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RESEARCH ARTICLE

Eliciting Prospective Science Teachers' Teaching Orientations by Using a Card Sorting Activity

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The purpose of this study is to develop a tool for prospective science teachers to elicit their beliefs about science teaching and learning, and goals or purposes of science teaching. We used the card sorting activity developed by Friedrichsen and Dana (2003). We took expert opinions for the produced scenarios. We conducted piloted card sorting activity first. Then, we prepared the final form of 16 scenario texts about electricity unit. We conducted this activity with ten junior prospective teachers. We used MAXQDA 2018 software to analyze the conversations of prospective teachers. The data revealed that most of the prospective teachers taught science in order to teach scientific knowledge. In addition, we found that prospective teachers who want to integrate technology into their teaching practices held mostly transitional and responsive orientations. As a result, we were able to demonstrate that this activity could be used to elicit prospective teachers' beliefs about science teaching and learning, and beliefs about goals or purposes of science teaching in technology integrated environments.

Keywords: Prospective science teachers, science teaching orientations, teacher epistemologies, teacher beliefs, card sorting activity

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Introduction

How teacher and prospective teacher knowledge and beliefs about teaching and learning are reflected in the classroom practice and how they change in the process have long been an important issue for educational researchers (Bryan, 2012). Studies show that beliefs about teaching and learning effect teaching practices (Darling-Hammond, 1998; Kagan, 1992; Pajares, 1992; Lumpe, Haney, & Czerniak, 2000; Guskey, 2002). Revealing teacher beliefs can provide important opportunities for improving teaching experiences and professional preparation (Wilson, 1989; Schraw and Olafson, 2014; Brookhart and Freeman, 1992).

Studies on teachers' knowledge and beliefs fall into category under science teaching orientations within the theoretical framework of Pedagogical Content Knowledge (PCK). Magnusson, Krajcik and Borko (1999) define the concept of science teaching orientations as "teachers' knowledge and beliefs about the purposes and goals for teaching science at a particular grade level" (p. 97). Friedrichsen, van Driel, and Abell (2011) identified three most important aspects of teachers' beliefs that, in turn, affect their science teaching orientations as follows: a) conceptions of science teaching and learning, b) conceptions about the nature of science, c) conceptions about the goals or functions of science education. These authors aimed to lay out the need to more clearly communicate the role of science teaching orientations from conceptual and methodological perspectives. In doing so, they recognized a consensus in the literature on the above-mentioned three aspects of teacher beliefs.

The experiences of teachers and prospective teachers in using current technologies (web 2.0 tools, animation, simulation, 3D glasses, etc.) in teaching activities are also closely related to their knowledge and beliefs like other teaching experiences (Kim, Kim, Lee, Spector, & DeMeester, 2013; Voogt, Fisser, Tondeur, & Vann Braak, 2016; Hsu, 2016; Rajbanshi, 2017). Teachers use technology in order to remain compatible with their existing belief systems (Palak & Walls, 2009). Therefore, integration of technology into teaching practices can be facilitated when existing beliefs of teachers and prospective teachers are taken into account and when teachers find it relevant to their goals: "The more valuable they judge an approach or tool to be, the more likely they are to use it." (Ertmer & Ottenbreit-Leftwich, 2010). Hence, we see an opportunity for development in beliefs regarding technology integration when prospective teachers become aware of their own knowledge and beliefs and feel a need for change or improvement.

A literature search with the keywords of "science teaching orientations" or "orientations" in ERIC, Web of Science, Google Scholar, Proquest and YÖK Tez databases in 2019 and earlier reveals many results (e.g., Kind, 2015; Park & Chen, 2012; Park & Oliver, 2008; Schwarz & Gwekwerere, 2007; Güven, Muğaloğlu, Doğança-Kücük, & Cobern, 2019). The fact that a limited number of studies exist on prospective teachers' orientations in technology integrated classrooms (e.g., Campbell, Longhurst, Duffy, Wolf, & Shelton, 2013; Looi, Sun, Seow, & Chia, 2014; Prestridge, 2017; Burke, Schuck, Aubusson, Kearney, & Frischknecht, 2018) provides a motivation and rationale for us to probe further this topic.

Hence, the purpose of this study is to develop a tool for prospective science teachers to elicit their beliefs about science teaching and learning, and goals and purposes of science teaching in technology-enriched teaching environments by making use of the card sorting task developed by Friedrichsen and Dana (2003).

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Conceptual framework

The literature on teacher knowledge and beliefs, Technological Pedagogical Content Knowledge (TPACK), and science teaching orientations defines the conceptual framework for this study. We explicate these topics below.

Teacher knowledge and beliefs

There exist multiple definitions of knowledge and beliefs about teaching. For example, Pajares (1992) makes a distinction between knowledge and beliefs and divides beliefs into components. According to him, when explaining objective reality, beliefs are subjective and based on judgments. Beliefs have cognitive, affective and behavioral components. The cognitive component represents knowledge; the affective component stimulates the senses; the behavioral component starts action when necessary. On the other hand, beliefs can be "thought of as psychologically-held understandings, premises or propositions about the world that are felt to be true" (Richardson, 1996). In addition, some studies reveal that teacher beliefs effect their content knowledge, ways of using demonstrations, providing instruction appropriate to students' characteristics, and integrating subject content into the applications they use (Fang, 1996; Veal, 2004).

Beliefs of individuals effect their sustained use of new teaching practices (Gregoire, 2003). Therefore, if teachers want to make changes in their teaching practices, their belief structures should be known (Van Driel, Bulte & Verloop, 2007). However, knowledge and beliefs about teaching and learning are implicit and resistant to change (Pajares, 1992; Kagan 1992; Richardson, 1996; Van Driel, Beijaard, & Verloop, 2001; Van Driel, Bulte, & Verloop, 2007; Postareff, Lindblom-Ylänne, & Nevgi, 2007; Le Fevre, 2014). There are various ways of making belief structures clear and understandable. The most important of these ways are individuals' deep thinking activities and feedback on teaching practices (Howard, McGee, Schwart, & Purcell, 2000).

The literature examined above shows that the beliefs of teachers effect their science teaching experiences. Thus, in order to ensure effective science teaching, teacher educators should try to understand the beliefs of teachers and prospective teachers during their development and at the same time uncover how their beliefs relate to teaching practices (Levin, 2014).

Technological Pedagogical Content Knowledge (TPACK)

What teachers and prospective teachers should know in the teaching process has been researched for many years. Then, came the concept of PCK. Shulman (1986) included within PCK "the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations-in a word, the ways of representing and formulating the subject that make it comprehensible to others." (p. 9). Many researchers (e.g., Shulman, 1987; Abell, 2007; Grossman, 1990; Magnusson, Krajcik, & Borko, 1999) have used this theoretical framework. In other words, PCK can be expressed as "what teachers know about how their students learn specific subject matter or topics and the difficulties or misconceptions students may have regarding this topic related to variety of representations and activities teachers know to teach this specific topic" (van Driel, Berry, & Meirink, 2014, p. 849). The demonstrations and tools used to teach the subject area have inevitably changed with technological developments. Although many of these tools were not originally developed for use in classrooms, they have become the tools used by educators in the recent years (Slotta & Linn, 2009).

In the standards published in both Turkey and elsewhere, the importance and necessity of teachers' adaptation to these changing and developing technologies are emphasized (e.g., UNESCO, 2008; NETS-T, 2008; MoNE, 2017). The statements in these standards are about teachers' ability to utilize digital technologies effectively in their classrooms together with their students. The term "effective use" means knowing which technology should be used, when and how. At this point, the concept of TPACK emerges (Niess, 2005; Mishra & Koehler, 2006; Koehler, Mishra, & Yahya, 2007).

There are two different perspectives for the TPACK theoretical framework. The first of these is the technological pedagogical content knowledge; technology knowledge, pedagogical knowledge and content knowledge, such as the emergence of a combination of knowledge that advocates the perspective (Mishra & Koehler, 2006; Koehler, Mishra & Yahya, 2007). Mishra and Koehler (2006) regard TPACK as a type of knowledge, which is composed of a combination of other types of knowledge. On the other hand, others argue that TPACK is different from the types of knowledge that are formed by the transformation of knowledge types such as technological knowledge, pedagogical knowledge and content knowledge (Niess, 2005; Angeli & Valanides, 2009; Niess, 2013; Canbazoglu Bilici, Guzey, & Yamak, 2016). The starting point of these researchers is based on the theoretical background created by Magnusson, Krajcik and Borko (1999) for PCK.

Magnusson et al. (1999, p. 99) provide a delineation of components of pedagogical content knowledge in which orientation to teaching science shaping four components: a) knowledge of science curricula, b) knowledge of students' understanding of science, c) knowledge of instructional strategies, d) knowledge of assessment of scientific literacy. Magnusson et al. (1999) identify science teaching orientations with "teachers' knowledge and beliefs about the purposes and goals for teaching science at a particular grade level" (p. 97). Therefore, it can be concluded that the most important factors influencing teachers' PCK are their knowledge and beliefs.

Among the models created for the TPACK theoretical framework, beliefs or orientations are not included in the integrative model, but they are covered in the transformative model. For Niess (2013) the first component of the transformative model of TPACK is "[A]n overarching conception about the purposes for incorporating technology in teaching subject matter topics." Identification of this component by Niess with "what teachers know and believe about the nature

of the subject, what is important for students to learn and how the technology supports learning provide the basis for their instructional decisions" leads us to the notion that TPACK is a body of knowledge that also includes beliefs.

Science teaching orientations

Hewson and Hewson (1989) formed the basis of science teaching orientations with the research program of "conceptions of teaching science." Within this domain many researchers examined beliefs about science teaching and learning under the title of "science teaching orientations" (e.g., Magnusson, Krajcik, & Borko, 1999; Friedrichsen, van Driel, & Abell, 2011). Science teaching orientations can be influenced by teachers' learning goals, beliefs about teaching and learning, and beliefs about assessment (Volkmann, Abell, & Zgagacz, 2005). Gess-Newsome (2015) argues that "beliefs and orientations act as amplifiers or filters to teacher learning and mediate teacher actions" (p.30).

Magnusson, Krajcik, and Borko (1999) emphasized that teachers can have nine different science teaching orientations: process, academic rigor, didactic, conceptual change, activity-driven, discovery, project-based science, inquiry and, guided inquiry. In addition, for Friedrichsen and Dana (2005) a single labeling of orientations (e.g, exploratory or activity-based, etc.) does not adequately define this complex nature of teachers.

In the current study, we adopted the five teaching orientations of teachers and prospective teachers from Luft and Roehrig (2007) as follows:

- *Traditional*: Focuses on information, transmission, structure or resources.
- *Instructive*: It tries to provide a teacher-centered experience environment.
- *Transitional*: Focuses on student-teacher relationship or affective responses.
- *Responsive*: Focuses on collaboration, feedback or knowledge development.
- *Reform-based*: Focuses on acting on students' knowledge or interactions.

In the classroom where teachers use educational technologies, there are few studies that determine the science teaching orientations. It is concluded that teachers' orientations affect their experiences of using technological tools in technology-enriched classrooms (Campbell, Longhurst, Duffy, Wolf, & Shelton, 2013; Looi, Sun, Seow, & Chia, 2014; Burke, Schuck, Aubusson, Kearney, & Frischknecht, 2018). In addition, teachers' orientations may change at the end of various practices (Campbell, Longhurst, Duffy, Wolf, & Shelton, 2014; Prestridge, 2017).

Assessment methods of science teaching orientations

Some activities can be organized to determine the prospective teachers' orientations about science teaching. However, it is important that these activities enable prospective teachers to observe, analyze, and reflect on their own teaching experiences (Magnusson et al., 1999; p. 122; Anderson & Piazza, 1996). Various methods and tools have been developed to achieve this objective. Ravitz, Becker, and Wong (2000) developed a Likert scale to identify constructivist and traditionally oriented teachers. In this scale, the participants are asked to what extent they agree with various statements including teacher and student roles as well as general classroom approaches. One of the tools that allows to measure orientations in a wider scope is the card sorting task developed by Friedrichsen and Dana (2003). This activity consists of instructional environment scenarios covering various subject areas and activity tasks related to these scenarios.

Loughran, Mulhall, and Berry (2004) developed Content Representation, and Pedagogical and Professional-experience Repertories to uncover, document, and portray science teachers' PCK. Loughran, Berry, and Mulhall (2012) described these two tools as a valid and reliable 'Resource Folio' for measuring PCK.

Moreover, Friedrichsen and Dana (2005) used data collection tools such as interviews, card sorting task, and classroom observations to determine the orientations of science teachers. They stated that these tools are effective but take a lot of time. Luft and Roehrig (2007), prepared interview questions to determine prospective teachers' beliefs. Campbell et al. (2013) used learning diaries and lesson observations in their study with teachers. Cobern et al. (2014), on the other hand, created a multiple-choice questionnaire about pedagogies that can be used for short stories describing the actual teaching environment in the classroom setting. Prospective teachers are expected to answer these questions in a way that best reflects their teaching experiences. The multiple-choice questions consisting of these short stories have been prepared with approximately 100 questions on various science subjects.

The aim of the study

The aim of this study is twofold: i) to develop an activity in order to implement technology enrichment for the electricity unit, ii) to elicit prospective science teachers' beliefs about the goals and purposes and, beliefs about science teaching and learning.

Hence, the research question for this study is as follows:

Can the card sorting activity be used to elicit prospective teachers' science teaching goals and purposes and their beliefs about science teaching and learning?

Method

Since several complex social factors are effecting our understanding of this topic, we adopted the case study method (Merriam, 1998, p.41) to study the phenomenon in hand. From a case study point of view we focused on participants' beliefs in depth.

This study was conducted in three stages: i) preparing the activity, ii) conducting a pilot study, and iii) implementing the activity with participating prospective teachers. We utilized Magnusson, Krajcik, and Borko (1999) for PCK topics and Luft and Roehrig (2007) for orientations in the creating the scenario texts. In data analysis we benefited from the theoretical frameworks

presented in Luft and Roehrig (2007) for determining the beliefs about science teaching, and Hodson (2014; 1992) for revealing the beliefs about goals and purposes of science teaching.

Stage 1: Preparing the activity scenario texts

We used ideas from Friedrichsen and Dana (2003) in the development of card sorting activity aiming to determine prospective science teachers' orientations. We also contacted Dr. Friedrichsen by email to discuss our purposes and ideas and to get permission to use their ideas formerly published. She suggested that new scenarios could be written for the topic of electricity, but she recommended to include Luft and Roehrig's orientation topics instead of that of Magnusson et al. so that we could presume that teachers can have more than one orientation at the same time.

While creating the scenario texts we paid attention to some particular points such as having the covered issues in the texts being suitable for the curricular outcomes. We noted that a total of 30 outcomes on electricity are listed at levels from grades 3-8 (MoNE, 2018). Then, in order to teach these outcomes, appropriate technological tools and materials were determined by searching in various articles and on the Internet. While integrating the determined technologies into the course, scenarios were written considering the theoretical framework of PCK (Magnusson et al., 1999) and science teaching orientations (Luft & Roehrig, 2007). A content expert (a doctoral candidate in science education) reviewed the scenarios and provided feedback. Then, we collected expert views from four science teachers with teaching experience ranging from 4-8 years. At the time, two of these experts were pursuing their master's degrees in science education.

We made major changes in one scenario text and minor changes in three scenarios texts as a result of the feedback obtained from expert teachers. For example, before the expert feedback, the ninth scenario was prepared as "As a teacher, you design a lesson around the question of 'How does lightning and thunderbolts occur?'". Two experts suggested a modification as follows: "As a teacher, you design a lesson around the question of 'How does a photocopy machine work?'. We took this suggestion and modified the scenario accordingly. On the other hand, we simplified two scenario text by removing some expressions. For example, in the eleventh scenario text, 'twin science set' proper noun exists as the name of the experiment set. We removed that proper noun in the final form of the scenario text. Following these revisions, a total of 16 scenario texts were produced for teaching the subject of electricity in technology enriched teaching environments. **Table 1** shows some of these texts.

In the process of preparing the event, secondly, activity task card was created (Friedrichsen & Dana, 2003). This task card is a written document providing some instructions to the interviewer and the card sorter. An expert doing PhD in science education reviewed these instructions. Following minor revisions, the task cards took the final form for the pilot study.

Table 1. Examples of scenario texts.

Number	Scenario
2	As a teacher, you give your students batteries, bulbs and connecting cables. You encourage your students to find all possible ways to light the bulb.
10	As a teacher, you want your students to learn the electrical charges. Students examine the movement of objects under different loads by simulations and classify the loads.
14	As a teacher, you teach the advantages and disadvantages of power plants by having your students use webpage tools (WordPress, blog, etc.) to discuss and to generate ideas.

Stage 2: The pilot study

We conducted the pilot study with 10 volunteer prospective science teacher. Before starting the activity, the researcher reminded the prospective teachers that the card sorter and the interviewer had separate roles and gave the time required for both people to take both roles. The researcher tried to guide prospective teachers during the activity. Prospective teachers were separated into groups of two and completed their activities by changing their roles. After the completion of the activity, the prospective teachers were asked about the likes and dislikes of the activity and solution suggestions were taken for the parts that they disliked.

In the interview held at the end of the activity, prospective teachers stated that they had difficulty in understanding the instructions in the task cards. For example, in relation to the 4th instruction on the task card, prospective teachers declared the following ideas: "*The statement at stage 4 was really troublesome. We had a hard time understanding.*" and "*Yes, we had difficulty understanding the instruction, so we got help from you. We could do it after getting help from you*". In addition to this, they also declared similar views about item 6 as follows: "*The item 6 can be misunderstood.*" Similarly, a prospective teacher stated that they were not used to such an activity: "*I do not think that I would easily understand if I read it alone*". Moreover, another teacher candidate pointed out that the instructions on the task cards were too long by stating, "*It was just long for me, after you explained I understood it was simple but I would get bored if I read it alone.*" Based on all these excerpts, it was understood that the instructions on the task cards were not understood sufficiently (not reliable) and the prospective teachers were confused about what to do. To avoid this, the statements were simplified. In addition, separate task cards were created for the interviewer and card sorter to provide a more comfortable working environment during the event.

Stage 3: Implementation of the activity

Scenario cards were printed on 6cm x 10cm sheets displaying the card number for the scenario card sorting activity. There are two officers in the activity, one of whom is an interviewer and the other one is a card sorter. The duty cards of these officers are printed in A4 size and presented to the participants. The participant, acting as a card sorter, reads the scenario texts and performs the instructions written on the card. On the other hand, the participant who receives the

interviewer's duty card asks various questions in order to reveal the science teaching goals and purposes of his fellow companion. The researcher applying this activity encourages the prospective interviewer teacher to ask in-depth questions to understand his / her beliefs about science teaching and learning. The researcher encourages the card sorter prospective teacher to express his / her ideas more clearly and understandable.

Data collection tools

Prospective teachers' beliefs about science teaching and learning in technology-enriched classrooms and their beliefs about science teaching goals and purposes were determined with the help of developed scenario cards sorting activity. For this purpose, we used the audio recordings of the participants during the activity.

Participants

Ten volunteer prospective science teachers, 1 male and 9 female, were chosen with the purposeful sampling method for the main study. All ten participants were in their junior years and were majoring in middle school science teaching at a public university. During their education, the participants took physics, chemistry, and biology courses as well as courses on science education curriculum, information technologies in education, and teaching methods.

Data analysis

Since the dialogues during the activity contained rich information, we ran a content analysis to allow us to go from the pieces to the whole (to categories and themes) (Miles and Huberman, 1994). For this purpose, we used MAXQDA 2018 software. A second expert coded the data with 85% similarity. Afterwards we reached a consensus between us.

We analyzed the data separately for the following three topics:

1. Beliefs about science teaching goals and purposes,
2. Beliefs about science teaching and learning
3. Tendency in using technology

We coded the dialogues and speeches firstly into meaningful pieces for each one of the above topics. We then placed these codes under the corresponding themes in the relevant literature.

For the purposes of science teaching, by analyzing the conversation texts we obtained the following codes: "Understanding the nature," "making students be able to use (scientific knowledge) in daily life," "having students do experiments," "presenting (scientific knowledge) with visuals," "educating future scientists," "having students gain inquiry and questioning skills," and "having students reach a scientific conclusion by themselves." These codes were then placed into themes according to the relevant literature (Hodson, 1992; 2014).

In order to determine their beliefs about science teaching and learning, the following theme titles in the literature were selected:

1. "Improving student learning"
2. "Determining the time when students learn the subject"
3. "Deciding to move on to a new topic"
4. "How science can be learned in the best way"
5. "Teacher's roles"

Afterwards, the most appropriate codes were determined for each prospective teacher and their orientations were determined (Luft & Roehrig, 2007).

We included animations, simulations, square code applications, social media and augmented reality applications in the analysis process while excluding from the analysis process experimental and visual materials, which are also among the technological applications that prospective teachers have tendency to use.

Findings

Below, we present finding in the following order: i) the prospective science teachers' beliefs about science teaching goals and purposes; ii) beliefs about teaching and learning science; iii) their tendency to use educational technologies; and iv) the possible relationship between technology uses and beliefs.

Beliefs about science teaching goals and purposes

Ultimately, we reached two themes regarding participants' goals and purposes of science teaching: i) improving scientific knowledge and ii) improving research inquiry skills. Some excerpts from the participants are presented in **Table 2**. Meltem, Elif and Buse stated that they aimed to improve their students' research and inquiry skills. For example, Elif stated that the scenarios that best reflect her teaching experience are the ones that allow students to discuss and interpret:

> In the scenarios, which I will explain more, students discuss and interpret the issue. Or, they generate a model. After building with materials, they interpret the subject. They make prototypes or learn from simulation.

Elif explained that she wanted to design an instructional environment in which students create their own experiments and then discuss the results. This request of Elif seems to aim to regulate the teaching environment in a way that allows her students to be individuals who question and research in the way of access to information. Similarly, Meltem asks the prospective teachers to share their results and comments with their peers at the end of the experiments. Meltem emphasized the importance of interpersonal interaction in the process of creating scientific knowledge: I would like them to share electricity bills with each other and explain how [their different practices] lead to a change in bills. Meltem described the purpose of science teaching as "I think the purpose of science is having a good understanding of nature, life and human being." Even though she defines purpose of science teaching as understanding nature, we see that she aims to teach science by improving students' research and questioning skills.

Table 2. Some excerpts for participants' beliefs about science teaching goals and purposes

To improve scientific knowledge	To improve research inquiry skills
Erdem: [Science] should be told to the student how it takes place in life, not as direct theoretical knowledge. *Ayşe*: Making animation shows and making use of visualizations is similar to my teaching style. *Meltem*: I think that the purpose of science is to understand nature, life and human. *Gülfem*: As I said, I think that the students will learn science by doing, living and observing and by supplying it to daily life. *Aslı*: I find it more meaningful for students to learn by doing and living. So, I think that if I create an experiment environment in one corner of the classroom and make different experiments and benefit from the creativity of the students, they will learn more meaningfully. *Buse*: If I am going to teach this chapter, after describing the power plants and teaching them what is that, I ask them, for example, whether there is such a power plant around their homes, what are their advantages and disadvantages? *Beyza*: I can make use of animation and simulation methods [when I am teaching the subject] to the children. I could ask them to set up an electrical circuit. Or, I can give a ready electric circuit and teach the children through this circuit. *Şenay*: He asked the teacher to find the light bulb himself. I think they need to be taught first and then applied to their scope. *Ece*: I think that science teaching is a lesson in the field that can answer how everything we use in daily life works.	*Meltem*: The student learns by doing it himself. His/her mistake. When he short-circuited, he realizes it. He starts questioning why it did not light up. He says where I made the mistake and creates the circuit again. So, he says it made a mistake and there occurred the short circuit. He says I should never do that again. He says this leads to a short circuit, and he places it more in his ego. *Buse*: I want the student to discover it himself. I want the student to be active in the classroom. As outlined in Scenario 11, I will establish an experiment center in part of the class. So, the student will go to test; he will experiment and make use of these experiments to develop a new design. He will discover the information from those experiments himself and will access the information himself *Elif*: In the scenarios, which I will explain more, students discuss and interpret the issue. Or, they generate a model. After making with the material, they interpret the subject. They build prototypes or learn from simulation.

Buse, on the other hand, aims to design an instructional environment that will improve her students' research and inquiry skills, but believes that the teacher should aim to provide information on some subjects:

> If I am going to teach this unit, after describing the power plants and teaching them what is that, I ask them, for example, whether there is such a power plant around their homes, what are their advantages and disadvantages?

Although Buse states that she wants her students to work like a scientist, she thinks that the teacher should first teach the subject about power plants and then the students should give examples. Buse, Meltem and Elif, both mentioned that students should have a research and questioning process in addition to conducting experiments.

It was determined that the goals and purposes of science teaching of the other group were appropriate to the theme of improving scientific knowledge. These prospective teachers generally aim to use the experiments and activities in which the students actively participate. However, they did not express the role of the students in the experiment process. For example, Erdem said, "I don't give the students batteries, light bulbs and connection cables directly but I teach the subject like 'this is a battery' and I draw with a visualization". He believes that it is the teacher who gives the information. In addition, some prospective teachers in this group stated that they tend to present as much visual material as possible to the students. Finally, in accordance with the theme of improving scientific knowledge, Ece, Gülfem and Erdem expressed, they believe that science is taught to explain natural phenomena in daily life.

Beliefs about teaching and learning science

Our conclusion is that each participant had more than one orientation. Therefore, evaluations are based on the participants' dominant orientation. We concluded that the participants mostly had transitional orientations, while a few showed responsive, and the remaining held onto instructive orientation (see **Table 3**). **Table 3** presents the distribution of codes seen in tendency of prospective teachers.

Table 3. Participants' beliefs about teaching and learning science

	Traditional	Instructive	Transitional	Responsive	Reform-based
Erdem	*	***	*		
Ayşe	*	**	*		*
Meltem				*****	
Elif				*****	
Gülfem			****	*	
Aslı			*****		
Beyza			****	*	
Buse			*	***	*
Şenay	*	*	***		
Ece		*	****		

Ece, Şenay, Beyza, Aslı and Gülfem tend to be transitional. Many of the participants in this group think that their students will learn science better when they do more than one activity on a topic. The participants in this group think that the teacher should guide the students to improve their conceptual understanding. Beyza, in her dialogues, stressed several times that the teacher should be encouraging in the process of students' learning. Beyza interested the scenario which teachers

guided "the most interesting aspect of this scenario for me is that it encourages and guides children".

Meltem, Elif and Buse have a tendency for responsive orientation. Participants in this group strive to ensure that their students take responsibility for their own learning. For example, Buse want to develop a reward system to encourage the active participation of her students "I will test the [student's] prior knowledge before starting the class and then let them discover the information themselves through trial and error. Or, I can develop a reward system". Participants with a tendency towards responsive orientation think that their students' communication skills are important. In this respect, Elif stated the following:

> Children can comment and discuss more; it attracted my attention, as it was an activity [animation] that they could do in collaboration.

Elif shows that she believes that the students should work collaboratively and try to make sense of the subject together. Elif stated that she would ask his students to create animations in order to evaluate their students' learning, unlike the other participants:

> I want to use technology in my class, and when creating animation, children need to fully understand a topic. When children learn the subject thoroughly... In other words, a concept is formed in their minds and they create animations.

At this point, prospective teachers the tendency of the responsive want to use technology in teaching. In fact, although there is no orientation in scenarios, Elif thinks that creating animation is an effective way for students to learn the subject.

Participants in this group believe that the best way to teach science is to help students make sense of their own data. Regarding this, Meltem stressed that students should explain the decline in electricity bills:

> It is interesting that they share [electricity] invoices on social media. And I am adding, they need to explain the reasons for the differences in the invoices... They share with each other here on social media, but what they did was a decrease in their bills, and I want them to share them.

Meltem wants her students to interact with each other to encourage the efficient use of electricity. Similarly, participants in this group believe that learning can be achieved through structuring information and communicating with each other.

Ayşe, one of the participants, said that although she had a tendency towards instructional orientation, she would perform her practices in a way that was suitable for other orientations. At this point, it is difficult to make an accurate interpretation of Ayşe. At this point, information from different data sources can lead to more realistic conclusions about Ayşe's science teaching and learning orientation. Erdem, another participant with instructional orientation, believes that his students understand a topic when they describe it using their own words:

> I think the student should understand and give an example to the question. If he/she can understand and give an example, I think my teaching method is good.

Erdem's self-determined role as a teacher is to provide opportunities and materials for students to learn. In addition, For example, by stating that "I will not give them bulbs and batteries directly, I will explain the subject first." he wants his students to do experiments, but he believes that he should explain the subject first. Because, according to him, students are not able to reach the necessary information themselves at this point. In order to be a student-centered methods, the student needs to structure the information in his/her mind and actively use the scientific process skills.

Tendency in using technology

Seven participants stated that they will use technological tools in their classes. Three of the participants did not express their ideas about using technology. Two participants who wanted to use the technological tools stated that they could use three different technological tools in the expression of different subjects (**Figure 1**).

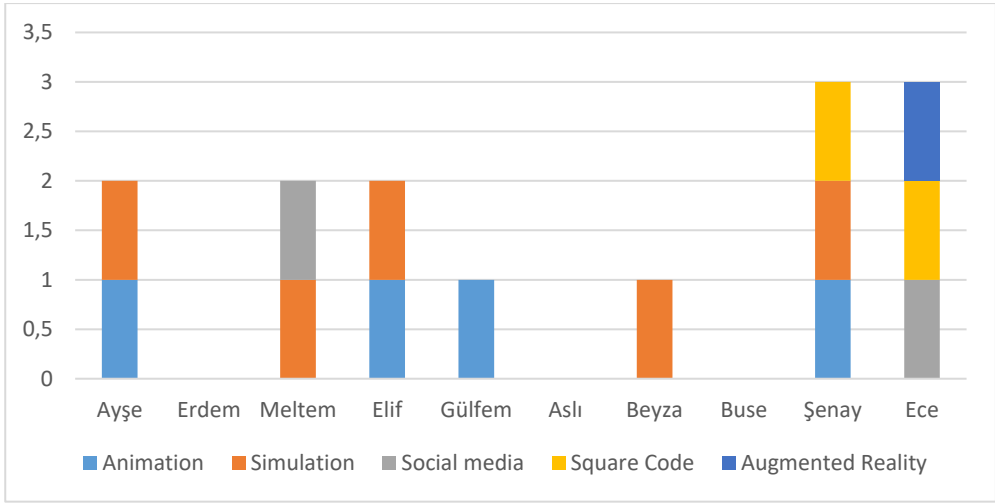

Figure 1. The technologies that participants want to use in their courses

Participants who aim to use technology said that they would use simulations and animations mostly in their teaching practices. Meltem, one of these teacher candidates, stated that she wanted to use simulation in her lessons with the following words:

> In my teaching experience, students have to learn by doing. In addition, they are more comfortable to learn by seeing different things, using the technology to make the student [more] benefit from the visuals and especially using simulations to do experiments..

Meltem thinks that simulations in her class will make it easier for students to learn. The participants in this group believe that the simulations enable students to learn by doing and experiencing. Similarly, Beyza's statement "Animation and simulations are scenarios that I can use because there are scenarios that make children fully active." expresses her idea of doing activities by using the scenarios. In one part of her speech, however, he stressed that not all students will have equal access to technological applications such as social media and square code:

> It says here [scenario] you can use square code application or blogs. Not all children may have access to a computer or telephone. I think it is more accurate to teach the individual or to do something with simpler materials rather than technological materials.

On the other hand, Beyza also prefers applications such as animations and simulations that can be done with the facilities of the school (via smart board). Elif sees animations both as a tool that students can evaluate their learning and as a tool to make it easier for students to understand the subject when used in the introduction phase of the subject.

Two of the participants mentioned three different technological tools to be used in teaching practices. Şenay expressed her belief that animations provide visualization of the subject in her courses "I chose to demonstrate the concept of current by animation. It has a positive effect on the student's understanding of the subject at the introduction stage." Moreover, "Square code application arouses curiosity for the student" and mentioned that the frame code application is included in the technologies that it wants to use. Ece, another participant in this group, stated that she would benefit from augmented reality applications in teaching practices:

> I think the augmented reality application that interests me in this scenario is very remarkable for our level of students.

Here, Ece and Şenay also emphasized that the use of technology will contribute to the increase of students' interest in the course.

Possible relationship between technology uses and beliefs

The analysis of prospective teachers' beliefs about science teaching goals and purposes and their tendency to use technology yields that those who want to use technology in their classrooms have the goals and purposes of improving scientific knowledge in general. In the other group which aims to improve inquiry skills, there is no common tendency towards use of technology. While Meltem and Elif want to use simulations in teaching, we see that Buse is not inclined to use any technologies. Buse rejects the suggestion that students produce ideas by using web pages tools:

> I don't give ideas, and not arouse curiosity. The student will open the website directly, read it and create a discussion environment on this subject... I do not think such an environment can occur.

Unlike the participants in the other group, Buse uses only experiments in the process of discovering information by herself. Meltem and Elif use technological applications only to improve their students' communication skills.

When we look into the relationship between prospective science teachers' beliefs about science teaching and learning and their use of technology, we see that prospective teachers who have tendency towards transitional orientation want to use technology in their classrooms. In addition, it can be said that Meltem and Elif, who have responsive orientation, also want to use technology in their classes. Meltem argued that they should share the reasons for the decrease in the invoices and suggested that the students should make an observation, record their observations, reach a result and share their results on social media. This behavior of Meltem states that students can use social media as a tool to discuss the data they produce. Elif, on the other hand, will have her students learn the subject in depth by having them create animations.

Discussion

Much research is underway on how teachers can use digital technology more effectively in their classrooms. Teachers' ability to use of technology effectively is closely related to their beliefs and orientations (Palak & Walls, 2009). In this study, a tool has been developed to determine prospective science teachers' beliefs about science teaching goals and purposes and beliefs about science teaching and learning.

Different data collection tools can be utilized to facilitate the identification of orientations. The card sorting activity developed in this study was chosen as a tool that could be used to reveal the science teaching orientations of prospective teachers in technology-enriched classes (Friedrichsen & Dana, 2003). In the card sorting literature (Musikul, 2007; Friedrichsen & Dana, 2003; Schwarz & Gwekwerere, 2007) there is no specific study to the subject of electricity. The aim of this study is to develop card sorting activity with scenario texts including technology enriched teaching practices in the subject of electricity.

While the activity was being developed, firstly the content of Friedrichsen and Dana (2003) was taken and new scenarios were developed. Later, the pilot study was conducted with ten prospective science teachers and revisions were made according to the feedback received.

We conducted the main study with ten prospective science teachers who did not participate in the pilot study. Based on the data obtained from conversations recorded during the

implementation, we determined that 70% of the prospective teachers want to teach science in order to improve students' scientific knowledge. Prospective teachers preferred to use various activities in which their students would be active in order to discover, change and improve scientific knowledge. Hodson (2014) claim that the prospective teachers in this group endeavored to teach science. We determined that the remaining 30% of prospective teachers want to teach science in order to develop research inquiry skills. Because these participants are not interested in the ability of students to find a solution to a problem. These participants aim to develop the students' scientific process skills by using the experiments provided to them. At this point, participants cannot be said to teach science to do science. Because doing science requires students to use scientific methods and procedures to solve a problem (Hodson, 2014).

An overwhelming 70% of the participants aim to integrate technology into their courses. While 30% of the participants in this group were responsive; whereas 70% tend to be transitional orientation. Participants with transitional orientation mostly focus on the interaction between teacher and student. They also aim to guide their students to conduct various experiments. They prefer to utilize simulations to construct experimental setups. They also want to use different technological applications (square code, augmented reality and social media) to attract the attention of their students. Two of the prospective teachers with transitional orientation stated that they would benefit from different technological applications but did not provide detailed explanations on how to use these technologies in the classroom. Similarly, research on the use of technology in education suggests that the technological competence of teachers does not guarantee that it can use it pedagogically (Uerz, Volman, & Kral, 2018). On the other hand, participants having responsive orientation aim to design a classroom environment where their students will interact with each other while using technology in their classrooms. It is noteworthy that one of the prospective teachers in this group wanted to have students make animation in their classes to evaluate their learning. Slavin (2012) similarly stresses the importance of enabling students to create products by using technology consciously (p. 277).

Another remarkable result of the study is that one of the prospective teachers gave responses in accordance with four different science teaching and learning orientations. It means prospective teachers have various teaching orientations in our study. Recently, Güven, et al. (2019) also reported such a finding and indicated that prospective teachers held different orientations at the same time in varying degrees. As a result, a prospective teacher's teaching orientation is a combination of competing orientations, rather than being a pure and rigid unit. This was evident in the case of Ayşe. Although she wanted to adopt a constructivist stance for teaching, we see that her belief about teachers being the authority in classrooms and holders of knowledge surfaces in her dialogues: "The teacher is the person who gives the information." Here we are witnessing a conflict in tendencies because the participant, as a prospective teacher, learns about new ideas (i.e., constructivist approach) but on the other hand still hold on to the previous beliefs. However, this effect is not at the same level for all participants. This finding can be attributed to the fact that beliefs resist to change by new learning (Kagan, 1992).

Revealing the beliefs of teachers and prospective teachers provides an important opportunity to improve their teaching experiences and future professional preparation (Wilson, 1989; Schraw & Olafson, 2014; Brookhart & Freeman, 1992). We recommend this activity to teacher educators who want to reveal teachers' and prospective teachers' goals and purposes of science teaching, and their beliefs about science teaching and learning. With the card sorting activity, prospective teachers have the opportunity to express themselves on their teaching experiences and what they want to do in the future. In addition, the case studies in the scenarios can give prospective teachers an idea of how to use technology in their classroom. Science teachers can also use this activity with their colleagues. They can realize their own goals and objectives about science teaching. Also, they can share their experiences about their teaching practices. This activity can be useful for enhancing their teaching because teachers believe that communicating with other teachers and realizing the weakness and strengths can support decision making about teaching (Mirzaei, Phang, and Kashefi, 2020).

This study has some limitations. Firstly, the technologies and the methods and techniques chosen to teach the subject are chosen according to the researchers' subjective preferences and they are not absolute or unique. The teaching environments described in the scenarios reflect the common ideas of researchers and experts. However, the same topics can be explained by different methods and techniques as well. Another limitation arises from the participants' ability to interview each other, ask questions, and express ideas. The nature of the data to be obtained from this activity depends on the ability of the participants to question themselves and the other person, and the variety of questions the participants ask each other. It should be noted that the card sorting task was written in Turkish. For use elsewhere, validity and reliability of the English form needs to be determined.

With this card sorting activity prospective teachers' beliefs about science teaching goals and purposes in technology-enriched classroom environments and the development of their beliefs about learning and teaching science during initial teacher education can be explored. In this way, newly recruited teachers' needs for their professional development can be identified.

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