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The Changes in Pre-Service Chemistry Teachers' Orientations Towards Chemistry Teaching During Chemistry Teaching Method Courses

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ABSTRACT
The purpose of this study is to examine pre-service chemistry teachers' orientations towards chemistry teaching during chemistry teaching method courses. This study was conducted with ten pre-service chemistry teachers for 28 weeks. The Draw-A-Science-Teacher-Test Checklist (DASTT-C), card-sorting activity, interviews, observations, and reflection paper were used to collect data. The data were analysed using the deductive approach. Analysis of data revealed that most of the pre-service chemistry teachers had teacher-centred orientations before chemistry teaching method courses. However, it was determined that their orientations changed into reform-based ones as a result of these courses. It was found that pre-service chemistry teachers had multiple purposes for chemistry teaching. Most of the participants included everyday coping as the main purpose of chemistry teaching. Moreover, it was determined that pre-service chemistry teachers' beliefs about chemistry teaching and learning and beliefs about goals or purposes of chemistry teaching were associated with the university entrance examination. Implications for chemistry teacher training programmes were discussed.

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Introduction

"Chemistry was not born in laboratory. The purpose of chemistry teaching is to understand the events in nature and make connections between these events."
(Helin, pre-service chemistry teacher, interview)

The statements of Helin, who is one of the pre-service chemistry teachers who had teacher-centred orientations at the beginning of the research, are an example of the change in the pre-service chemistry teachers' orientations at the end of the research. Orientation towards science teaching directly affects a teacher's decisions about teaching and learning, such as instructional strategies and assessment (Aydin & Boz, 2012; Borko & Putnam, 1996; Demirdöğen, 2016; Gess-Newsome, 2015; Magnusson et al., 1999). It refers to a teacher's perspective on science teaching or the conceptualisation of science teaching. Moreover, orientation is an extremely important component of pedagogical content knowledge (PCK), defined by Shulman (1986) as a type of knowledge specific to teachers, because this component also directs other PCK components. While Magnusson et al. (1999) defined orientation as the knowledge and beliefs about the purposes and goals for teaching science at a particular grade level, Friedrichsen et al. (2011) stated that orientation consists of a set of teacher's beliefs (beliefs about science teaching and learning, beliefs about the goals or purposes of science teaching, and beliefs about the nature of science). It can be said that orientation is closely related to teacher's belief (Friedrichsen et al. 2011; Magnusson et al., 1999). In this study, the term "orientation" is used to refer pre-service chemistry teachers' beliefs about chemistry teaching and learning and beliefs about the goals or purposes of chemistry teaching.

The nature and role of orientations should be examined to reveal their influences in instructional decisions (Demirdöğen & Uzuntiryaki-Kondakci, 2016). The method courses taught at the university and field experiences play an essential role in the creation of teachers' orientations (Hancock & Gallard, 2004). Since pre-service teachers' orientations can be seen as important indicators of their classroom practices, teacher educators should help pre-service teachers recognize their own orientations and revise them for the benefit of their pupils (Koballa et al., 2005).

Understanding about orientations may help understanding the ways to develop effective teachers and teachers' PCK (Kind, 2016). According to Abell (2008), orientation deserves more attention in the studies. However, the chemistry education community has paid little attention to investigate the orientation (Abell, 2007; Boesdorfer & Lorsbach, 2014; Friedrichsen et al., 2011). Chan and Hume (2019), in their review of the science education literature, stated that most studies did not include orientations to teaching science as a part of their investigation. Science teaching method courses in teacher training programmes are considered as the first teaching experience of pre-service teachers and are some of the courses that help pre-service teachers to become aware of their orientations and develop and change these orientations from traditional to student-centred ones. It is of great importance to investigate the effect of these courses on pre-service teachers' orientations. One of the factors that influences pre-service teachers' orientations is their university experience (Avraamidou, 2013). However, very little research has been done to examine how the courses in teacher training programmes contribute to the development of pre-service teachers' orientations (Brown et al., 2009; Subramaniam, 2021). More studies are needed investigating how pre-service teachers' orientations change and how this change is reflected in their teaching practices (Demirdöğen & Uzuntiryaki-Kondakçı, 2016). To plug this gap, pre-service chemistry teachers' orientations and the change in their orientations during chemistry teaching method courses were examined in this study. The research questions of this study were as follows:

- How did pre-service chemistry teachers' beliefs about chemistry teaching and learning change during the chemistry teaching method courses?
- How did pre-service chemistry teachers' beliefs about goals or purposes of chemistry teaching change during the chemistry teaching method courses?

Theoretical Background

The PCK of science teachers directs their decisions (Ambusaidi et al., 2021). The orientation is the PCK component that guides teachers when making decisions about teaching process (Borko & Putnam, 1996). Mavuru and Ramnarain (2018) identified orientation as teachers' beliefs about the nature, goals and purposes of science, and how science teaching and learning occur in a particular learning environment. In the literature, orientation in PCK models has been expressed in various terms: conceptions of purposes for teaching subject matter (Grossman, 1990), purposes for instruction (Marks, 1990), and general views about science teaching and learning (Anderson & Smith, 1987). According to Magnusson et al. (1999), orientation refers to teachers' knowledge and beliefs about the purposes and goals for teaching science at a particular grade level. They defined nine orientations (process, academic rigor, didactic, conceptual change, activity-driven, discovery, project-based science, inquiry, and guided inquiry) for teaching science in terms of goals of teaching science and characteristics of instruction. These orientations are a list of orientations that have been identified in the literature (Boesdorfer, 2012). In another PCK model (Gess-Newsome, 2015), orientations act as amplifiers or filters for classroom practice.

Friedrichsen et al. (2011) propose that science teaching orientations consist of three dimensions. These dimensions are beliefs about science teaching and learning, beliefs about the goals or purposes of science teaching, and beliefs about the nature of science. Teachers' beliefs about science teaching and learning include the role of the teacher, the role of the students, and the ways to enhance students' understanding (Demirdöğen, 2016). Beliefs about the goals or purposes of science teaching address questions such as "Why do I teach science to the students?" or "Why is it important for students to learn these topics?" (Demirdöğen, 2016; Ekiz-Kıran, 2016).

Magnusson et al.'s (1999) PCK model has been preferred by many science researchers (Aydin et al., 2014; Evens et al., 2015), since this model provides a useful approach and a reliable framework to detect PCK components (Abell, 2007; Soysal, 2018). On the other hand, Friedrichsen et al. (2011) stated some problems about orientations: (i) using the term "orientation" in different or unclear ways, (ii) ignoring the relationship of orientations with the other PCK components, and (iii) assigning science teachers to one of the nine orientations stated by Magnusson et al. (1999). Because of these problems, Magnusson et al.'s (1999) definition of orientation was used interrelated with Friedrichsen et al.'s (2011) definition and pre-service chemistry teachers were not assigned to one of the nine orientations. In this study, Friedrichsen et al.'s (2011) and Magnusson et al.'s (1999) definitions of orientation were utilized together. However, this study was actually based on Friedrichsen et al.'s (2011) definition of orientation, since it provides multidimensional nature and different aspects of teacher beliefs, and also pedagogical beliefs lead to the actual behaviour of the teacher (Namoco & Zaharudin, 2021). In other words, in this study, orientation is considered as an interrelated set of beliefs consisting of beliefs about the purposes of science teaching, beliefs about science teaching and learning, and beliefs about the nature of science.

Studies in the literature examining pre-service or in-service teachers' orientations can be divided into two categories: (i) research examining orientations using a PCK framework and (ii) research examining the effect of a course or an intervention on orientations. In these studies, Friedrichsen et al.'s (2011) framework or Magnusson et al.'s (1999) framework was used to examine orientation. For example, Avraamidou (2013) examined pre-service elementary science teachers' orientations by using Friedrichsen et al.'s (2011) definition. It was reported that the participants' orientations changed by multiple experiences through their teaching programme at the university. In another study, Demirdöğen and Uzuntiryaki-Kondakçı (2016) investigated pre-service chemistry teachers' orientation changes in a course during an intervention designed to develop their PCK using Friedrichsen et al.'s (2011) definition. They found that participants' orientations were changed to more reform-based orientations at the end of the course. Cansız and Cansız (2016) investigated pre-service science teachers' orientations by using Magnusson et al.'s (1999) definition and found that pre-service science teachers had multiple orientations and didactic orientation was the most preferred orientation by participants. In another study using Magnusson et al.'s (1999) definition, Şen and Nakiboğlu (2019) investigated chemistry teachers' orientations via card-sorting activity. They found that chemistry teachers held various orientations and preferred student-centred scenarios in the card-sorting activity. Yıldız Feyzioğlu et al. (2016) identified science teachers' orientations and found that their orientations were consistent with guided inquiry.

Significance of This Study

There are great expectations from teacher training programmes; therefore, it is necessary to examine the extent to which teacher training programmes and teacher educators in these programs meet the desired expectations. Considering the role of chemistry teacher education programmes on the orientations of pre-service chemistry teachers, it is a necessity to investigate the effects of the courses in these programmes on pre-service chemistry teachers' orientations. However, the effects of these courses have seldom been investigated when the literature is examined. Taking this gap into consideration, the changes in pre-service chemistry teachers' orientations during chemistry teaching method course-I (CTMC-I) and chemistry teaching method course-II (CTMC-II) were investigated in this study. Therefore, the results of this study may give the chemistry education community a sight about the effects of courses in chemistry teacher training programs on pre-service chemistry teachers' orientations. Moreover, the present study was one of the first to examine the pre-service chemistry teachers' orientations by using drawings (via DASTT-C) as well as the card-sorting activity, interview, and observation. Drawings may express many things which are not easily put into words, so they are one of the best ways to detect beliefs or images of people (Weber & Mitchell, 1996). Drawings are rich sources of information reflecting teachers' or pre-service teachers' beliefs about science teaching (Hancock & Gallard, 2004). The results of this study may accordingly present new ways to examine the orientations of pre-service teachers for chemistry teacher educators and chemistry education researchers.

In this study, pre-service chemistry teachers' orientations were observed in their teaching practices as indicators of how those reflect their orientations. In this respect, it can be said that this study differs from other studies in the literature. The orientations of pre-service teachers are one of the factors that can reflect the characteristics of their teaching in the future. For this reason, it is thought that this study, in which pre-service chemistry teachers' orientations are examined, is important in this respect. The additional value of this study is that it may help to understand how the courses (CTMC-I and CTMC-II), which require the combination of chemistry courses and general education courses, affect pre-service chemistry teachers' orientations.

Methodology

Research Design

In this research, a case study approach was used to explore pre-service chemistry teachers' orientations. Case studies are a type of qualitative research design wherein one or several cases are subjected to an in-depth holistic analysis without any intervention and questions of why and how are investigated (Creswell, 1994; Çepni, 2018; Yin, 2003). According to Merriam (2009), "for it to be a case study, one particular program or one particular classroom of learners (a bounded system) or one particular older learner selected on the basis of typicality, uniqueness, success, and so forth would be the unit of analysis" (p. 41). This study presents the characteristics of the case study: a case (pre-service chemistry teachers' orientations), multiple data collection tools (DASTT-C, card-sorting activity, interview, observation, and a reflection paper), and in-depth examination from a holistic perspective without any intervention.

Participants

This study was conducted with 10 pre-service chemistry teachers (three males and seven females) in a state university in Türkiye. Participants were selected on the basis of convenience sampling method (i.e. they were easily accessible). In convenience sampling, the researcher selects the participants based on time, money, location, and availability of them (Merriam, 2009). Their ages ranged from 21 to 23. Participants were 3rd year students studying in a four-year chemistry teacher training programme. The four-year chemistry teacher training programme consists of chemistry courses, general education courses, and chemistry education courses. Before this study, participants had taken some chemistry courses such as general chemistry, analytical chemistry, inorganic chemistry and some general education courses such as classroom management, learning, teaching theories and approaches, measurement and assessment. All participants were taking the CTMC-I and CTMC-II for the first time.

Ethical Considerations

Before conducting the study, the participants were informed about the process of the study and told that participation was on a volunteer basis and that they could withdraw from the study at any time they wished. All pre-service chemistry teachers participated in the study voluntarily and provided their written consent. In this study, pseudonyms were used to keep the participants' identities confidential.

Context of the Study

This study was conducted in the context of CTMC-I and CTMC-II in the chemistry teacher training programme. These courses are compulsory courses for pre-service chemistry teachers in four-year teacher education programme and chemistry education courses. In other words, these courses involve the blending of chemistry courses and general education courses. CTMC-I is about an overview of teaching methods used in chemistry, preparing lesson plans about different teaching approaches, methods and techniques used in chemistry teaching. CTMC-II is about applying different teaching approaches, methods, and techniques in the classroom. Pre-service chemistry teachers take CTMC-I in the 5th semester and CTMC-II in the 6th semester of this programme. CTMC-I is the first course that requires the use of the knowledge learned in education courses and chemistry courses together. CTMC-II is the first course during pre-service chemistry teachers experience teaching.

CTMC-I was scheduled for 4 hours a week for 14 weeks during the fall semester, while CTMC-II was scheduled for 4 hours a week for 14 weeks during the spring semester. This study was scheduled for 28 weeks. During CTMC-I, theoretical presentations about learning cycles, inquiry-based teaching method, cooperative learning, laboratory-based chemistry teaching, conceptual change, problem-based learning, project-based learning, and assessment in chemistry education were presented by instructor. After theoretical presentations, participants prepared lesson plans for each teaching approach, method, and technique. These plans were presented in the classroom in 10-15 minutes and critiqued by the instructor and peers. For CTMC-II, participants applied different teaching approaches, methods, and techniques in the classroom for different chemistry topics in the chemistry curriculum. Each participant is allotted one lesson hour (40 minute) for teaching practice. The pre-service chemistry teacher engaging in teaching practice takes on the role of a chemistry teacher, while their peers take on the role of students. Each participant made teaching practices three times. After each teaching practice of participants, they are critiqued by themselves, their peers, and the instructor. In these critiques, it was discussed how the orientations of participants were reflected to the lessons was discussed by considering Friedrichsen et al.'s (2011) and Magnusson et al.'s (1999) definitions of orientation. Thus, it was provided that the participants recognized different orientations, became aware of these orientations, and realized how they could use these orientations when planning their lessons.

Data Collection Tools

To investigate participants' orientations, the data was obtained by DASTT-C, the card-sorting activity, and interviews. In addition, participants' teaching practices were observed in CTMC-II in order to see how participants reflect their orientations to teaching practices.

DASTT-C

The DASTT-C was developed by Thomas et al. (2001) and can be used to reveal pre-service teachers' beliefs about science teaching and learning (Markic & Eilks, 2008). The DASTT-C was administered, before CTMC-I, after CTMC-I, and after CTMC-II, making three times in total. In this study, participants were asked to "Draw a picture of yourself as a chemistry teacher" and to write an explanation about their drawings and answer the questions, "What is the teacher doing?" and "What are the students doing?". The drawings of participants were scored according to the 13-item checklist that consists of teacher, students, and environment sections. Total checklist scores can range from 0 to 13. The lowest score (0) represents the most student-centred image, and the highest score (13) represents the most teacher-centred image. The scores of 0-4 show student-centred, 5-9 show between student-centred and teacher-centred and 10-13 show teacher-centred images.

Card-Sorting Activity

A card-sorting activity was conducted before CTMC-I, after CTMC-I, and after CTMC-II. Card-sorting activities were completed in 15-20 minutes. Orientations in Magnusson et al. (1999) were referred to in writing the scenarios for the card-sorting activity. Moreover, a scenario was included in the card-sorting activity for exam-focused orientation. An example of a scenario used for didactic orientation was: "One way to effective chemistry teaching is to present information through lecturing". Participants were asked to sort scenario cards into three groups "best represents her/his teaching", "does not represent her/his teaching" and "unsure". In addition, they were asked to explain characteristics, similarities, and differences of scenarios chosen within a group of cards.

Interviews, Observations and Reflection Paper

Semi-structured interviews were conducted with participants before CTMC-I, after CTMC-I, and after CTMC-II. Participants' opinions were asked about the purposes of chemistry education, the importance of chemistry education, roles of teacher and roles of students in these interviews. Interview questions were constructed with the help of the related literature (Demirdöğen, 2016; Friedrichsen et al., 2011; Luft & Roehrig, 2007). "What is the purpose of chemistry education?", "How do the students learn chemistry best?", and "What is the role of theteacher in chemistry teaching?" were examples of interview questions used in this study.

Researcher observations were used to detect the reflections of participants' orientations to their teaching practices during CTMC-II. In these observations, the teaching approach chosen by the participant and how she/he applied this approach in the teaching practice, the role of the participant as a teacher, whether students were active in the lessons, and how the participants reflected the purposes of teaching chemistry in the teaching of the topic were examined. Finally, participants were asked to write a reflection paper about their orientations at the end of the CTMC-II. These papers were used to understand changes in the orientations of the participants from their own perspectives. Examples of questions for these reflection papers were: "How did CTMC-I change your views about chemistry teaching?", "How did CTMC-II change your views about chemistry teaching?", and "What did you learn from these courses about chemistry teaching?".

Data Analysis

Before analyzing the data, all interviews, observations, and the card-sorting activity were transcribed. All transcribed data were read and analysed using deductive approach (Patton, 2002). In this study, participants' orientations were analyzsed in terms of two dimensions. First dimension is the beliefs about chemistry teaching and learning. For the analysis of this dimension, the categorizations proposed by Luft and Roehrig (2007) and Magnusson et al. (1999) were used. To analyse the data obtained by DASTT-C and interviews, the categorisation of Luft and Roehrig (2007) was used while the categorisation of Magnusson et al. (1999) was used for the data obtained by the card-sorting activity. Magnusson et al. (1999) described the following nine orientations related to the targets of science teaching and the general characteristics of teaching. According to Friedrichsen (2002) didactic and academic rigor orientations are teacher-centred orientations. The categorization of Magnusson et al. (1999) is given in Table 1. Luft and Roehrig (2007) categorized beliefs about science teaching and learning under five categories. This categorisation used for analyzing participants' beliefs about science teaching and learning was given in Table 2.

Table 1

The Nine Orientations Toward Science Teaching

Category	Characteristics of the category
Process	Teacher helps students develop scientific process skills.
Academic rigor	Teacher makes students challenge with difficult problems and activities.
Didactic	Teacher presents information generally through lecturing.
Conceptual change	Teacher facilitates the development of scientific knowledge by confronting students with their alternative conceptions.
Activity-driven	Teacher makes students participate in hands-on activities.
Discovery	Teacher provides opportunities for students to discover the natural world following their own interests.
Project-based science	Teacher makes students investigate solutions for authentic problems.
Inquiry	Teacher presents science as inquiry and makes students to investigate problems.
Guided inquiry	Teacher provides opportunities for students to constitute a community of learners and both teacher and students participate in investigating problems.

Note. Magnusson, Krajcik & Borko (1999), (pp. 95-132)

Table 2

Categorization Used to Analyze Participants' Beliefs about Science Teaching And Learning

Category	Characteristics of the category
Traditional	Teacher focused, focus on information, transmission, structure, or sources
Instructive	Teacher focused, focus on providing experiences, teacher-focus, or teacher decision
Transitional	Focus on teacher/student relationships, subjective decisions, or affective response
Responsive	Student-focused, focus on collaboration, feedback, or knowledge development
Reform-based	Student-focused, focus on mediating student knowledge or interactions

Note. Luft & Roehrig (2007)

When analysing participants' beliefs about chemistry teaching, both categorizations in Table 1 and Table 2 were used. In this study, by using the related literature, the relationship between these categorisations was established as follows: (i) academic rigor and didactic orientations were classified under traditional beliefs, (ii) discovery, project-based, and inquiry orientations were classified under reform-based beliefs, (iii) guided inquiry, conceptual change, and process orientations were classified under responsive beliefs, (iv) activity-driven orientation was classified under transitional beliefs. Apart from the orientations mentioned in Table 1, it was found that there was another emerging orientation from the context in which this study was conducted: exam-oriented orientation. It was determined that the participant whose orientation was exam-oriented considered preparing students for the university entrance exam as the main focus of her/his teaching, rather than facilitating the students' understanding of chemistry. The fundamental goal of the participants with this orientation was to ensure that the students gave the correct answers when they entered the university entrance exam or when asked questions similar to the questions in the university entrance examination. In order to classify this orientation under a belief, the studies in the literature were used. According to Wills (2006), the demands of state testing control over the teaching and undermine the rich learning environment, and may lead teachers to teach more didactically. In another study conducted by Aydin et al. (2014), chemistry teachers stated that one of the reasons for having didactic orientation towards chemistry teaching was the university entrance exam. Similarly, Akin and Uzuntiryaki-Kondakci (2018) found that the university entrance exam influenced chemistry teachers' instructional decisions and lead them to be didactic teachers. In the above-mentioned studies and the data obtained in this study, it is possible to say that there is a relationship between exam-oriented orientation and didactic orientation. In this study, it was seen that the participant whose orientation was exam-oriented tended to favour lecturing to prepare students for the university entrance exam. Hence, an exam-oriented orientation was classified, based on the related literature, under traditional beliefs.

Second dimension is the beliefs about goals or purposes of science teaching. To analyze this dimension; data obtained by interviews about participants' beliefs about goals or purposes of science teaching were analyzed by using curriculum emphases proposed by Roberts (1982, 1995). Seven curriculum aspects were defined in the categorization proposed by Roberts (1982, 1995). Categorization used to analyze participants' beliefs about goals or purposes of chemistry teaching was given in Table 3.

Table 3

Categorisation Used To Analyse Participants' Beliefs about Goals or Purposes of Chemistry Teaching

Category	Explanation
Correct explanations	Learning science as reliable, valid knowledge accepted by the scientific community
Everyday coping	Using science to understand and control both technology and everyday events
Scientific skill development	Understanding the development of processes within science, the "science as process" approach
Science, technology, decisions	Understanding the role scientific knowledge plays in decisions which are socially relevant
Personal explanation	Understanding one's own way of explaining events in terms of personal and cultural (including scientific) influences
Solid foundation	Using science to facilitate students' understanding of future science instruction, science as cumulative knowledge
Structure of science	Understanding how science functions as a discipline

Note. Roberts (1982); Roberts (1995).

Regarding the third dimension of Friedrichsen et al.'s (2011) orientation definition, which is beliefs about the nature of science, in the present study, no data were gathered from the participants. Therefore, no results about this dimension could be presented owing to the lack of data in the study.

In this study, data triangulation and long-term interaction were employed for credibility. Multiple data sources (DASTT-C, card-sorting activity, interview, observation, and reflection paper) were used to achieve triangulation. The researchers spent 28 weeks with participants during this study. By this way, long-term interaction was ensured. Moreover, at the end of each interview with participants, the conclusion of the interviews was briefly summarised back to them, and they were asked whether there was anything they wished to add, change, or remove. After the teaching practices of the participants, the participants confirmed the observation notes taken by the researchers on their orientations and the inferences drawn from these notes. With the fulfillment of this process, the participants' confirmation of the observations was affirmed. Researchers independently coded the data during the analysis process. To verify the consistency between the analyses conducted by the researchers, the formula [Agreement / (Agreement + Disagreement) x 100] suggested by Miles and Huberman (1994) was used. The application of this formula revealed a consistency of 90%. Disagreements were resolved, and consensus was reached through discussion.

Results

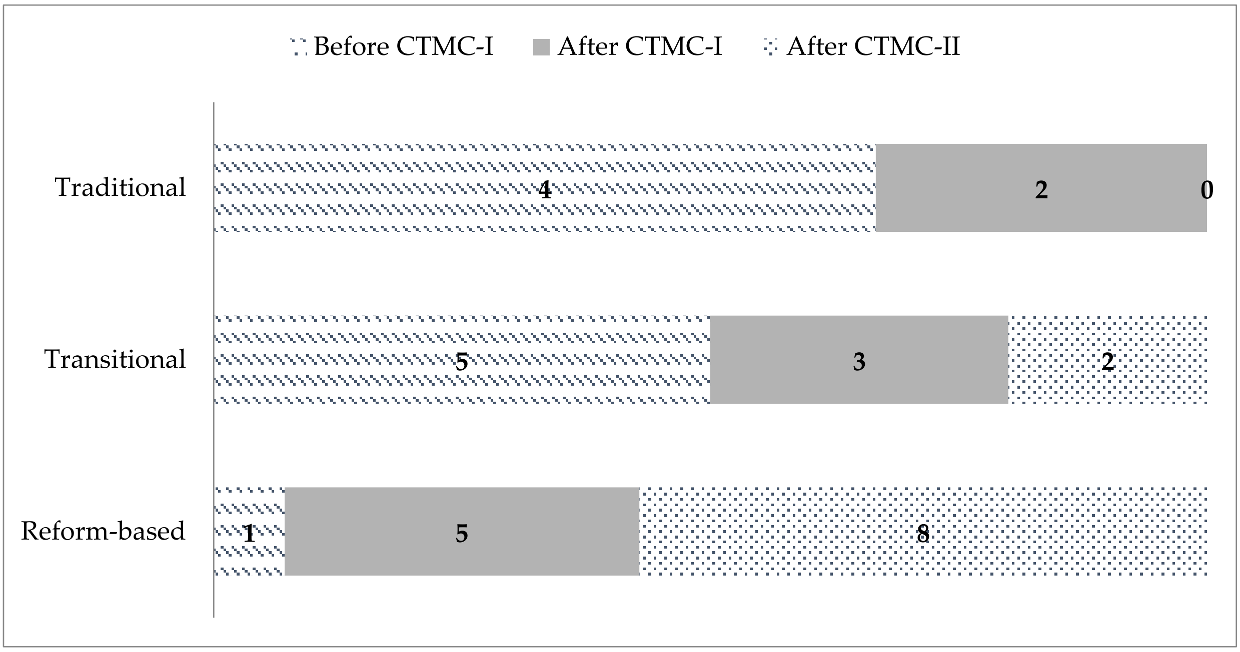
According to the results of data analysis, it was revealed that participants' orientations had changed during CTMC-I and CTMC-II. The results were presented separately for two research questions in terms of two dimensions of orientation, (i) beliefs about chemistry teaching and learning and (ii) beliefs about goals or purposes of chemistry teaching.

The Results About the Change in The Participants' Beliefs About Chemistry Teaching and Learning

The participants' beliefs about chemistry teaching and learning were examined via DASTT-C, the card-sorting activity, interview, observation, and a reflection paper during CTMC-I and CTMC-II. When the data obtained with DASTT-C were analyzed, it was found that, before CTMC-I, the participants' beliefs about chemistry teaching and learning were predominantly traditional (n=4) and transitional (n=5). After CTMC-I, it was determined that the number of participants with traditional beliefs was decreased and the number of participants with reform-based beliefs was increased. It was found that there were no participants with traditional beliefs after CTMC-II. Moreover, it was determined that, after CTMC-II, the participants' beliefs about chemistry teaching and learning were transitional (n=2) and reform-based (n=8). The results obtained by analyzing the data obtained with DASTT-C can be seen in Figure 1.

Figure 1

Participants' Beliefs about Chemistry Teaching and Learning According to DASTT-C



When Figure 1 analysed, it is seen that participants' beliefs about chemistry teaching and learning were shifted from traditional to reform based during CTMC-I and CTMC-II. Before CTMC-I, participants generally drew themselves as knowledge transmitters and students as passive listeners and preferred traditional classroom environments in their drawings. After CTMC-I, it was found that there were partial changes that could reflect student-centred perspectives in participants' beliefs (e.g., in their drawings, the participants drew activities in which students actively participated). Participants had undergone three teaching experiences during CTMC-II. After this course, participants drew lessons in which students were active. In their drawings, participants drew themselves as guides allowing the students to search for and answer questions, they are curious about. In these drawings, there were environments that were far from the traditional classroom layout and that allowed students to experiment or do research in collaboration. Findings obtained from DASTT-C showed that participants approached chemistry teaching from a teacher-centred perspective before the CTMC-I and participants' beliefs about chemistry teaching and learning had changed especially after CTMC-II, in other words after their teaching experiences. During CTMC-I and CTMC-II, the number of participants with traditional and transitional beliefs decreased, while there was an increase in the number of participants with reform-based beliefs.

The change in the orientation of one of the participants, Belma, is explained with the quotations below as an example. Figure 2 and Figure 3 show her DASTT-C drawings. Figure 2 shows the drawing that reflects the traditional (teacher-centred) and Figure 3 shows the drawing that reflects the reform-based (student-centred) beliefs of the same participant.

Figure 2

A Participant's, Belma's, DASTT-C Drawing Before CTMC-I

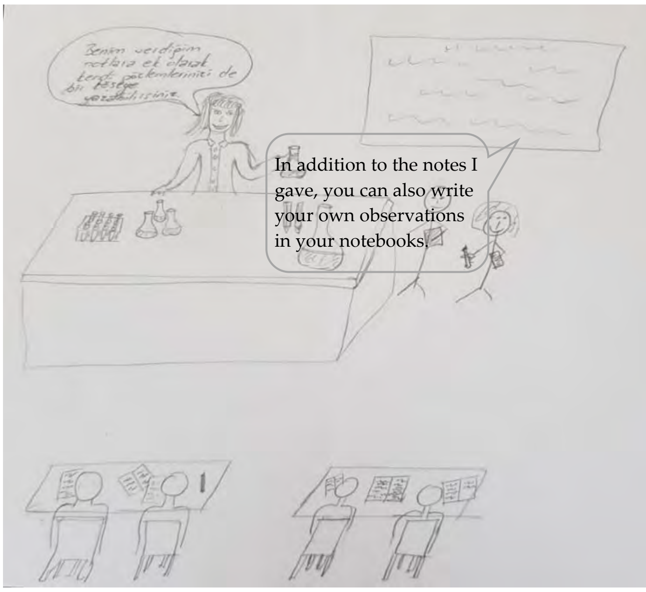
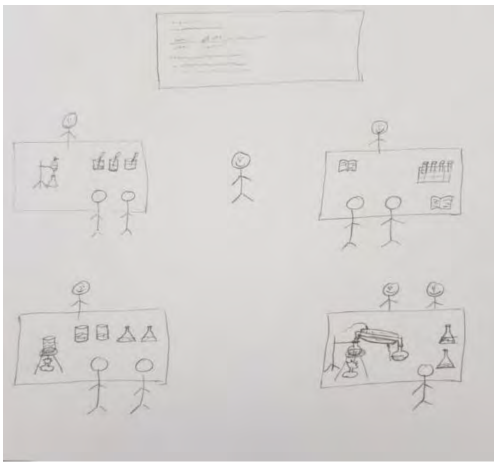


Figure 3

A Participant's, Belma's, DASTT-C Drawing after CTMC-II



In Figure 2, the drawing is Belma's DASTT-C drawing before CTMC-I. According to her drawing, an experiment was carried out in the classroom. However, when the drawing and the explanation about her drawing were examined together, it was found that this experiment was conducted by the teacher and the students were involved the process only as an audience. Moreover, it is seen that, after providing the information didactically, she did the experiment and solved algorithmic problems. It was understood from Belma's explanation that passive roles, in other words traditional roles, were given to the students. Her drawing in Figure 2 was accordingly classified as traditional. The explanation of Belma about her drawing presented in Figure 2 is given below.

> Belma: "Teacher explains the topic through lecturing and makes students take notes about the topic. The teacher is doing a demonstration experiment; students are observing the experiment in turn. Then, the teacher solves problems that require mathematical operations about the topic." (DASTT-C, Before CTMC-I)

The drawing in Figure 3 is Belma's DASTT-C drawing after CTMC-II. Her drawing reflects reform-based beliefs about chemistry teaching. The explanation of Belma about her drawing presented in Figure 3 is given below.

> Belma: "Teacher asks students in groups to design an experiment on a specific topic. After examining the experiment plans, the teacher gives students the opportunity to do their experiments. While the students do their experiments, the teacher guides the student groups. Students are doing experiments under the supervision of the teacher. Students get help from the teacher when help is needed. They make observations during the experiment, record the data, prepare a report including the results and comments of the experiment and present this report." (DASTT-C, After CTMC-II)

When comparing to Figures 2 and 3, it is seen that the beliefs of Belma had shifted from traditional to reform-based. The first drawing, Figure 2, shows that the teacher is in the centre and acts as a knowledge transmitter. However, the second drawing, Figure 3, shows that the students are active in the lesson and the teacher acts as a guide helping them to construct knowledge. In the interviews with Belma, she made explanations in accordance with the findings obtained from her DASTT-C drawings. An excerpt from interviews with Belma is given below.

> Belma: "The best way to teach chemistry is to provide a learning environment where students can search for solutions to their own research questions and perform different experiments. In this environment, students should be actively involved in the lesson process, and I should direct them as a guide. This learning environment for chemistry teaching should be just like a science [research] centre." (Interview, After CTMC-II)

When analysing Belma's 15-minute lesson presentations in CTMC-I and teaching practicesessions in CTMC-II, it was determined that her lesson presentations in CTMC-I were totally didactic. In these presentations, it was seen that she planned to explain the topic through lecturing without giving the students the opportunity to think about the topic. Similarly, her orientation was didactic, and she reflected her traditional beliefs into the classroom in her first teaching practice session of her in CTMC-II. On the other hand, in the second teaching practice of her in CTMC-II, it was determined that her orientation had started to change. She started to actively involve the students in the lesson. Moreover, it was seen that Belma reflected reform-based beliefs into the classroom during her third teaching practice in CTMC-II. During this one, she prepared a learning environment where students could work together in collaboration and tried to use activities, analogies, educational games, and daily life examples to enable them to construct the knowledge themselves. When interpreting Belma's drawings and classroom practices in tandem, it is possible to say that she reflected her beliefs about chemistry teaching and learning determined via DASTT-C to her teaching practices.

The results obtained from card-sorting activity are shown in Table 4. When examining the change of participants' beliefs about chemistry teaching and learning during CTMC-I and CTMC-II, it is seen that there is a general increase in the overlap of student-centred orientations (e.g., process, discovery) with their own teaching. One of the participants' views about the scenarios that reflected her teaching is given below.

Eda: "The common feature of the scenarios that I place in the "best represents how I would teach" category is that they enable the students to discover the knowledge and learn it by themselves. These scenarios are student-centred rather than teacher-centred." (Card-sorting activity, After CTMC-II)

Table 4

The Distribution of Participants' Views about the Scenarios in the Card-Sorting Activity during CTMC-I and CTMC-II

Scenarios in the card-sorting activity	The relationship with Luft and Roehrig's (2007) categorization	Before CTMC-I			After CTMC-I			After CTMC-II		
		i	ii	iii	i	ii	iii	i	ii	iii
Exam-oriented	Traditional	4	4	2	3	3	4	3	2	5
Academic rigor	Traditional	-	6	4	1	7	2	2	4	4
Didactic	Traditional	6	-	4	3	3	4	1	5	4
Activity-driven	Transitional	6	-	4	7	-	3	6	-	4
Process	Responsive	6	2	2	8	-	2	10	-	-
Conceptual change	Responsive	8	-	2	9	-	1	9	-	1
Guided-inquiry	Responsive	6	-	4	4	1	5	7	2	1
Discovery	Reform-based	7	-	3	6	-	4	10	-	-
Project-based	Reform-based	4	2	4	3	1	6	6	2	2
Inquiry	Reform-based	9	-	1	6	-	4	10	-	-

Note: i: "best represents how I would teach", ii: "does not represent how I would teach", iii: "unsure"

The number of participants who preferred teacher-centred orientations, especially didactic orientation, decreased over time. The opinions of one of the participants about didactic orientation are given below.

Belma: "I am undecided whether this scenario [the scenario of didactic orientation] I included in the "unsure" category will reflect my teaching. Because all students may not understand the topic through lecturing like in this scenario… However, the content of the topic and the situation of the class may lead me to do this. (Card-sorting activity, After CTMC-I)

In addition, it was determined that some participants had exam-oriented orientation during CTMC-I and CTMC-II. These participants continuously reminded their srudents about the university entrance examination during the teaching practice sessions. Moreover, they made regular mention of the questions that could be asked on the university entrance exam. When considered in the context of the country where this study is conducted, it is seen that university entrance exam affects the participants' beliefs about chemistry teaching and learning. One of the participants' views about the exam-oriented orientation is given below.

Gamze: "I included this scenario [the scenario of exam-oriented orientation] in the "unsure" category. Although I am not a teacher like the one in this scenario, I have to be a teacher with exam-oriented." (Card-sorting activity, After CTMC-II)

When the teaching practices of the participants were examined, it was determined that the participants were mostly teaching with a traditional perspective in the first teaching practices at the beginning of CTMC-II. But it was observed that this predominantly traditional perspective was transformed into a transitional or reform-based perspective over time. Especially in the last teaching practice sessions during CTMC-II, it was observed that the participants made the students active in the lessons, directed the lesson according to the question or interest of the students, and conducted their lessons in a way that allows the student to do research about the things they were curious about. For example, in the first teaching practice of Helin, one of the participants, it was seen that she taught the ideal gas laws from a didactic point of view through lecturing; she did not give the students the opportunity to think about the concepts and she acted as a knowledge transmitter. However, it was found that her stance changed following teaching practices. She adopted the inquiry-based approach to her lesson as her beliefs about chemistry teaching and learning changed towards reform-based. Helin's explanations about her beliefs about chemistry teaching and learning are given below.

> Helin: "One of the most effective ways to teach chemistry is to link between chemistry knowledge on the topics, daily life, and chemistry experiments. Inquiry is the approach I find most suitable for teaching chemistry." (Interview, After CTMC-II)

It was found that most of the participants reflected their reform-based beliefs about chemistry teaching and learning during their teaching practice sessions for CTMC-II. One of the participants' statements about her beliefs about chemistry teaching and learning that was classified as reform-based is given below.

> Verda: "A chemistry teacher should not be the transmitter of knowledge. Teacher's role is to help students as a guide. Students are active and construct their knowledge by themselves with the help of the teacher." (Interview, After CTMC-II)

It was seen that the participants reflected exam-oriented orientations to their teaching process during CTMC-II. During their teaching practices, participants emphasized the importance of university entrance exam and solved the questions similar to the questions in this exam. Quotation reflecting a participant's exam-oriented beliefs in her teaching practice is given below.

> Meryem: "In the university entrance exam, there will be questions similar to the questions we solved in our lessons." (Observation, second teaching practice at CTMC-II)

In the light of the results regarding the participants' beliefs about chemistry teaching and learning, it was seen that the participants made drawings to reflect their general beliefs about chemistry teaching and learning when they were asked to paint a moment of their classroom via DASTT-C. On the other hand, when their beliefs about chemistry teaching and learning were detected by using card-sorting activity, it was found that participants had multiple orientations. The participants stated that they could have multiple or different orientations according to the factors (e.g., topic, classroom context, physical facilities of the school, university entrance exam) that affect teaching. When interpreting the results in Figure 1 and the results in Table 4 together, it is possible to say that DASTT-C may provide a more general perspective about participants' beliefs about chemistry teaching and learning, but card-sorting activity, interviews, and observations may ensure more detailed information about these beliefs.

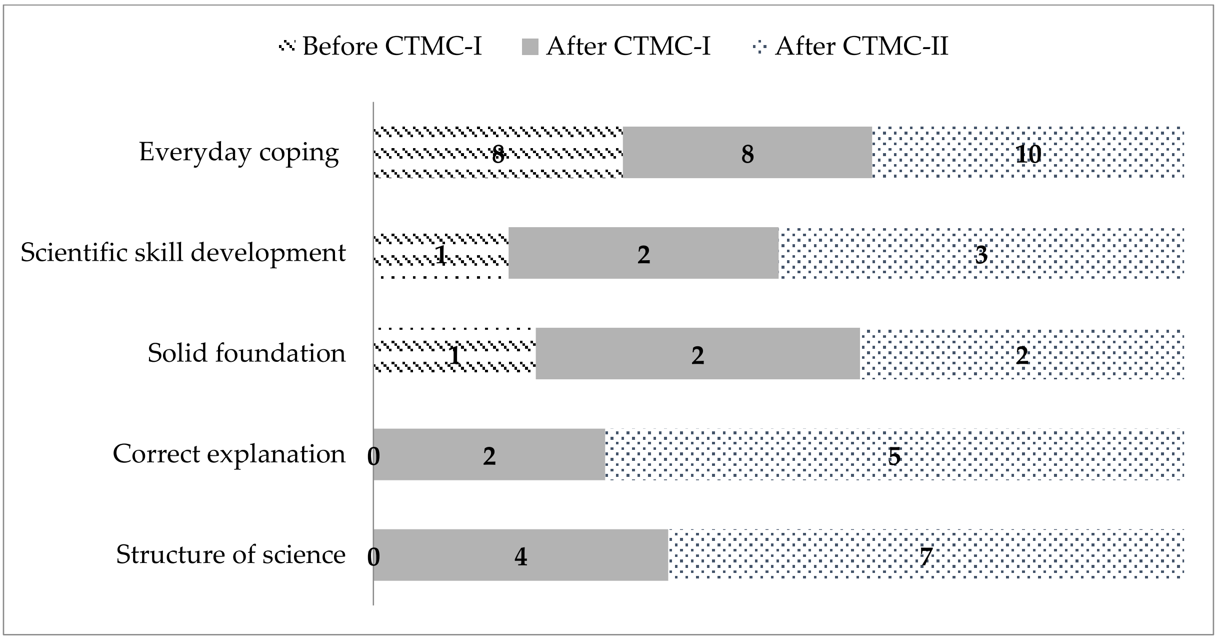
In summary, most participants' beliefs about chemistry teaching and learning shifted from teacher-centred to student-centred. Especially after CTMC-II, in other words after teaching practices sessions, they started to look from a more student-centred point of view at chemistry teaching.

The Results About the Change in the Participants' Beliefs About Goals or Purposes of Chemistry Teaching

Analysis of the participants' beliefs about goals or purposes of chemistry teaching showed that participants had various purposes for chemistry teaching during CTMC-I and CTMC-II. The distribution of participants' beliefs about goals or purposes of chemistry teaching was given in Figure 4.

Figure 4

The Distribution of Participants' Beliefs about Goals or Purposes of Chemistry Teaching



When Figure 4 is examined, it is seen that participants emphasised everyday coping as the basic purpose of chemistry teaching throughout CTMC-I and CTMC-II. Before CTMC-I and after CTMC-I, everyday coping was the most stated purpose of chemistry teaching by the participants. After CTMC-II, all participants stated everyday coping as the purpose of chemistry teaching. Two participants' views about the goals or purposes of chemistry teaching that were classified as everyday coping are given below.

Helin: "Chemistry was not born in laboratory. The purpose of chemistry teaching is to understand the events in nature and make connections between these events." (Interview)

Kumru: "The purpose of chemistry teaching is to provide students with a better understanding of the nature of everyday events." (Card-sorting activity)

Everyday coping was dominantly uncovered as participants' purpose of chemistry teaching. Moreover, they always underlined daily life examples related to the topic and established relationship between daily life and chemistry during their teaching practices. For example, one of the participants, while she was talking about oxidation-reduction reactions, gave photography as an example and said:

Verda: "One of the metals we frequently encounter in daily life is silver. Silver has many uses in our daily life such as photography and metal plating. While the photos are in the bath stage, Ag^{+} ions are reduced to metallic silver." (Observation, first teaching practice at CTMC-II)

The participants also asked students to make connections between the topic and daily life and asked them questions about daily life examples. The question of one of the participants, while he was talking about acids and bases, is given below.

Bartu: "We can't keep some of our food in metallic containers. Have you ever thought about this situation? Why can't we keep them in metallic containers? I want you to think about the reason for this with your group friends." (Observation, first teaching practice at CTMC-II)

Scientific skill development and solid foundation were identified as some participants' beliefs about goals or purposes of chemistry teaching during CTMC-I and CTMC-II. One of the participants' views about the goals or purposes of chemistry teaching that was classified as "solid foundation" is given below.

Helin: "Chemistry should be taught to students who will have a career in chemistry in the future." (Reflection paper)

Developing scientific process skills, understanding science as a discipline, and understanding scientific concepts were purposes of chemistry stated by more participants after CTMC-I and CTMC-II. One of the participants' views about the goals or purposes of chemistry teaching that was classified as scientific skill development is given below.

Eda: "When students learn chemistry, they can develop scientific process skills and higher order thinking skills." (Card-sorting activity, after CTMC-II)

Correct explanation and structure of science were not previously mentioned by the participants as a goal or purpose of chemistry teaching, but after CTMC-I and CTMC-II, correct explanation and structure of science were also mentioned by the participants as goals or purposes of chemistry teaching. One of the participants' views about the goals or purposes of chemistry teaching that was classified as correct explanation is given below.

Kumru: "One of the purposes of chemistry teaching is to make students understand scientific concepts and explain these concepts." (Reflection paper)

In summary, participants thought that everyday coping was the main purpose of chemistry teaching during CTMC-I and CTMC-II. Especially, after the CTMC-I, it is seen that the diversity in participants' beliefs about goals or purposes of chemistry teaching has started to increase. Moreover, it was determined that there was an increase in the number of participants who varied their beliefs about goals or purposes of chemistry teaching after CTMC-II.

Discussion, Conclusion, and Implication

In this study, which aimed to determine how pre-service chemistry teachers' orientations changed during chemistry teaching methods courses, CTMC-I and CTMC-II, it was determined that pre-service chemistry teachers' orientations shifted from teacher-centred to student-centred. It was found that pre-service chemistry teachers usually had a didactic orientation before CTMC-I. This result of the current study was consistent with the study conducted by Aydin et al. (2015). It is thought that pre-service chemistry teachers look at chemistry teaching from a traditional point of view because of the traditional teaching that they had previously been exposed to as a student during their three years in the chemistry teacher education programme. However, an effective science teacher should place the pupil at the heart of the teaching and learning process (Adu-Gyamfi, 2020). Chemistry courses in chemistry teacher education programmes are themselves usually taught didactically. Even if they address to student-centred approaches, it is possible to say that the situation in general education courses is similar to that in chemistry courses. It was concluded that pre-service chemistry teachers who were generally exposed to didactic teaching in the chemistry teacher education programme tried to carry their didactic point of view to their lessons.

The orientation has been proposed as very influential to a teacher's PCK and teaching practice (Boesdorfer & Lorsbach, 2014). Therefore, pre-service chemistry teachers' orientations were examined in terms of beliefs about chemistry teaching and learning and beliefs about goals or purposes of chemistry teaching in this study. No results about the beliefs about the nature of science could be introduced due to the lack of data. According to Ekiz-Kıran and Boz (2020), in pre-service chemistry teacher education programme, more importance is given to chemistry courses (e.g., analytical chemistry) and the nature of science is neglected. Therefore, it is likely that pre-service chemistry teachers did not emphasise the nature of science during the present study.

In the first research question of this study, the pre-service chemistry teachers' beliefs about chemistry teaching and learning were investigated during CTMC-I and CTMC-II. It was found that pre-service chemistry teachers' beliefs about chemistry teaching and learning shifted from traditional to reform-based during these courses. CTMC-I and CTMC-II are the first courses requiring pre-service chemistry teachers to use their chemistry knowledge and general education knowledge together. It is likely that pre-service chemistry teachers became aware of their own orientations and changed them thanks to these courses. Throughout CTMC-I, they began to develop awareness of the effectiveness of student-centred approaches in chemistry teaching. Thus, they began to be dissatisfied with their initial orientations. Especially during CTMC-II, they realised that their initial orientations had prevented them from conducting their lessons as planned. Moreover, they realised that they had difficulty integrating students into the lesson due to these initial orientations. Therefore, they developed student-centred orientations. According to Avraamidou (2013), pre-service teachers' orientations change via multiple experiences through teacher training programmes. It seems that science method courses have great impact in enhancing pre-service teachers' orientations and aim to support pre-service teachers in developing reform-based views about science teaching and learning (Avraamidou, 2013; Seung et al., 2011). These courses would help pre-service teachers become dissatisfied with their teacher-centred orientations (Brown et al., 2009). Although both of CTMC-I and CTMC-II are chemistry education courses, it is noteworthy that the main change in pre-service chemistry teachers' orientations takes place in CTMC-II. Since they were students themselves until the teaching practices in CTMC-II, it can be said that they have difficulty in changing their orientations without seeing the reflection of these orientations in the classroom. It seems that pre-service teachers' immediate experiences as learners have much less effect on their orientations (Güven et al., 2019). As stated in the studies in the literature, this study showed that CTMC-I and CTMC-II influenced pre-service chemistry teachers' orientations. However, the present study also gave us the chance to see the difference of changes in the orientations of pre-service chemistry teachers when they were merely students (at CTMC-I) and when they acted as teachers (at CTMC-II).

One of the participants' orientations identified during the study was exam-focused orientation. It can be said that, depending on the context in which the study was conducted, the exam-focused orientation was detected throughout the study. As in the context in which this study is conducted, one of the objectives of the teachers of secondary education is to prepare the students for the university entrance exam in the countries where the university entrance examination is held. When considering this objective, the exam-focused orientations of pre-service chemistry teachers were not surprising giving that the obligation to engage in exam-focused teaching naturally affects teachers' orientations (Nargund-Joshi et al., 2011). Similarly, in a study conducted by Abrams et al. (2003), teachers stated that the pressure to raise test scores lead them to teach in a way that reflects the format of the state test and spent time to prepare their students for the external examination.

In the second research question of this study, the pre-service chemistry teachers' beliefs about goals or purposes of chemistry teaching were investigated during CTMC-I and CTMC-II. In this study, it was found that pre-service chemistry teachers had multiple purposes for chemistry teaching. Most of them included everyday coping as a main purpose of chemistry teaching at each stage of the study. Similarly, they reflected this purpose in their teaching practices. It can be said that everyday coping was the central goal for pre-service chemistry teachers while others (e.g., scientific skill development) were peripheral for them. This result of the current study was consistent with the studies conducted by Demirdöğen (2016) and Friedrichsen and Dana (2005). At the same time, it was found that pre-service chemistry teachers' beliefs about chemistry teaching and learning and beliefs about goals or purposes of chemistry teaching were also under the effect of university entrance exam. It can be said that nationwide examinations are one of the important factors for participants to develop solid foundation as a purpose. This result of the current study was similar to that reported in several studies (Aydin, 2012; Aydin et al., 2014; Demirdöğen; 2016; Ekiz-Kıran, 2016).

There were several limitations inherent to this study. First, the results of this study are limited to ten pre-service chemistry teachers. Therefore, these results cannot be generalised to different pre-service chemistry teachers and contexts. A second limitation arises from the convenience sampling method used in that the generalisability of the results of this study may be limited. However, the purpose of this study was not to make a statistical generalisation. Further research is needed to explicate pre-service chemistry teachers' orientation development during teacher training programs. It can be thought that the participants selected with convenience sampling are not enough information-rich cases. On the other hand, it can be said that the participants in this study exemplify the typical pre-service chemistry teachers in the country. In other words, although convenience sampling appears to be a limitation, the participants in this study reflect the profile of pre-service chemistry teachers studying at a state university. A third limitation arises from the environment of this study. In this study, the reflection of participants' orientations was observed in an artificial classroom at CTMC-II, not in a real classroom. Because of this reason, third limitation might be arising from the environment of this study. To eliminate this limitation, pre-service chemistry teachers' lessons should be observed in real classrooms to understand their enacted orientations in further studies. Although this study has not been conducted in a real class environment, it can be said that this situation is not exactly a limitation according to the results of some studies (e.g., Markic & Eilks, 2008; Markic & Eilks, 2013; Zeichner & Tabachnick, 1981) in the literature. According to Boz et al. (2019), Markic and Eilks (2013), and Zeichner and Tabachnick (1981), pre-service chemistry teachers might look at teaching from a traditional perspective after being or working in a real classroom.

Based on the results of this study, it can be concluded that the orientations of pre-service chemistry teachers are influenced by chemistry teaching method courses. Demirdöğen and Uzuntiryaki-Kondakçı (2016) emphasized that the importance of introducing professional knowledge bases and the role of the orientation in knowledge bases to help pre-service chemistry teachers align their beliefs with their practice. This situation highlights that the importance of teacher training programmes to train qualified teachers. These programmes may be arranged to create awareness in pre-service teachers about their orientations. Moreover, these programmes should provide student-centred learning environments to develop more student-centred orientations among pre-service teachers. Further studies should be conducted in different courses of chemistry teacher training programmes, so that the courses that are more effective for pre-service chemistry teachers' orientations can be identified.

According to Boesdorfer and Lorsbach (2014), teachers who do not think about why and how they teach will have deficiencies in their beliefs about science teaching, and this will be reflected in their science teaching orientation. The results of this study may have valuable implications for chemistry teacher educators and chemistry education researchers. To help pre-service chemistry teachers to become aware of their orientations and to revise these orientations, chemistry teacher educators should find the ways to make their orientations visible. Chemistry teacher educators can reveal these orientations by using data collection tools similar to those used in this study or developing new instruments. Moreover, chemistry teacher educators should guide pre-service chemistry teachers to transfer their student-centred orientations into their teaching practices. For instance, teacher educators should provide more mentoring about how teaching strategies which are more reform-based should be implemented in classrooms. This study revealed that CTMC-I and CTMC-II courses, the courses related to methods of chemistry teaching, influenced pre-service chemistry teachers' orientations about chemistry teaching. Chemistry education researchers should focus the effect of the courses in different categories (e.g., chemistry courses, general education courses, and chemistry teaching courses) on pre-service chemistry teachers' orientations.

The present study provides support for the use of drawings could be used to examine pre-service teachers' orientations. However, there are some points to be considered in the use of drawings. First of all, for chemistry education researchers, it is recommended that drawings which are one of the tools that can be used to detect orientations should not be used alone for this purpose since the drawings provide a snapshot and the factors that affect orientations cannot be accurately determined. A perspective that is not easily recognisable through written or verbal statements may be provided with drawings (Weber & Mitchell, 1996). According to Markic and Eilks (2013), in the drawings, the risk of pre-service teachers giving socially expected answers; is less than in the case of data collection using other data collection tools (e.g., interviews). Moreover, DASTT-C forces a pre-service teacher or a teacher to think deeply about teaching (Markic et al., 2006). For chemistry education researchers, it is recommended that it should be more effective to interpret the data obtained by DASTT-C together with the results obtained with other data collection tools in order to understand the orientations in depth.

The results of this study showed that pre-service chemistry teachers' orientations were started to change after CTMC-I. Therefore, it can be concluded that theoretical presentations about student-centred learning approaches probably influenced pre-service chemistry teachers' orientations. However, there were still pre-service chemistry teachers with teacher-centred orientations after CTMC-I. This can be considered as an expected outcome because pre-service teachers may not have developed their knowledge of "how" to teach "what" based on the lack of their teaching experiences (Kasapoglu, 2021). On the other hand, the results of this study showed that CTMC-II especially influenced pre-service chemistry teachers' orientations. After CTMC-II, almost all pre-service chemistry teachers started to look atchemistry teaching and learning in a reform-based perspective. The main difference between CTMC-I and CTMC-II is that pre-service chemistry teachers have a real teacher role in CTMC-II. According to the results of this study, it can be concluded that although pre-service chemistry teachers had seen theoretical presentations about student-centred approaches in CTMC-I; their orientations changed when they realised that student-centred approaches were more effective in teaching practice sessions in CTMC-II. It can be said that the way to change pre-service chemistry teachers' orientations is to ensure that they exist in environments where they can reflect their current orientations and that they realize the points where their current orientations are inadequate in terms of chemistry teaching. This study should give the chemistry education community a glimpse about how to organise a course to change or develop the orientations of pre-service chemistry teachers. For example, organising the courses to give pre-service chemistry teachers the chance to do more teaching practices. According to the results of this study, it is recommended that a chemistry teacher educator should give opportunities (such as CTMC-II) to pre-service chemistry teachers to see how their orientations are reflected in the classroom. In addition, the chemistry teacher educator can provide examples of the goals or purposes of chemistry teaching in order to develop or change orientations about why chemistry should be taught. For example, the chemistry teacher educator can provide examples of whether life itself is related to chemistry or the relationship of chemistry with other disciplines or the need to teach chemistry to facilitate and control life. In addition, the chemistry teacher educator can prepare student-centred instructional environments to change pre-service chemistry teachers' orientations about how chemistry should be taught, enabling pre-service chemistry teachers to be present in these environments and discover the effectiveness of student-centred approaches by themselves. Another situation that may be remarkable for chemistry education community is that pre-service chemistry teachers who had knowledge about student-centred teaching approaches, due to the general education courses (e.g., learning and teaching approaches) they took before, still had teacher-centred orientations at the beginning of this study. It can be said that the orientations of pre-service chemistry teachers have not changed since they who have learned about student-centred approaches in the general education courses did not apply these approaches themselves in a chemistry topic. Therefore, in order to develop the orientations of pre-service chemistry teachers about chemistry teaching, it is recommended that the contents of general education courses in chemistry teacher training programmes should be reorganised to include chemistry and pre-service chemistry teachers should be provided with environments in which they can apply the approaches they have learned.

References

Abell, S. K. (2007). Research on science teacher knowledge. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 1105-1149). Lawrence Erlbaum Associates.

Abell, S. K. (2008). Twenty years later: Does pedagogical content knowledge remain a useful idea? *International Journal of Science Education, 30*(10), 1405-1416. https://doi.org/10.1080/09500690802187041.

Abrams L. M., Pedulla J. J., & Madaus G. F., (2003). Views from the classroom: Teachers' opinions of statewide testing programs. *Theory into Practice*, *42*(1), 18-29.

Adu-Gyamfi, K. (2020). Pre-service teachers' conception of an effective science teacher: The case of initial teacher training. *Journal of Turkish Science Education, 17*(1), 40–61. https://doi.org/10.36681/tused.2020.12.

Akin, F. N. & Uzuntiryaki-Kondakci, E. (2018). The nature of the interplay among components of pedagogical content knowledge in reaction rate and chemical equilibrium topics of novice and experienced chemistry teachers. *Chemistry Education: Research and Practice, 19*(4), 80-105. https://doi.org/10.1039/C7RP00165G.

Ambusaidi, A., Al-Hajri, F., & Al-Mahrooqi, M. (2021). Gender differences in Omani students' perception of the pedagogical content knowledge of their science teachers as appeared in reality and students' preferences. *Journal of Turkish Science Education, 18*(4), 781-797. http://doi.org/10.36681/tused.2021.103.

Anderson, C. W. & Smith, E. L. (1987). Teaching science. In V. Richardson-Koehler (Ed.), *Educators' handbook a research perspective* (pp. 84-111). Longman.

Avraamidou, L. (2013). Prospective elementary teachers' science teaching orientations and experiences that impacted their development. *International Journal of Science Education, 35*(10), 1698-1724. https://doi.org/10.1080/09500693.2012.708945.

Aydin, S. (2012). *Examination of chemistry teachers' topic-specific nature of pedagogical content knowledge in electrochemistry and radioactivity* [Unpublished doctoral dissertation]. Middle East Technical University.

Aydin, S. & Boz, Y. (2012). Review of studies related to pedagogical content knowledge in the context of science teacher education: Turkish case. *Educational Sciences: Theory & Practice*, *12*(1), 479-505.

Aydin, S., Demirdogen, B., Akin, F. N., Uzuntiryaki-Kondakci, E., & Tarkin, A. (2015). The nature and development of interaction among components of pedagogical content knowledge in practicum. *Teaching and Teacher Education, 46*, 37-50. https://doi.org/10.1016/j.tate.2014.10.008.

Aydin, S., Friedrichsen, P. M., Boz, Y., & Hanuscin, D. L. (2014). Examination of the topic-specific nature of pedagogical content knowledge in teaching electrochemical cells and nuclear reactions. *Chemistry Education: Research and Practice, 15*(4), 658-674. https://doi.org/10.1039/C4RP00105B.

Boesdorfer, S. B. (2012). *PCK to practice: Two experienced high school chemistry teachers' pedagogical content knowledge in their teaching practice* [Unpublished doctoral dissertation]. Illinois State University.

Boesdorfer, S. & Lorsbach, A. (2014). PCK in action: Examining one chemistry teacher's practice through the lens of her orientation toward science teaching, *International Journal of Science Education*, *36*(13), 2111-2132. https://doi.org/10.1080/09500693.2014.909959.

Borko, H. & Putnam, R. T. (1996). Learning to teach. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 673-708). Macmillan.

Boz, Y., Ekiz-Kiran, B., & Kutucu, E. S. (2019). Effect of practicum courses on pre-service teachers' beliefs towards chemistry teaching: A year-long case study. *Chemistry Education: Research and Practice, 20*(3), 509-521. https://doi.org/10.1039/C9RP00022D.

Brown, P., Friedrichsen, P., & Abell S. K. (2009, August 31-September 4). *Do beliefs change? Investigating prospective teachers' science teaching orientations during an accelerated post-baccalaureate program*. [Paper presentation]. European Science Education Research Association, Istanbul, Turkey.

Cansız, N. & Cansız, M. (2016). Preservice science teachers' orientations towards teaching science to middle schoolers. *International Journal on New Trends in Education and Their Implications, 7*(3), 69-78.

Chan K. K. H. & Hume A. (2019). Towards a consensus model: Literature review of how science teachers' pedagogical content knowledge is investigated in empirical studies. In A. Hume, R. Cooper, & A. Borowski (Eds.), *Repositioning pedagogical content knowledge in teachers' knowledge for teaching science* (pp. 3-76). Springer.

Creswell, J. W. (1994). *Research design: Qualitative & quantitative approaches*. Sage.

Çepni, S. (2018). *Introduction to research and project studies* (Extended 3rd ed.). Pegem Academy.

Demirdöğen, B. (2016). Interaction between science teaching orientation and pedagogical content knowledge components. *Journal of Science Teacher Education*, *27*(5), 495-532.

Demirdöğen, B. & Uzuntiryaki-Kondakçı, E. (2016). Closing the gap between beliefs and practice: Change of pre-service chemistry teachers' orientations during a PCK-based NOS course. *Chemistry Education: Research and Practice, 17*(4), 818-841. https://doi.org/10.1039/C6RP00062B.

Ekiz-Kiran, B. (2016). *Interaction between experienced chemistry teachers' science teaching orientations and other components of pedagogical content knowledge in mixtures* [Unpublished doctoral dissertation]. Middle East Technical University.

Ekiz-Kiran, B. & Boz, Y. (2020). Interactions between the science teaching orientations and components of pedagogical content knowledge of in-service chemistry teachers. *Chemistry Education: Research and Practice*, 21(1), 95-112. https://doi.org/10.1039/C9RP00092E.

Evens, M., Elen, J., & Depaepe, F. (2015). Developing pedagogical content knowledge: Lessons learned from intervention studies. *Education Research International*, 1-23. https://doi.org/10.1155/2015/790417.

Friedrichsen, P. J. (2002). *A substantive-level theory of highly-regarded secondary biology teachers' science teaching orientation* [Unpublished doctoral dissertation]. The Pennsylvania State University.

Friedrichsen, P. M. & Dana, T. M. (2005). Substantive-level theory of highly regarded secondary biology teachers' science teaching orientations. *Journal of Research in Science Teaching*, *42*(2), 218-244. https://doi.org/10.1002/tea.20046.

Friedrichsen, P., van Driel, J. H., & Abell, S. K. (2011). Taking a closer look at science teaching orientations. *Science Education*, *95*(2), 358-376. https://doi.org/10.1002/sce.20428.

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK: Results of the thinking from the PCK summit. In A. Berry, P. Friedrichsen & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 28-42), Routledge.

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

Güven, D., Muğaloğlu, E. Z., Doğança-Küçük, Z., & Cobern, W. W. (2019). Teaching orientations of freshman pre-service science teachers. *Journal of Turkish Science Education, 16*(4), 508-520. doi: 10.36681/tused.2020.4.

Hancock, E. & Gallard, A. (2004). Preservice science teachers' beliefs about teaching and learning: The influence of K-12 field experiences. *Journal of Science Teacher Education*, *15*(4), 281-291. https://doi.org/10.1023/B:JSTE.0000048331.17407.f5.

Kasapoglu, K. (2021). A meta-synthesis research on knowledge of pre-and in-service science teachers in Turkey. *Journal of Turkish Science Education, 18*(4), 732-747. https://doi.org/10.36681/tused.2021.100.

Kind, V. (2016). Preservice science teachers' science teaching orientations and beliefs about science. *Science Education*, *100*(1), 122-152. https://doi.org/10.1002/sce.21194.

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

Luft, J. A. & Roehrig, G. H. (2007). Capturing science teachers' epistemological beliefs: The development of the teacher beliefs interview. *Electronic Journal for Research in Science & Mathematics Education*, *11*(2), 38-63.

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

Markic, S. & Eilks, I. (2008). A case study on German first year chemistry student teachers' beliefs about chemistry teaching, and their comparison with student teachers from other science teaching domains. *Chemistry Education: Research and Practice, 9*, 25-34. https://doi.org/10.1039/B801288C.

Markic, S. & Eilks, I. (2013). Potential changes in prospective chemistry teachers' beliefs about teaching and learning-A cross-level study. *International Journal of Science and Mathematics Education*, *11*, 979-998.

Markic, S., Valanides, N., & Eilks, I. (2006). Freshman student teachers' beliefs about science teaching – A mixed methods study. In I. Eilks & B. Ralle (Eds.), *Towards research-based science teacher education* (pp. 29-40), Shaker.

Marks, R. (1990). Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of Teacher Education*, *41*(3), 3-11. https://doi.org/10.1177/002248719004100302.

Mavuru, L. & Ramnarain, U. (2018). Relationship between teaching context and teachers' orientations to science teaching. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(8), 1-14. https://doi.org/10.29333/ejmste/91910.

Merriam, S. (2009). *Qualitative research: A guide to design and implementation*. Jossey-Bass.

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, California: SAGE.

Namoco, S., & Zaharudin, R. (2021). Pedagogical beliefs and learning assessment in science: teacher's experiences anchored on theory of reasoned action. *Journal of Turkish Science Education, 18*(2), 304-319. https://doi.org/10.36681/tused.2021.67.

Nargund-Joshi, V., Park Rogers, M. A., & Akerson, V. L. (2011). Exploring Indian secondary teachers' orientations and practice for teaching science in an era of reform. *Journal of Research in Science Teaching*, *48*(6), 624-647. https://doi.org/10.1002/tea.20429.

Patton M. Q. (2002) *Qualitative research and evaluation methods* (3rd ed). Sage.

Roberts, D. A. (1982). Developing the concept of "curriculum emphases" in science education. *Science Education*, *66*(2), 243-260. https://doi.org/10.1002/sce.3730660209.

Roberts, D. A. (1995). Junior high school science transformed: Analysing a science curriculum policy change. *International Journal of Science Education*, *17*(4), 493-504. https://doi.org/10.1080/0950069950170408.

Seung, E., Park, S., & Narayan, R. (2011). Exploring elementary pre-service teachers' beliefs about science teaching and learning as revealed in their metaphor writing. *Journal of Science Education and Technology, 20*, 703-714. https://doi.org/10.1007/s10956-010-9263-2.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14, https://doi.org/10.3102/0013189X015002004.

Soysal, Y. (2018). An exploration of the interactions among the components of an experienced elementary science teacher's pedagogical content knowledge. *Educational Studies*, *44*(1), 1-25. https://doi.org/10.1080/03055698.2017.1331839.

Subramaniam, K. (2021). Prospective teachers' pedagogical content knowledge development in an elementary science methods course. *Journal of Science Teacher Education*, 1-23. https://doi.org/10.1080/1046560X.2021.1939944.

Şen, A. Z. & Nakiboğlu, C. (2019). Exploring experienced chemistry teachers' science- teaching orientations (STOs) via a card-sorting task: Physical-chemical change topic. *Journal of the Turkish Chemical Society: Chemical Education*, *4*(1), 15-16.

Thomas, J. A., Pedersen, J. E., & Finson, K. (2001). Validating the draw-a-science-teacher-test checklist (DASTT-C): exploring mental models and teacher beliefs. *Journal of Science Teacher Education*, *12*(3), 295-310. https://doi.org/10.1023/A:1014216328867.

Weber, S. & Mitchell, C. (1996). Drawing ourselves into teaching: studying the images that shape and distort teacher education. *Teaching and Teacher Education*, *12*(3), 303-313. https://doi.org/10.1016/0742-051X(95)00040-Q

Wills, J. (2006). Authority, culture, context: Controlling the production of historical knowledge in elementary classrooms. In J. L. Pace & A. B. Hemmings (Eds.), *Classroom authority: Theory, research, and practice* (pp. 33-62). Lawrence Erlbaum.

Yıldız Feyzioğlu, E., Feyzioğlu, B., & Demirci, N. (2016). Aktif doğrudan veya yapılandırılmış buluş: Fen bilimleri öğretmenlerinin fen öğretimi yönelimlerinin belirlenmesi [Title in English: Active direct or guided inquiry: Examining the science teaching orientations of science teachers]. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi*, *39*, 150-173. https://doi.org/10.21764/efd.49128.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Sage.

Zeichner, K. M. & Tabachnick, B. R. (1981). Are the effects of university teacher education 'washed out' by school experience? *Journal of Teacher Education, 32*(3), 7-11. https://doi.org/10.1177/002248718103200302.