of background information about each participant.

Case 1 – Sinan. Sinan was 27 years old. He was in the first year of teaching profession when the data collection of this study began. He has been working in Anatolian High School since September 2010. He graduated from the department of secondary science and mathematics education as a physics teacher in 2009. He has been a master of physics student in the field of general physics since 2009. He did not attend any in-service training programs or seminars related to physics education or the THSPC. Moreover, during his teacher training years, none of the courses informed him about the THSPC.

Case 2 – Fatih. Fatih was 35 years old. Like Sinan, Fatih was in the first year of teaching profession when the data collection of this study began. He has been working in Anatolian High School since January 2010. He graduated from the department of physics in 1998. He had a non-thesis master degree in physics education. However, he has never worked as a physics teacher until January 2010. In addition to his current position, he was also the physics teacher of another, vocational school in the city center. The Anatolian High School which he is working now had some discipline problems according to Fatih. Therefore, this school was very infamous in the city due to some discipline problems. He, similar to Sinan, did not attend any in-service training programmes or seminars related to physics education and/or the THSPC.

Case 3 – Tarık. Tarık was 33 years old. He graduated from the department of secondary science and mathematics education in 2001. He has been working as a science and physics teacher for nine years. He had four years of teaching experience in primary schools and five years of teaching experience in high schools. He always worked as a teacher in the Eastern Anatolia region of Turkey. He has been a physics teacher of Science High School in the city center since September 2010. He did not attend any in-service training programmes related to physics education or the THSPC.

Case 4 – Altan. The last case teacher of this study was Altan. He was 29 years old. He was graduated from the department of secondary science and mathematics education in 2006. He has worked as a physics teacher for six years in private institutions which offer private preparatory courses and public schools. He worked as a physics teacher in private institutions offering private preparatory courses during two years before graduating the university. He has been a physics teacher of Anatolian Teacher High School since January 2010. He was, at the time of data collection, a graduate student studying towards MS degree in the field of general physics. Like other participants, he did not attend any in-service training programmes or seminars related to physics education or the THSPC.

Data Collection

According to Yin (1993), several techniques such as collection of documents and archival records, interviews, observations and physical artifacts can be used in data collection in case studies. Throughout the data collection, the first author interviewed with participants, observed their instructional practices in the classroom, and administered an open-ended questionnaire to them. We described data collection sources in detail in the following sections.

Interviews: The first data source was the interview. In the interview, we asked teachers how to teach physics according to the real-life context-based approach, PSS, PTSEO and ICS to be able to understand how they teach physics according to the THSPC. Interview was conducted to be able to answer research question 1. All the interviews were conducted in a relaxed environment. After that, all of them were transcribed into the documents.

Open-ended questionnaire: The second data source was an open-ended questionnaire. It was prepared for triangulation aims and eliciting teachers' teaching beliefs related to the THSPC. We tried to identify teachers' teaching beliefs about skill objectives of 'nature of physics' and 'energy' units by administering an open-ended questionnaire to teachers. In the open-ended questionnaire, we asked teachers how to help students attain some PSS, PTSEO and ICS. Table 1 presents some of the skills asked in the open-ended questionnaire.

Table 1. Some of the PSS, PTSEO and ICS in the 'nature of physics' and 'energy' units

Problem Solving Skills	Distinguishing scientific knowledge, and view and values from each other
	Formulating a testable hypothesis for an identified problem
	Determining appropriate measurement tool to measure variables
	Performing adequate number of measurements to reduce measurement errors
	Expressing findings obtained after the analysis of data as models such as mathematical equations
Physics-Technology-Society-Environment-Objectives	Examining the past, present and future, positive and negative effects of physics and technology on the individual, society and environment (on social, cultural, economic, political, ethical etc. issues):
	Determining and explaining with examples the contribution of scientific knowledge in physics to development of technology
	Comprehending testable, questionable, falsifiable and evidence-based structure of physics
	Realizing that knowledge in physics increases in an accelerated way
	Realizing that scientific knowledge in physics is not always absolutely true; it is valid under certain conditions and limitations
	Observing how physics and technology is used by society while deciding in environmental problems
	Offering a solution by considering needs of individual, society and environment to social problems by using physics and technology for better life
Information and Communication Skills	Using appropriate terminologies in their communications (written, verbal and visual) related to physics
	Preparing presentations with correct outputs and appropriate for one's aims
	Using different formats such as text, number, picture, graph, diagram or table as much as possible while preparing presentation
	Controlling whether the sources of information is reliable and valid
	Using multiple search criteria
	Searching, finding and choosing the information appropriate for one's aim

Video-recorded classroom observations: The third data source for this study included observations of the case teachers' instructional practices during the fall semester of 2010-11 education-year. Teachers' practices on the *nature of physics* and *energy* units were observed. Each teacher was observed from the start of these units until they were completed to be able to answer research question 2.

Observations were made as non-participant fashion as Fraenkel and Wallen (2005) described. The first author observed teachers' instructional practices. He did not interact with students and teachers in the classroom. He sat on the desk at the end of the classroom. He recorded teachers' instructional practice in the classroom by using video-camera. He observed only one class for each teacher, and followed collecting data by observing the same classes during the entire data collection process. In so doing, he intended to investigate if the teachers' beliefs revealed during the interviews and open-ended questionnaires were reflected in their actions by focusing on how they attempted to help their students attain those skill objectives related to the 'nature of physics' and 'energy' units.

Data Analysis

Qualitative data analysis, according to Miles and Huberman (1994), consists of three components: data reduction, data display, and conclusion drawing and verification. First of all, all the interviews and video-recordings were transcribed into documents. Then, we used coding strategy for data reduction. We constructed categories and codes after analyzing the transcripts of interviews and teachers' responses to the open-ended questionnaire by focusing on research questions. We used tables to display data. Moreover, Miles and Huberman (1994), for drawing conclusions and verification, proposed some tactics such as 'clustering', 'counting', 'checking for representatives' and 'triangulation'. In this regard, we clustered codes under the categories. In addition, we obtained the occurrence frequencies of the teaching techniques that used by teachers in their instructional practices. At the end, we triangulated some of the findings obtained from the interview and open-ended questionnaire with each other.

Validity and Reliability

Four criteria were stated by Yin (2003) to judge the quality of case study research designs. These are construct validity, internal validity, external validity and reliability. Yin (2003) defined construct validity as an "establishing correct operational measures for the concepts being studied" (p. 34). Three tactics were suggested to increase the construct validity of the case studies. These are using multiple source of evidences, establishing chain of evidence and having key informants review draft case study report (Yin, 2003). First of all, we used multiple sources such as interview, classroom observation, and an open-ended questionnaire to collect data. Secondly, we always considered our research questions and revised them during the data collection. When evidences which were collected in data collection were not related to our research questions and did not help us reach conclusions, we tried to add extra questions into the interviews. Finally, one participant examined his case study report to increase the construct validity of the study.

Meriam (1998) suggested some strategies such as triangulation, member checks, long term observation, and peer examination to enhance internal validity in qualitative studies. We triangulated our data results by using multiple sources for the confirmation of our findings. We request one case teacher of this study to examine some parts of our data results to enhance the internal validity of this study. In addition, all of the lessons of participants were observed during one semester to increase internal validity. During the data collection, all results were examined by us.

External validity is the extent to which results of the study is generalizable to other situations (Meriam, 1998). Replication strategy (Yin, 2003) was used to generalize the results of this study. Yin (2003) proposed that "a theory must be tested by replicating the findings in a second or even a third neighborhood, where the theory has specified that the same results should occur" (p. 37). Therefore, we chose four case teachers to compare the results obtained from open-ended questionnaires, classroom observations and interviews.

Yin (2003) explained reliability in case studies as conducting the same case study with the same procedures to reach same result. Therefore, we followed the same procedure in the data collection for each participant to increase the reliability. Robson (2002) also suggested another alternative way to increase the reliability. Keeping a full record of activities such as interviews and field notes and details of coding and data analysis increase the reliability of study. Therefore, we recorded all the interviews, and classroom observations in addition to details of coding and data analysis. In addition, we transcribed all interviews and some of the talks of teachers and students in the classroom into documents.

Results

This part was divided into five parts. Firstly, we presented teachers' teaching beliefs about real-life context-based approach and reflection of these beliefs in their instructional practices. Then, we presented teachers beliefs about PSS, PTSEO and ICS and reflection of these beliefs in their instructional practices respectively. Finally, we presented to what extent these beliefs are reflected in their instructional practices.

Teachers' Beliefs about How to Teach Physics according to the Real-Life Context-Based Approach and Reflection of These Beliefs on Their Instructional Practices

We asked teachers about how to teach physics by considering real-life context-based approach in the interview. Based on their responses, we found two teaching techniques that represent teachers' teaching. Table 2 presents the teaching beliefs of teachers related to real-life context-based approach.

Table 2. Beliefs of physics teachers related to how to teach physics by considering real-life context-based approach

Beliefs		Code	Teachers			
			Sinan	Fatih	Tarık	Altan
Physics can be taught by considering real-life context-based approach by	giving examples from daily life	TGE	√	√	√	√
	creating a discussion environment	TCD		√	√	√

As indicated in Table 2, all teachers believed that physics could be taught by considering real-life context-based approach by giving examples from daily life. The following excerpt from the interview with Sinan illustrates this belief:

> Now, we try to mention the experiences of students more. While helping students remember the events which they face in their daily life, we try to relate them to physics. We wish go to laboratory. However, we cannot. We talk about the examples which are related to daily life. We try to perform some activities… We choose them from course book. For example, we demonstrate visuals which are related to daily life in the course book in the classroom. We associate these visuals with life. (Interview with Sinan)

This belief was reflected in instruction of Sinan. For example, while he was teaching measurement error, he related this concept to daily life. He wanted students to imagine how the grocer measures something wrong:

> For example, we go to the grocer. If the grocer is not honest, he/she can try to deceive people by measuring wrong. For example, let's have a balance like this. [He drew the sketch of balance on the blackboard.] For example, you want to buy five kilograms of rice. The grocer put five kilograms in this pan. [This pan refers the pan which he drew on the blackboard.] However, it is not actually five kilograms, it is four kilograms. He/she tries to deceive you. He/she measures one kilogram missing. The measurement error in this situation is one kilogram. (Observation of Sinan)

Like Sinan, Fatih believed that he could teach physics by considering real-life context-based approach by giving examples from daily life. He claimed that he asked students some questions related to transformation of heat. He tried to relate this concept to daily life:

> For example, I teach the transformation of heat. I ask students that can you [students] touch the wooden spoon when your mother forgets it in the kettle. When we give examples like this, students become more interested. In the transformation of heat, I ask students that how the heater heats your room, and how the sun heats us. In addition, I ask that do you [students] do work when

you move your bag along a straight road. We try to give examples which are related to students' experiences. (Interview with Fatih)

Similarly, Tarık believed that physics could be taught by considering real-life context-based approach by giving examples from daily life. The following excerpt from the interview with Tarık exemplifies his belief:

> Now, physics takes its power from technology. While teaching physics, we mention electrical installations in the school, X-ray films in hospitals, cars, bus and planes. They facilitate our life and they are operating according principles of physics. For example, one of the important tools which facilitate our life is mobile phone. It is operating according to principle of wave physics. We try to mention all of them. Therefore, we do not begin our teaching immediately without explaining them. (Interview with Tarık)

The instructional practice of Tarık was manifestation of his belief about teaching of real-life context-based approach. He tried to give examples from daily life in mentioning branches of physics. As they indicated in the interview he talked about some technological devices such as cell phone:

> For example, we can use cell phone as a result of modern physics. Why? How is the connection between base station and cell phone? Wave only comes, there is no cable. However, there are many disadvantages. For example, we are exposed to radiation; there are many damages of technology. For example, you have an operation in your kidney. What do you do? [He asked students; however, he answered this question without waiting students' responses] Kidney stone is decayed with laser gun.

Like other teachers, Altan believed that he could teach physics by considering real-life context-based approach by giving examples from daily life. In this regard, he thought that students did not forget the information and they were more interested in lesson:

> Before beginning to lesson, we talk about examples which are related to daily life. We asked that how it [referring to events in daily life] occurred. Student interprets. Then, there is something in physics; it [referring to events in daily life] is explained like this. Students say that if you explained it before, we have already known it. Due to this reason, student does not forget it. He/she becomes interested in lesson and comment a lot. After they learned some physics rules, they realize whether their interpretation is true. I teach like this. (Interview with Altan)

Additionally, Fatih, Tarık and Altan believed that physics could be taught by considering real-life context-based approach by creating a discussion environment. For example, Fatih discussed some physical events with their students by giving examples from daily life:

> I remember that I talked about the fossil fuels in the classroom. I said that they were exhausted after 50 years. Wars will begin. They attract students' attention. We have also discussed hydroelectric centrals and solar energy. I have talked about the working principle of cars. We try to give examples from daily life. (Interview with Fatih)

This belief of Fatih was reflected in his instructional practice. For example, he discussed disadvantages of using fossil fuels in the classroom. He started the lesson by asking students the kind of energy sources used in the cars. The following dialog between Fatih and his students exemplifies his instruction:

> Fatih: Which kind of energy source is used in the cars now?
>
> Student 1: Benzine
>
> Fatih: Benzine and diesel, petroleum products. We try to diminish the use of them. What is done? Cars which work with electricity are produced.
>
> Student 2: Teacher! With solar energy.
>
> Fatih: The cars which work with solar energy are also produced.

Student 3: Water.

Fatih: Ok! The cars which work different kinds of fuels are tried to be produced. For example, think! If all the cars consume oils, what will we do in 2030, 2040 and 2050. (Observation of Fatih)

Teachers' Beliefs about How to Teach Physics by Considering PSS and Reflection of These Beliefs on Their Instructional Practices

In addition to asking teachers about how to teach physics by considering real-life context-based approach, we asked them how to teach physics by considering PSS in the interview. However, Tarık and Altan indicated that they did not teach physics by considering PSS due to some technological and physical deficiencies of their schools. Sinan and Fatih indicated some teaching techniques to teach physics by considering PSS in the interview. Table 3 presents teachers' teaching beliefs related to PSS.

Table 3. Beliefs of physics teachers related to how to teach physics by considering PSS

Beliefs		Code	Teachers	
			Sinan	Fatih
Physics can be taught by considering PSS by	creating a discussion environment	TCD	√	√
	carrying out hands-on activities	TCO	√	√
	giving examples from daily life	TGE		√
	giving students research homework	TGS	√	

Sinan believed that he could help his students attain PSS by performing some activities, creating a discussion environment, and giving students research homework. The following excerpt from the interview with Sinan illustrates his belief that *physics can be taught by considering PSS by creating a discussion environment*:

… I asked students questions from the course book. For example, there were two pictures in the course book. I asked which crane was more powerful and lifted objects higher. I wanted students to guess. In addition, there were pictures which were related to energy sources. I asked students the efficiency of these energy sources. I tried to collect students' ideas. (Interview with Sinan)

Investigation of how Sinan would teach PSS also included collecting data with an open-ended questionnaire. Sinan indicated in the open-ended questionnaire that he could help students attain four PSS among 10 PSS of 'nature of physics' and 'energy' units. He indicated that he could help students attain two of them by creating a discussion environment, and two of them by carrying out hands-on activities. For example, he believed that he could help students attain the skill *formulating a testable hypothesis for an identified problem* by creating a discussion environment:

I can help students attain this skill by discussing what is needed for hypothesizing and how is hypothesized. (Open-ended questionnaire of Sinan)

This belief was reflected in instructional practice of him. He asked students questions and discussed some steps of scientific method in the classroom. However, it was very difficult to claim that he could help students hypothesize by using this technique when the following dialog between Sinan and his students from the video-recordings of Sinan was examined:

Sinan: Friends, we collect data after observation. Then what do we do? We present a temporary solution according to collected data. Is it Ok? What is this? First of all, we say this as hypothesis. Let's write. Are you ready?

Students: Yes.

Sinan: Yes, Friends! Now we have collected data after the observations, haven't we?

Students: Yes.

Sinan: What do we do now? Friends! We hypothesize. Do you know what is hypothesis? Hypothesis is a temporary proposed solution according to data. We said that if there was a problem, there had to be hypothesis. It is a temporary solution. Is it Ok? Friends! Do you understand it? (Observation of Sinan)

Fatih believed that he could help students attain PSS by performing some hands-on activities, giving examples from daily life, and creating a discussion environment in the classroom. The following excerpt from the interview with Fatih illustrates his beliefs about how to teach physics by considering PSS:

We try to choose easy examples from daily life. We talk about them in the classroom. We use accessible materials in the classroom. For example, we pour water into the perforated bottle. We try to mention the examples in the daily life. For example, we determine a problem. I ask students that how we can solve it. They suggest their solution ways. We encourage them to discuss them. Everybody in the classroom says their ideas. (Interview with Fatih)

Fatih indicated that he could help students attain four PSS of 'nature of physics' and 'energy' units. He thought that he could help students attain one of these by creating discussion environment, and the others by performing hands-on activities. The following excerpt from the open-ended questionnaire illustrates how he wanted to help students attain the skill *distinguishing scientific knowledge, and view and values from each other*:

We can discuss which knowledge are scientific and which knowledge are not scientific in the classroom. (Open-ended questionnaire of Fatih)

The belief of Fatih about how to teach physics by considering PSS was reflected in his teaching. When he helped students attain the skill *distinguishing scientific knowledge, and view and values from each other*, he created a discussion environment:

Fatih: I want one student who will read the reading part. [He wanted one of the students in the classroom to read a reading part in the course book.]

Student 1: Can I read? Teacher!

Fatih: Yes.

Student 1: …. What is the difference between scientific knowledge and personal view? Are you curious about these questions? Let's try to explain this with one example. You know that objects which are dropped from rest in the air falls in the ground…. [She read this reading part. Then, Fatih asked students questions.]

Fatih: …which one is scientific view and which one is personal view?

Student 2: Teacher! Can I say?

Fatih: Yes!

Student 2: First one is scientific and other is personal.

Fatih: In the first situation, he/she hypothesizes. He tried to construct theory. He said that there was gravitational force among masses and therefore it fall down toward ground. (Observation of Fatih)

Teachers' Beliefs about How to Teach Physics by Considering PTSEO and Reflection of These Beliefs on Their Instructional Practices

Like in the previous section, the data for analysis of beliefs about how to teach physics by considering PTSEO were obtained from the interview. Teachers indicated some teaching techniques that they would use in their instruction for the purpose of helping students attain PTSEO. Table 4 presents the beliefs of physics teachers related to how to teach physics by considering PTSEO.

Table 4. Beliefs of physics teachers related to how to teach physics by considering PTSEO

Beliefs		Code	Teachers			
			Sinan	Fatih	Tarık	Altan
Physics can be taught by considering PTSEO by	creating a discussion environment	TCD	√	√	√	√
	giving examples from daily life	TGE	√		√	√
	carrying out hands-on activities	TCO	√			
	giving students research homework	TGS		√		
	using information and communication technologies	TUI			√	

As can be seen in Table 4, all teachers believed that they could teach physics by considering PTSEO by means of creating a discussion environment. The following excerpt from the interview with Sinan illustrates this belief:

> There were some activities in our course book. For example, we discussed the renewable and non-renewable energy sources. We discussed why wind energy was renewable. (Interview with Sinan)

Investigation of how Sinan would teach PSTEO also included collecting data with an open-ended questionnaire. Sinan, in his answers to this questionnaire, indicated that students could attain 18 of the 21 PTSEO of 'nature of physics' and 'energy' units in the classroom. He thought that he could help students attain 12 of these by creating a discussion environment, four by giving examples from daily life and two by both giving examples from daily life and creating a discussion environment. He indicated that he could not help students attain three of them. Sinan's following response explains how he wanted to help attain students the objective *examining the past, present and future, positive and negative effects of physics and technology on the individual, society and environment (on social, cultural, economic, political, ethical etc. issues)*:

> In the classroom environment, students can attain this skill by discussing the examples in the course book and their research homework. (Open-ended questionnaire of Sinan)

The belief, that a discussion environment is a means for attaining PTSEO, was reflected in Sinan's instructional practice. For example, he, for the objective *examining the past, present and future, positive and negative effects of physics and technology on the individual, society and environment (on social, cultural, economic, political, ethical etc. issues)* created a discussion environment, which can be seen from the following excerpt:

> Sinan: Why do we use nuclear centrals? Friends!
> Student 1: For nuclear bomb.
> Sinan: For example, America threw nuclear bomb to Japan. One of the cities was destroyed. This bomb has huge energy. Is it Ok?
> Student 2: Teacher! Plants do not grow in there.
> Student 3: Teacher! New-born were deformed due to this nuclear bomb.
> Sinan: It has huge effects.
> Student 3: Nuclear centrals affected also the black sea region… (Observation of Sinan)

Like Sinan, Fatih believed that a discussion environment is useful for helping students attain PTSEO. The following excerpt from the interview with Fatih illustrates his belief:

> We generally discuss physics and technology relationship in the classroom. I ask students questions and try to answer their questions. (Interview with Fatih)

In the open-ended questionnaire, Fatih indicated that he could help students attain 17 of 21 PTSEO of 'nature of physics' and 'energy' units. He believed that he could help students attain 10 of these by creating a discussion environment and seven of these by giving examples from daily life. He indicated that he could not help students attain four of them. For example, the following excerpt from the open-ended questionnaire illustrates how he wanted to help students attain the objective *determining and explaining with examples the contribution of scientific knowledge in physics to development of technology*:

> Working principle of some devices can be discussed by considering physics rules. (Open-ended questionnaire of Fatih)

He believed that he could teach physics by considering PTSEO by creating a discussion environment. He acted according to his belief to help students attain the skill *determining and explaining with examples the contribution of scientific knowledge in physics to development of technology*:

> Student 1: …What is the relationship between technology and science? [Fatih allowed one of the students in the classroom to read a reading part in the course book. She asked the question to her friends at the end of the reading part].
>
> Fatih: Yes. Friends! What is the relationship?
>
> Student 2: Technology improves with science.
>
> Fatih: Yes it is true. They are dependent on each other. To improve technology we need science. For example, how is Hubble telescope built without development in scientific knowledge? To construct Hubble telescope, we need scientific knowledge. To develop science, it is necessary to use technology. For example, we need to build a laboratory like in the CERN. (Observation of Fatih)

Similar to Sinan and Fatih, Tarık believed that he could help students attain PTSEO by creating a discussion environment. The following excerpt from the interview with Tarık illustrates his belief:

> We give examples from our environment…We create a discussion environment in the classroom. We ask students questions. (Interview with Tarık)

Differently, Tarık also believed that he could teach physics by considering PTSEO by using information and communication technologies. The following excerpt from the interview with Tarık illustrates his belief:

> We try to demonstrate students some animations. For example, when we ask students how the energy is produced [meaning to say that he asked students production of energy, when they watched animation], they talk about their ideas. (Interview with Tarık)

Tarık indicated that he could help students attain 19 of 21 PTSEO in 'nature of physics' and 'energy' units in the open-ended questionnaire. He believed that he could not help students attain only two of them. He believed that he could help students attain 10 of these by creating a discussion environment, four of these by giving students research homework, one of these by giving examples from daily life and two of these by both creating discussion environment and using information and communication technologies. Tarık's following response explains how he wanted to help students attain the objective *determining and*

explaining with examples the contribution of scientific knowledge in physics to development of technology:

> For this, the working principle of some products such as cell phone, and cars around our environment can be discussed. (Open-ended questionnaire of Tarık)

His belief about how to teach physics by considering PTSEO was reflected in his teaching. For example, he used animations in the 'nature of physics' unit. He sometimes stopped to play animations on the media player. Then, he tried to discuss some points with students. The following excerpt from the video-recordings of Tarık illustrates how he helped students attain the skill *determining and explaining with examples the contribution of scientific knowledge in physics to development of technology*:

> [Having played the animation, Tarık started explaining relationship between physics and technology to students]. When we say technology, physics comes to my mind. When we look at our environment now, technological tools such as television, computers are certainly related to physics. All of them work with electricity. You will learn later, all of them include resistant, capacitor, and circuit… (Observation of Tarık)

Like other teachers, Altan believed that he could teach physics by considering PTSEO by creating a discussion environment. The following excerpt from the interview with Altan exemplifies his belief:

> First of all, I have talked about the examples which are related to physics in the environment. It takes approximately 10 to 15 minutes. I try to draw attention of students with that way. I try to provide students to realize it by observing… I sometimes ask students their ideas. If I only speak, it is meaningless. Students do not speak due to their respect to me in this situation. However, when you ask students their ideas, students say their ideas. (Interview with Altan)

Altan indicated that he could help students attain 18 of 21 PTSEO of 'nature of physics' and 'energy' units in the open-ended questionnaire. He thought that he could help students attain 14 of these by creating a discussion environment and three of these by giving examples from daily life. He did not write anything for one of the objectives in the open-ended questionnaire. He believed that he could not help students attain three of them. The following excerpt from the open-ended questionnaire illustrates how he wanted to help students attain the objective *comprehending testable, questionable, falsifiable and evidence-based structure of physics*:

> I can help students attain it by giving examples in the classroom environment. For example, which changes emerge with quantum physics when the Newton's physics is used can be discussed. (Open-ended questionnaire of Altan)

Altan helped students attain the skill *comprehending testable, questionable, falsifiable and evidence-based structure of physics* as he believed. He discussed whether there was a certainty in the science in the classroom. He discussed different kinds of thermometers such as Celsius and Fahrenheit with students. The following excerpt from the video-recordings of Altan illustrates his teaching:

> Student 1: Scientist found many thermometers. There is no need to find new ones.
> Altan: Why?
> Student 1: Teacher! Why are there Celsius and Fahrenheit?
> Altan: Friends! Is there a certainty in the science?
> Student 2: I think that there is not.
> Student 3: No!

Altan: Hence, for example, Newton physics has been known as true for many a long year. However, with the quantum physics, we realize that Newton physics cannot explain many physical events… (Observation of Altan)

Teachers' Beliefs about How to Teach Physics by Considering ICS and Reflection of These Beliefs on Their Instructional Practices

The final question related to how to teach physics in the interview was about ICS. Teachers indicated some teaching techniques to teach physics by considering ICS. The beliefs of physics teachers related to how to teach physics by considering ICS were given in Table 5.

Table 5. Beliefs of physics teachers related to how to teach physics by considering ICS

Beliefs		Code	Teachers			
			Sinan	Fatih	Tarık	Altan
Physics can be taught by considering ICS by	creating a discussion environment	TCD	√	√	√	√
	giving students research homework	TGS	√			√
	using information and communication technologies	TUI			√	
	carrying out hands-on activities	TCO	√			

According to Table 5, all teachers believed that physics could be taught by considering ICS by creating a discussion environment. The following excerpt from the interview with Fatih exemplifies this belief:

I do not claim that I can help students attain all ICS. I try to encourage students to participate in discussions. I try to create a discussion environment when I can keep order in the classroom. (Interview with Fatih)

Fatih's acceptance that he cannot not help students attain all ICS was supported by his responses to open-ended questionnaire, in which he indicated that he could help students attain only two ICS among 10 ICS of 'nature of physics' and 'energy' units; and he could do this by only creating a discussion environment. The following excerpt from the open-ended questionnaire illustrates how he wanted to help students attain the skill *using appropriate terminologies in their communications (written, verbal and visual) related to physics*:

When we ask students questions, they use this skill. For example, when we define 'work', we discuss it and demonstrate students how work is done. (Open-ended questionnaire of Fatih)

Like Fatih, Altan believed that he could help students attain ICS by creating a discussion environment. The following excerpt from the interview with Altan illustrates his belief:

First of all, we create a discussion environment in the classroom. Everybody try to say their ideas, however, we sometimes cannot do it. There can be some problems in curriculum. When there is a discussion in the classroom, students cannot accept ideas of other students or they can reject ideas of others. In this situation [meaning to say that students say their ideas], we can create a discussion environment. (Interview with Altan)

In the open-ended questionnaire, Altan indicated that he could help students attain five of 10 ICS. He indicated that he could help students attain two of them by giving students research homework, and one by both giving students research homework, creating a

discussion environment. However, he did not write anything about how to help students attain two ICS in the open-ended questionnaire. The following excerpt from the open-ended questionnaire exemplifies how he wanted to help students attain the skill *preparing presentations with correct outputs and appropriate for one's aims*:

> Whether the correctness of the results and whether they are presented according to desired aim can be discussed by giving homework. (Open-ended questionnaire of Altan)

Like Altan, Sinan believed that he could help students attain ICS by giving them research homework. The following excerpt from the interview with Sinan illustrates his belief:

> We cannot teach students computer programs. However, we assign research homework. They try to investigate them by using internet. In addition, I encourage them to investigate their homework from some books or journals. In addition, while we are performing activities, we separate students into groups. They discuss their findings with each other. We ask questions to students and create a discussion environment. (Interview with Sinan)

Sinan indicated that he could help students attain three of ICS in the open-ended questionnaire. He believed that he could help students attain two of them by creating a discussion environment, and one by giving students research homework. The following excerpt from the open-ended questionnaire illustrates how he wanted to help students attain the skill *using different formats such as text, number, picture, graph, diagram or table as much as possible while preparing presentation*:

> Research homework can be given to students as wanted in the course book and curriculum. Students can attain this skill by preparing posters. (Open-ended questionnaire of Sinan)

Sinan acted according to his belief which was about how to teach physics by considering ICS. For example, Sinan gave students research homework to help students attain the skill *using different formats such as text, number, picture, graph, diagram or table as much as possible while preparing presentation*. He wanted students to investigate what kind of precautions can be taken to decrease the energy lost in buildings and why the front of vehicles is pointed. However, he warned students about how to conduct their research. The following excerpt from the video-recordings of Sinan illustrates this situation:

> Sinan: In page 66, there is research homework. [He gave students homework from the course book.] It is wanted you to explore what kind of precautions can be taken to decrease the energy lost in buildings and which technological equipment were used. Investigate it for next lesson. For next lesson. [Students wanted to say their ideas immediately. However, he did not listen their ideas. He wanted them to investigate the research homework for next week.]
>
> Student 1: Using styrofoam.
>
> Sinan: For next lesson. Friends! Investigate it. I do not want you to bring print output. Write them.
>
> Student 2: Can we write summary of our readings?
>
> Sinan: It is not story. You will write your findings.
>
> Sinan: Friends! You are investigating why the front of vehicles is pointed. Is it Ok? You can investigate it from internet, library and books. You will prepare a poster according to your findings which are obtained from your readings in the articles and books. Friends! It will not be big. It will be like a poster on the wall. Do not prepare big posters. Is it understood? Prepare it as in the course book. You will prepare by sticking on visual materials on the poster and explaining why the front of vehicles is pointed. We will hang your posters on the wall. (Observation of Sinan)

Tarık indicated that he could help students attain seven of ICS of 'nature of physics' and 'energy' units in the open-ended questionnaire. He indicated that he could help students attain three of them by giving students research homework, one by using information and

communication technologies, and one by creating a discussion environment. He did not write anything about how to help students attain two of them in the open-ended questionnaire. The following excerpt from the open-ended questionnaire exemplifies how he wanted to help students attain the skill *preparing presentations with correct outputs and appropriate for one's aims:*

> We can want students to prepare their term paper as a power point presentation. It is wanted from students who completed their term paper to present them in the classroom. (Open-ended questionnaire of Tarık)

The Extent of Reflection of Teachers' Beliefs about How to Teach Physics in Their Instructional Practices

We also calculated the occurrence frequencies of teaching techniques that physics teachers used in 'nature of physics' and 'energy' units to teach physics according to the THSPC in their instructional practices. However, it was extremely difficult, if not impossible, to identify that a teaching technique used by a teacher for considering real-life context-based approach, PSS, PTSEO or ICS. For example, when a teacher gave a daily life example during his instruction, one could not easily decide whether that example was given as a result of real-life context-based approach consideration or for helping student attain one of PTSEO. In this regard, instead of calculating the occurrence frequencies of teaching techniques used by teachers in the classroom for different considerations, we calculated the occurrence frequencies of each teaching technique that participants indicated in the interviews and open-ended questionnaire by observing their instructional practices (see Tables 6, 7, 8 and 9).

Table 6. Occurrence frequencies of teaching techniques that Sinan used in his instructional practice

Teaching techniques	Code	Observation Weeks												Total freq.
		1	2	3	4	5	6	7	8	9	10	11	12	
giving students research homework	TGS	–	–	–	–	–	–	2	–	–	1	2	–	5
giving examples from daily life	TGE	10	1	3	–	3	12	5	12	8	2	–	–	56
carrying out hands-on activities	TCO	–	–	–	–	–	1	1	–	–	–	–	–	2
creating a discussion environment	TCD	8	6	7	2	3	8	4	9	3	3	8	4	65

As shown in Table 6, Sinan gave 56 daily life examples and created 65 discussion environments. Compared to these seemingly high numbers, he gave students five research homework and carried out two hands-on activities.

Table 7. Occurrence frequencies of teaching techniques that Fatih used in his instructional practice

Teaching techniques	Code	Observation Weeks										Total freq.
		1	2	3	4	5	6	7	8	9	10	
giving students research homework	TGS	1	–	1	–	–	1	–	–	–	–	3
giving examples from daily life	TGE	4	6	5	11	4	15	7	19	6	–	77
carrying out hands-on activities	TCO	–	–	2	–	–	–	–	1	–	–	3
creating a discussion environment	TCD	7	6	5	6	7	10	5	21	4	–	71

Fatih gave students three research homework and carried out three hands-on activities as can be seen in Table 7. Moreover, he gave 77 examples from daily life and created 71 discussion environments during 10 weeks of observation.

Table 8. Occurrence frequencies of teaching techniques that Tarık used in his instructional practice

Teaching techniques	Code	Observation Weeks						Total freq.
		1	2	3	4	5	6	
giving examples from daily life	TGE	19	15	2	4	3	3	46
using information and communication technologies	TUI	6	5	–	–	–	–	11
creating a discussion environment	TCD	15	8	2	2	1	2	30

As can be seen in Table 8, Tarık gave 46 examples from daily life and created 30 discussion environments. In addition, he used information and communication technologies in his teaching 11 times in six weeks. He finished the units 'nature of physics' and 'energy' in six weeks because he used animations in his teaching.

Table 9. Occurrence frequencies of teaching techniques that Altan used in his instructional practice

Teaching techniques	Code	Observation Weeks													Total freq.
		1	2	3	4	5	6	7	8	9	10	11	12	13	
giving students research homework	TGS	–	–	–	–	–	–	–	–	–	–	–	–	–	0
giving examples from daily life	TGE	5	1	3	3	3	–	1	1	2	1	3	8	2	33
creating a discussion environment	TCD	4	3	6	1	4	2	–	–	–	2	4	3	3	32

Altan stated that he would give students research homework in the interview; however, he did not give students research homework, when actually it was possible to give such homework. In addition, he gave 33 examples from daily life and created 32 discussion environments as given in Table 9.

Conclusion and Discussion

The results of this study showed that all participating teachers believed that they could teach physics according to the THSPC by giving examples from daily life and creating a discussion environment. However, in addition to these teaching techniques, participants (Sinan and Fatih) who are in the first year of teaching profession believed that they could teach physics according to the THSPC by carrying out hands-on activities and giving students research homework. They tried to carry out hands-on activities and give students research homework in their instructional practices. More experienced participants (Cenk and Altan) did not perform any hands-on activities or give students research homework in their instructional practices as they believed to teach physics according to the THSPC. Additionally, Sinan and Fatih used teaching techniques 'giving examples from daily life' and 'creating a discussion environment' in their instructional practices more than Cenk and Altan used.

We think that these findings show that participants could perceive that they are required to teach physics by using generally these techniques. However, the reality is not like what

teachers seem to have perceived. Teachers are required to use various teaching methods to teach physics in the THSPC. For example, it is suggested in the THSPC that teachers can use the inquiry based-learning and constructivist teaching methods for the units 'nature of physics' and 'energy' (MoNE, 2007). However, none of the participants mentioned the techniques related to inquiry and constructivism in the interviews and open-ended questionnaire. The reason for this could be that they might not believe in the effectiveness of the use of these techniques or they might not have sufficient knowledge about these techniques.

Additionally, important finding of this study related to teachers' beliefs about teaching physics according to the THSPC was that teachers Sinan and Fatih who are in the first year of teaching profession believed that they could teach physics according to the THSPC by carrying out hands-on activities. However, Tarık and Altan did not mention this technique in the interview, although teachers are required to use hands-on activities in their instruction (MoNE, 2007). I think that the reason of this can be that Sinan and Fatih are more willing to teach physics according to the THSPC or school types where teachers worked can affect the formation of this belief. Tarık and Altan who worked in the schools composing of mainly high-achieving students could think that students did not need to perform any activities to learn physics because they were hard-working and successful. In addition, some factors such as university entrance exam, insufficient lesson hours or inadequacy of laboratory environment could affect the use of various teaching methods as participants indicated in the interviews. The results of the studies conducted by Baybars and Kocakülah (2010) and Ergin et al. (2011) supported our results. They found that insufficient lesson hour and physical and technological facilities of the schools made teaching physics according to the THSPC difficult.

When the studies related to teaching beliefs of teachers were examined, researchers (e.g., Olafson & Schraw, 2006; Porlán & Martín, 2004; Tsai, 2002; Uzuntiryaki et al., 2010) generally tried to categorize teachers' beliefs. They sometimes thought teachers as constructivist and sometimes as traditional. However, naming the participants in this study as traditional or constructivist is not logical. The participants in this study had sometimes constructivist roles, sometimes traditional roles and sometimes both of them in their teaching. However, it was obvious that they generally chose instructional methods generally based on traditional instruction. Although they indicated some techniques making students active in learning in the interviews, their instruction resembled more traditional teaching. Some researchers (e.g., Levitt, 2002; Mellado, 1998; Uzuntiryaki et al., 2010) also indicated that there were sometimes inconsistency between what teachers said in the interviews and their instructional practices. This inconsistency can be due to teachers' insufficient pedagogic knowledge. They cannot know what they do exactly according to the THSPC. To overcome this problem, teachers can be trained about how to teach physics according to the THSPC. Additionally, teachers' previous teaching and learning experiences could affect this consistency. For example, the results of the studies conducted by Mellado (1998) and Levitt (2002) support our claims. They found that teachers' previous experiences had a serious effect on their instructional practices.

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