Developing Context-Based Teaching Competencies of Chemistry Teachers: Designing and Implementing Context-Based Activities

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Abstract

Context-based teaching is the use of contexts as a starting point for the development of scientific ideas in learning environments. Teachers can use this teaching approach to increase students' motivation and willingness to learn science. The focus of this research was to develop context-based teaching competencies of teachers. With this in mind, this research aimed to determine the effects of feedback on the development of teachers' context-based teaching competency and the factors affecting the teaching process. In the study, collective case study design was employed. The study was carried out with two chemistry teachers who participated in the In-Service Training Course on Context-Based Chemistry Teaching conducted by the researcher. The data of the research were collected through field notes, semi-structured interview, follow up interviews and video recordings. As a result of the research, it was determined that the feedback had a positive effect on the development of chemistry teachers' context-based teaching competency. It was revealed that teacher anxiety, professional knowledge, difficulty in designing materials and lack of interest of students affected the teaching process.

Keywords: Context-Based Approach, Context-Based Teaching Competencies, Feedback, Chemistry Teachers

INTRODUCTION

New approaches have emerged in science teaching as a result of research on how to teach scientific concepts to students within the frame of sociological events. One such approach is context-based teaching. The aim of context-based teaching is to relate daily life with scientific concepts taught at school and thus increase students' willingness to learn science (Barker & Millar, 1999; Bennett et al., 2005; Fensham, 2009; Kang et al., 2019; Özay-Köse & Çam-Tosun, 2011). The need for science teachers, who are proficient enough to guide the context-based practice to the learning environment, increases day by day (Taconis et al., 2016). This also brings with it, the need to inform teachers about creating context-based learning environments (Stolk et al., 2016). In some countries such as the UK, Holland, and Germany, the context-based teaching approach was introduced to teachers through training classes, professional development programmes, and projects. In these educational introductions, teachers were both informed about the context-based teaching method and took part in the material design process (Bennett & Lubben, 2006; Parchmann vd., 2006; Pilot & Bulte, 2006).

In this study, the process was initiated similarly and chemistry teachers attended an in-service training course on context-based teaching approach. During the training, teachers were given materials prepared by the researcher and then new materials were prepared together with the teachers. Teachers who volunteered to participate in the study were observed in their learning environments, and the development of their context-based teaching competency was followed up. The development of teachers was evaluated within the frame of context-based teaching competencies identified by De Putter-Smits (2012); and the effect of the feedback given by the researcher on the development of these competencies were also investigated. This study was conducted to determine teachers' context-based teaching competencies and the effect of the feedback given by the researcher on these competencies, with the belief that this would contribute to the literature.

Context-Based Teaching Approach and Chemistry Teaching

Problems faced in chemistry education in the last 40 years have brought about the idea that context-based teaching approach might be effective in chemistry learning environments (Sevian et al., 2018). Context-based teaching is defined as the approach in which contexts are used as a starting point in the development of

scientific ideas in learning environments (Bennett et al., 2007). Context is sample situations selected from real life, social-social events, scientific practices (Wieringa et al., 2011). The focus point of context-based teaching approach is to present the scientific concepts in the teaching programme to the students in familiar contexts so that the gap between learning and daily life is filled (Bennett, 2003; Gilbert, 2006; Glynn & Koballa, 2005; Glynn & Winter, 2004; Xiao, 2018). Teachers should use this approach to increase students' willingness and motivation to learn science by presenting scientific concepts with daily life contexts (Barker & Millar, 1999; Özay-Köse & Çam-Tosun, 2011). Moreover, teachers may use context-based approach for innovate their teaching practice. The role of the teacher in the context-based learning environment is to arrange the class environment, facilitate the practice process, and encourage students to share their knowledge and thoughts (Stolk et al., 2009; Van Driel et al., 2001). In this respect, teachers are expected to create learning environments in which students can be responsible for their own learning, contexts are used as a starting point for learning scientific concepts, and students' needs are considered (Gilbert, 2006).

Context-Based Teaching Competencies

Teachers are expected to have certain competencies in order to create effective context-based learning environments. Teachers may encounter context-based teaching materials that contain contexts that are unfamiliar to them. In such cases, teachers should have the competency to learn the new context and explain it in a way that suits to the characteristics of the students in class (Van Driel et al., 2005). The context should make the student feel the need to research and learn about the scientific concept. The teacher should be able to evaluate the context from the perspective of the students, take care to use contexts suitable for the student's development level/interests and help students by transferring the concepts to other contexts (Bennett et al., 2007; Bulte et al., 2006; De Putter-Smits, 2012). In traditional teaching approaches, learning process is designed in control of the teacher. In context-based teaching, on the other hand, the responsibility of learning is shared equally between the teacher and the student. In context-based learning environments, the teacher is required to include students in the process by designing suitable activities for this teaching approach. A teacher who embraces this approach would provide

their students, for instance, the opportunity to solve a problem through their own experiences or determine their study times (Bulte et al., 2006; De Putter-Smits, 2012; Vermunt & Verloop, 1999). There are three difference teaching programme emphases in chemistry education, namely, fundamental chemistry, chemistry-technology-society, and knowledge development in chemistry. The commonly used in traditional chemistry education is the fundamental chemistry emphasis in which theoretical concepts are taught first (Roberts, 1982; Van Driel et al., 2008). To teach subjects through contexts, different from traditional teaching, either chemistry-technology-society emphasis or knowledge development in chemistry emphasis or both should be given in context-based teaching (Vos et al., 2010).

Context-based materials in curricula are standard materials prepared by considering a general framework. Evidently, a teaching material designed in a generalised manner cannot always be suitable to the needs/conditions of the teacher nor the students. Thus, teachers are expected to update materials or design alternative ones based on the physical characteristics of the class, their students' needs (De Putter-Smits et al., 2012) or their own perception and expectations (Parchmann et al., 2006; Vos et al., 2011). Teachers who adopt context-based teaching should take a leading role in introducing their colleagues to this approach. They should design context-based materials in collaboration with their colleagues in their own fields (Stolk et al., 2016, p. 206), inform colleagues in other disciplines about context-based teaching and support them in context-based teaching related subjects (De Putter-Smits, 2012). Context-based teaching competencies were gathered under five headings by De Putter-Smits et al., (2012), and they were briefly defined in Table 1 based on this research.

Table 1. Context-Based Teaching Competencies and Their Definitions

Competency	Definition
Context handling	The way the context is handled, selection of context and how it is used, context's appropriateness for students
Regulation	Encouraging students for active learning, ensuring students' take their own learning responsibility, being a guide during learning
Emphasis	Explaining chemistry through science-technology and knowledge development in society.
Design	Updating the materials before practice according to the needs of the class, designing alternative materials
School innovation	The teachers being the representative of innovative approaches in their own schools

The Importance of In-Service Training and Feedback in the Development of Teacher Competency

One of the most important ways to make teaching effective in the 21st century is to ensure teachers' professional development (OECD, 2005; Seferoğlu, 2004). In-service training is one of the necessary steps underlined in the relevant literature for professional development (Aytaç, 2000; George & Lubben, 2002; Le Roux & Ferreira, 2005; Mishal & Patkin, 2016; Spector, 1987; Toran & Yağan Güder, 2020). To obtain successful results in in-service trainings, these trainings should be continuous and spread over a period (Günel & Tanrıverdi, 2014). Moreover, how the teachers apply in their schools the know-how they obtained in these trainings should be followed up (Kanlı & Yağbasan, 2001; McDonald, 2011) and the practices these teachers do in their classes should be supported by feedbacks (Joyce & Showers, 1980). Nevertheless, it was seen that the number of studies where in-service trainings for teacher development are supported by feedbacks is limited in literature. In this respect, it is believed that this study, which uses feedbacks during the in-service training to develop teachers' context-based teaching competencies, will contribute to teachers' professional developments on a scientific level.

Research Aim and Research Questions

The aim of this research, which focused on the development of context-based teaching competencies of chemistry teachers, was to determine the effects of the feedback given to the teachers during the practice on their context-based teaching competencies. In addition, it was aimed to determine the factors affecting the teaching process in the research. This research seeks

answers to the research question "What is the effect of the feedback given after practices on teachers' context-based teaching competencies?" and "What are the factors affecting the teaching process?"

METHOD

Stake's (1995) collective case study pattern was used in this study. Collective case study denotes studies where multiple cases are examined to understand a specific subject and in which cases are compared and combined whenever necessary. Collective case study enables one to examine cases within themselves, determine differences between cases, and compare findings (Stake, 1995). Since this study aimed to examine how the context-based teaching competency of two chemistry teachers change during the process, it was thought that collective case study pattern would be the most appropriate to do so. Each teacher represents a case.

Population and Sampling

The universe of this study consists of 21 chemistry teachers who participated in the In-Service Training Course on Context-Based Chemistry Teaching conducted by the researcher. The selection of participants was done during the in-service training by using stratified purposeful sampling which is used to show, define, and compare the characteristics of relevant sub-groups (Patton, 2002). When determining the participants nonallelic basis, the diversity of faculties they graduated from, the similarity of their professional experience, and the difference of their perspectives on teachers were considered. The study was carried out with two chemistry teachers. These teachers work at two different high schools. After the in-service training, both teachers agreed to attend the lectures of one of the researchers and make observations and interviews throughout the implementation. Teachers were named T1 and T2 for anonymity.

T1: He is a teacher with 29 years of experience, open to applying different teaching methods and likes backing chemistry subjects up with examples from daily life. He is of the opinion that students should be active in class and that the real objective of teaching is to ensure meaningful learning. Nevertheless, he carries out his classes in the traditional method.

T2: She is a teacher with nearly 30 years of experience. She continues to do her job in the way she had experienced it as a student. T2 is, in this sense, a traditionalist. Although she has expressed that she is open to change, she has the demeanour to resist process and change.

Instrument and Procedures

In this study, which aims to develop chemistry teachers' context-based teaching competency, it was decided that the process should start by first briefing teachers on context-based teaching. To this end, General Directorate of Teacher Training and Development under the Ministry of National Education was contacted; 21 chemistry teachers residing in Ankara who volunteered to participate were given in-service training for one week (30 hours). Planning and practice of the training was carried out by the first author. In the training, teachers were briefed on Context-Based Learning Approach and context-based teaching competencies; context-based teaching materials designed by the researcher were presented; the teachers were told how these materials were designed, and then new context-based teaching materials were prepared together with the teachers. After in-service training, volunteers for research were determined.

The present study consists of designing a context-based chemistry teaching activities and applying these activities in class by teachers, and giving feedback to teachers by the first author after each practice. Each teacher designed and carried out three context-based teaching activities on a Year 9 chemistry curriculum of their own choosing (Table 2).

Table 2. Contexts and Topics Selected by Teachers For Teaching Materials

Teacher	Context	Topic
T1	Robots	Metallic bond and characteristics of metals
	The effect of acid rains on world heritage	Reaction equations
	Why does southwest wind cause poisoning? Water cycle	Vaporisation, boiling, condensation
T2	Accidents with chemicals	Our safety and chemistry
	Why does milk go bad in hot weather?	Physical-chemical changes
	Flying principle of balloons	Gases

Practices were carried out in the Year 9 section in which each teacher taught. All teaching activities were recorded via video camera. Before the practices the participant teachers and the students were all informed about the aim of this study via a consent form. The consent form openly stated that participants can withdraw from the study at any stage and that the course will be recorded via video. Moreover, teachers were asked for permission to have video and voice recordings. First author participated in the practices as a participant observer, and she took field notes. A participant observer interacts with participants and tries to evaluate the research process (Fraenkel & Wallen,

2006). After each practice, follow-up interviews were held with the teachers separately. Afterwards, teachers were given feedback which was thought to help improve their context-based teaching competencies. Content of these feedbacks were determined as a result of observing the teachers during in-class practices and school environment; it was made sure that these feedbacks covered their context-based teaching competencies. After the practices were completed, semi-structured interviews were conducted with both teachers in order to evaluate the teaching process. Sample questions from the semi-structured interview are shared below:

1. What are the factors affecting your context-based teaching process?
2. What were your students' attitudes towards practices?
3. What are your views on context-based chemistry teaching and preparing/applying context-based teaching materials?

Data collection tools were presented in Figure 1.

Data Analysis

In this research, data obtained from the field notes, follow-up interviews, semi-structured interviews and video recordings were analysed through content analysis. While establishing codes, definition of competencies determined by De Putter-Smith (2012) and definitions of these competencies in the relevant literature were utilised. Oral data obtained through video recording were transcribed into a written text, then, analysis was begun with the reading of all written material. . First of all, open coding was done, which is called the first-step coding in data coding techniques. Data were coded line by line or paragraph by paragraph depending on how they made sense. Codes obtained in open coding were classified according to the frequency with which they are repeated and according to their importance; some codes were put together based on their similarity-difference, and categories were formed. After the analyses, 8 codes were obtained. Then these codes were classified according to their similarities and were gathered under 4 categories. These categories, namely, context handling, regulating the learning process, teaching emphasis and material design, correspond to context-based teaching competencies. To ensure the reliability of codes, 20% of data were re-coded by two different experts. Reliability coefficient between coders was calculated to be 0.83 for one researcher and 0.87 for the other. According to Miles & Huberman (1994), reliability percentage should be at least 80%.

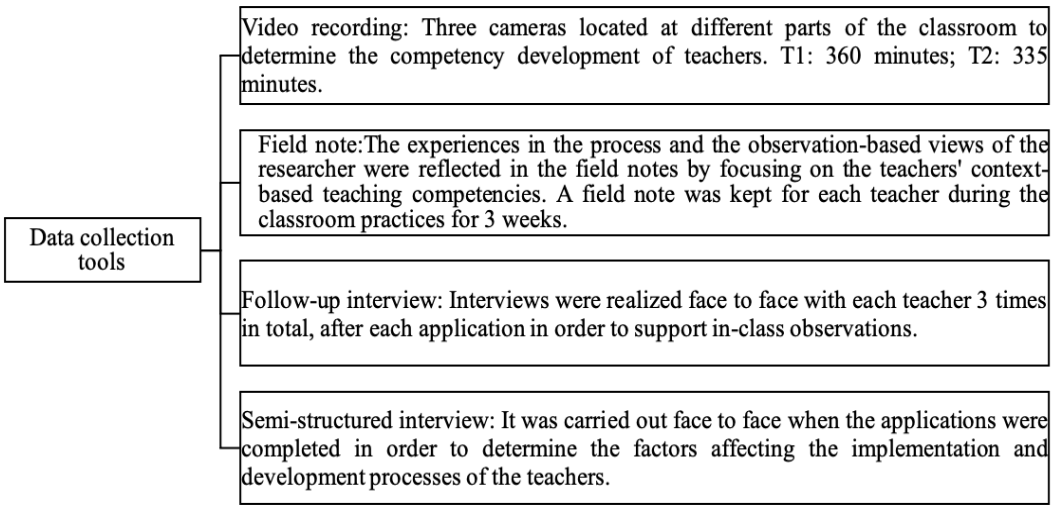

Figure 1. Data Collection Tools

Validity and Reliability

To ensure validity and reliability of this study, believability, transferability, consistency, and verifiability strategies were utilised. Participants and the environment were observed for a year; multiple and sustained interviews were carried out. Throughout material design process, the researcher participated in the classes where teachers carried out the practices in order to minimise the researcher effect in the practice process. Different data collection tools were used in the study; interviews were recorded by a voice recorder while the in-class practices were recorded by video. Video recordings were watched multiple times; all processes of the study were evaluated together with the experts, confirmation was sought from the participants at the end of the study, and results were presented objectively. Codes and categories that came about as a result of analyses were presented by direct quotations to ensure transferability. To ensure reliability of codes, data were re-coded by two different experts. For confirmability, raw data obtained from the study were stored.

RESULTS AND DISCUSSION

Development of Context-Based Teaching Competencies

At the end of the analyses of data obtained from field notes, video recordings, and follow-up interviews, context-based teaching competencies were gathered under 8 codes and 4 categories. Context-based teaching competencies and the change the context-based teaching competencies of two teachers have undergone during the process were presented in Table 3.

Table 3. Context-Based Teaching Competencies Teachers Based on the Practices

Category	Code	Teacher	Practice 1	Practice 2	Practice 3
Context handling	Appropriateness to development level	T1	+/-	+	+
		T2	-	+	+
	Context-subject association	T1	-	+	+
		T2	-	+/-	+
Regulating the Learning Process	Teacher-student co-regulation	T1	-	+/-	+/-
		T2	-	-	-
	Student-controlled teaching	T1	-	-	+/-
		T2	-	-	-
Emphasis in Teaching	Chemistry-technology-society	T1	-	+	+
		T2	-	+	+
	Development of knowledge in chemistry	T1	-	-	+
		T2	-	-	-
Designing materials	Updating materials	T1	-	+	+
		T2	-	-	-
	Designing alternative material	T1	-	-	+
		T2	-	-	-

(+), the teacher has the relevant competency; (-), the teacher does not have the relevant competency; (+/-), the teacher partially has the relevant competency.

It is enough for teachers to show development in one of the codes (competency expressions) to claim that their relevant context-based teaching competency has developed. However, in order to mention an development in the competency of context handling, it is necessary to observe an development in both codes. When presenting the findings, only the quotations related to the competencies the teachers developed in were shown.

1. Development of "context handling" competency

It was seen that there is a positive change in both sub-competencies of the context handling competency of T1 and T2 during the time that passed from the first practice to the third.

Appropriateness to development level: The students' interest in the lesson and the behavior of asking questions to the teacher show that the context is appropriate for the development levels of the students. Table 3 shows that at the end of three practices, context selections of both teachers developed to be appropriate to students' development level. Although the context T1 selected for the first practice seems to be appropriate for students' development level at first glance, it is thought that the way the context is presented to the students makes it difficult for students to understand it. The context was familiar and interesting for some students. Based on this, it can be argued that the context is partially appropriate for students' development level.

T1: Doesn't anyone wonder why these metal men have these explained characteristics?

Student 3: Ma'am, we read it, what shall we do now? Are we going to make robots in this class? (Video recording, Practice 1)

In Practices 2 and 3, contexts selected by T1 were observed to be more appropriately determined for students' development levels and more appropriately presented. Researcher's observation during Practice 2 were reflected in her research notes as follows:

In this practice, the teacher presented the context through pictures and context-based questions. Most of the students ask for permission to speak in class. They listen to their teacher very attentively. The teacher's inclusion of pictures and schemes in the material is appropriate for the students in this group.

In one of the interviews carried out after these practices, the teacher was asked based on what criteria he selected the context. His answer is significant in that it supports the researcher's view.

T1: Because I am highly eco-conscious, I had mentioned acid rains in class before. I mean it is not the first time they are hearing of this. We studied acid rains in the first-semester's project course. Also, this is a subject they have heard of even in the news. They all have an idea what it is. (Follow-up Interview 3)

T2 was unable to realise a context-based teaching even though she had prepared a context-based material for the first practice. Therefore, there was none of the sub-competency of context handling competency in her first practice. After receiving necessary feedback, she lectured on "Physical and Chemical Change" through the context of "milk turning bad in hot weather." This context is appropriate for students' development level since it is highly likely that almost all of them had an experience of this at their homes. Moreover, as indicated in the field notes, the fact that students were able to talk about this context supports this assumption:

Students sitting in front rows discuss whether UHT distorts milk's chemical structure. One student claims that there is physical change. Students seem to be eager to share their knowledge and participate in class discussions.

In Practice 3, T2 managed to grab students' attention by using the context effectively. The interview after the practice also supports the assumption that T2 took into account the feedback and tried to improve herself.

Researcher: Why did you select an opinion piece?

T2: I wanted the students to see that chemistry is everywhere. Today even a journalist writes a piece utilising his knowledge of chemistry. Also, the opinion piece has a very simple and easy to understand language. (Follow-up interview 3).

Based on the findings obtained from the data and the observations of students' behaviour in class, it can be claimed that at the end of the process T1 and T2 have an developed competency of context handling and selecting contexts appropriate for students' development levels.

Context-subject association: It was seen that in the first practices neither teacher had enough competency for context-subject association. However, after the practices their ability to associate the context with the subject developed. T1 had an impressive change taking into account the feedback he received after the first practice; on the other hand, the development of T2's competency in this area was slower. In the first practice, T1 spent a good part of his lesson talking about the context. In Practice 2, he presented acid rains as the context; he then discussed with the students the reasons for the formation of acid rains and related all reaction types with his selected context. As can be seen in the example given below, the teacher tried to help students segue into the subject:

T1: …Based on what you know of them, what kind of reaction do you think the acid rain creates?

Student 7: Chemical gases coming out of fossil fuels mix with the water vapour in the air and form harmful acids.

T1: Yes, quite right. Okay then, what if I ask you to rephrase this in a more chemistry-friendly way. You can take your cue from the things on the whiteboard.

Student 4: Two different chemical compounds come together and form one (Video recording – Practice 2)

As can be seen in the dialogues, the teacher was able to associate the context with the subject and enabled students to reach at the intended point by giving them clues. In Practice 3, T1 used water cycle as the context. After giving the context, he asked students to find concepts relevant for the topic on the water cycle scheme to ensure context-subject association. Below is a dialogue from the after-practice interview:

Researcher: At which stage did you try to establish a context-subject association?

T1: I asked the students to write down the concepts in this scheme to the boxes. Then I asked them to interpret the scheme. I underlined that there is no way

chemistry cannot be present in a material cycle that constantly exists in nature. By asking questions based on the picture, we talked about how boiling points can change in different altitudes. (Follow-up Interview 3)

Since T2 did not use a context in the first practice, there was no competency of context-subject association. In Practice 2, she tried to make students associate the context and the subject through a reading piece included in the student pack and through Q&A. As indicated in the field notes, T2 started lecturing on theoretical information keeping the association part short for fear of not being able to keep up with the schedule.

Students verbally indicate that they have noticed the connection between the subject and the context in the reading material, but T2 does not consolidate the validity of their ideas. She rushes through the theoretical part.

Because T2 was not able to make clear the connection between the subject and the context, her competency on this was partially developed in Practice 2. In Practice 3, T2 gave the context in a text. T2 asked students to underline the concepts related to chemical gases in the opinion piece. Making sure that students are aware of the concepts in this opinion piece prepared the grounds for segueing into the subject. T2 established the connection between the subject and the context by questions. The fields notes concerning this is as follows:

The teacher professionally relates the subject with the context. She reinforces what they say by allowing them to speak up.

It can be seen that T1 and T2's skills of associating the context with the subject developed after practices. However, T1 evaluated the feedback better after the first application and showed a positive change before T2.

2. Development of the "Regulating The Learning Process" Competency

Under the category called regulating the learning process, there are two codes, namely, teacher-student coregulation and student-controlled teaching. At the end of the practices, it was determined that only T1's regulation competency developed partially. Thus, in this section, only T1's improvement steps and related quotations were provided.

Teacher-student co-regulation: This regulation type was evaluated by taking into account the requirements such as the teacher actively involving the student into the process, the teacher assuming the role of a guide, and the teacher providing applied exercises. There were no findings of teacher-student co-regulation activities in T1's first practice. The control of the learning

process in the first practice was mostly in the teacher. In Practice 2, T1 changed the conventional seating plan of the class. Different from the first practice, it was a class where groups exchanged ideas and had discussions of the subject. The quotation about this positive change in T1 was taken from the interview between the teacher and the researcher:

Researcher: This time you have asked students to study in groups. Why?

T1: I said that I would try more to encourage students to be more active in class. I had taken notes of your feedback. I decided what to do based on that feedback.

Researcher: Wouldn't it have been better to give the students the option to choose between group study and individual study?

T1: Yes, I will do that in the next practice. (Follow-up interview 2)

As can be inferred from the interview, the idea of forming groups came from T1 and he decided on the group members, which created a learning environment where the teacher is more dominant than the student. In this respect, teacher-student co-regulation was partially met in Practice 2.

In Practice 3, T1 steered discussions and helped students share their ideas. Nevertheless, he still decided who would be in which group herself. Although T1 managed to meet most of the criteria for teacher-student co-regulation competency, he still interfered with the process significantly, which was written down in the field notes as follows:

T1 tries to enable brainstorming by asking students questions, but he also tries to steer them towards the right answer without giving them sufficient time to discuss it among themselves.

As can be inferred from the field notes, T1 interfered with the process rather than control it although he included activities that make sure active learning of students. Based on this finding, it was concluded that T1's competency of teacher-student co-regulation developed partially in Practice 3.

Student-controlled teaching: In student-controlled teaching, teachers are expected to create opportunities for students to take responsibility of their own learning as well as to evaluate it. T1's competency of student-controlled teaching partially developed at the end of the three practices. In the first two practices, he did not include student-controlled teaching criteria. In Practice 3, he let students decide on the duration of study and discussion. However, he warned students not to move too far away from the subject to be covered in class or the class hour. An extract from

the video recording of the conversation between T1 and the students is given below:

T1: You can decide how much time you need to think on the subject. If you then decide that you have not properly understood the subject, please identify some activities and we can do them. But please keep in mind that there is a syllabus we should follow.

In Practice 3, T1 sometimes left the control to the students and sometimes limited them through warnings. Based on this, it was determined that his competency of student-controlled teaching was partially developed.

3. Development of the "Emphasis In Teaching" Competency

Under this category there are two codes called chemistry-technology-society and development of knowledge in chemistry. While T1 developed in both sub-dimensions of this competency in his practices, T2 developed only in chemistry-technology-society sub dimension. Based on this, it was determined that the competency of emphasis in teaching of both T1 and T2 developed.

Chemistry-technology-society: In their first practices, T1 and T2 had the tendency to teach their subjects theoretically by putting emphasis in the idea of science. In his second and third practice, T1 put emphasis not only on basic chemistry but also on chemistry-technology-society in his activities. T1 gave students activities in which there were social subjects with a scientific angle on chemistry. T1's explanations during the interview held after Practice 2 support the researcher's view on the issue:

Acid rains and their environmental damage is a globally significant social matter..That's why I tried to include contextual matters on social and technological events. (Follow-up interview 2)

Although T2 relied heavily on activities aiming to improve students' knowledge of chemistry in the first practice, she did bring in the emphasis to chemistry-technology-society in other practices. The exemplification of the emphasis to chemistry-technology-society during Practice 3 was reflected in the field notes as follows:

T2 asked students why engineers have designed air bags. After listening to the answers of some students, she explained that airbags are designed to minimise the impact of a collision during a car crash.

It was seen that both T1 and T2 included an emphasis on chemistry-technology-society in their activities, which implied that they developed

themselves in this matter at the end of the practices.

Development of knowledge in chemistry: Emphasis on the development of knowledge in chemistry is an emphasis on showing students that scientific knowledge is obtained through research. At the end of the analyses, criteria related to this emphasis could be found only in T1's practices. Even though T1 did not use this emphasis in the first two practices, he managed to include it in the third one. At the end of Practice 2, T1 assigned students a project which would include the steps of experiment, observation, data collection, and reporting. This assignment meets the objectives of the development of knowledge in chemistry since it can enable students to interpret a new subject they have learned after the experiment and research. The dialogue between the teacher and students during the submission of their project assignments is as follows:

T1: You have prepared your reports excellently. Are you also happy with the results? Do you think it contributed to your learning?

Student 5: It was great to conduct the experiment ourselves and verify its validity. We reached the conclusion and saw it for ourselves. (Video recording – Practice 3)

The fact that T1 included an emphasis on the development of knowledge in chemistry in his last practice is a sign of an improvement of this competency for him.

4. Development of the "Designing Materials" Competency

The category of designing materials consists of two codes, namely, updating materials and designing alternative materials. T1 included both sub competencies in his practices while T2 included neither. These findings indicate that T1's competency of designing materials developed; however, T2 did not have any improvement concerning this competency.

Updating materials: When updating materials, a previously designed material is re-structured according to the conditions of the environment it will be used (classroom, students, etc.). T1 received feedback that he should both shorten the questions he asks to establish a connection between the selected focal event and the subject and make sure the text which consists of the context is more comprehensible. In Practice 2, he revised the questions which he thought had long question roots, and he made them shorter. It was concluded that T1's material revision competency developed after the practices. Figure 2, is an example to such a revision:

First version of the question	The question after the revision
Last year in June, Batu and his family were in their car on their way to Antalya for a vacation. While travelling through Konya highway, Batu's father did not see the car coming from the other direction and crashed into it. During the collision airbags open, so the people in the car survive the accident with minor scrapes and injuries. After the accident Batu decided to understand how airbags intercede and researched how they inflate. He found out that airbags inflate due to the shattering of sodium azide (NaN_3). Based on this, write down type of the reaction and the names of the products formed after the shattering of sodium azide.	*A student investigates how airbags work and sees that they work through the shattering of NaN_3 (sodium azide). Based on this, write down the type of the reaction and the names of the products formed after the shattering of sodium azide.*

Figure 2. The First and Last Version of the Problem in the Material

Designing alternative materials: T1 prepared and used in class an alternative activity only in Practice III to facilitate the association of the subject with the context. His explanation for this is as follows:

This time I prepared another material containing different questions and activities with which I lecture on the same subject through two different contexts. The context in the first material is a difficult one, which I would like to discuss with students but is from another discipline. To make it more accessible for students, I selected more familiar context, prepared another material, and lectured through these two materials. (Follow-up Interview 3)

The researcher examined these materials; it was seen that the alternative material also fits criteria. In this respect, it was concluded that T1's competency in this matter developed.

Factors Affecting Teaching Processes

After the analyses of data obtained from semi-structured interviews, factors affecting the process were gathered under 4 categories, namely, "teacher anxiety", "professional knowledge for teaching", "difficulty of designing materials" and "students' lack of interest". During the interviews, teachers indicated that the factors affecting the teaching process also affect their own improvement processes. Teachers' answers were explained by the following findings.

The participating teachers indicated that they had such anxieties about being unsuccessful during the process and not being able to complete the teaching of the subject in time even though they were comfortable before the practices began. This anxiety of not being able to complete the teaching of the subject in time was expressed by T2 as follows:

It took a long time to dictate to students and try to deliberate on the context at the same time. I was always afraid of not covering everything I wanted to cover in the given time. If I had been able to overcome this anxiety, I would have had more improvement.

While T2 was anxious about not covering the whole subject, T1 said he was dreading to seem he does not know anything and thus tarnish his reputation as a successful teacher:

My biggest fear was to look like someone who does not know anything in front of my students. Since this was a new thing for me, I experienced lots of awkwardness. I was afraid of reflecting this to the students.

In addition to the anxieties teachers experience, their professional knowledge for teaching is also among the factors affecting the process. As T1 explained, while having sufficient subject-matter knowledge positively affected the process, his insufficient pedagogical content knowledge limited him:

Thanks to my knowledge of chemistry, I easily found examples from daily life. It was easy to make associations. When it comes to how I could teach this; I have tried my best to improve myself as a teacher throughout the years, but I still have a long way to go.

It was also determined that another factor affecting the practice process is the difficulties teacher have in designing materials. T1 and T2 used materials they themselves designed in this study. Designing materials was challenging for T1 and T2 because finding contexts, writing down a text for the focus case, and preparing contextual content questions were both time-consuming and exhausting. In the semi-structured interviews, T1 and T2 explained this as follows:

If I had had ready-made materials, the whole process could have been much easier for me. It was exhausting and difficult to find a context from scratch and to design an activity that would present it properly. (T1)

Designing materials is really difficult, one has to go to great lengths to do it. When I have spent that much time on designing materials, actually carrying out the first practice felt daunting. (T2)

During the interviews with T1 and T2, it was revealed that in addition to their personal difficulties, students' inattentiveness to class also affected the progress of their practices. T1 said the following for this problem:

Students who did not enjoy doing research also wanted no part in the lesson. No matter what I do or say, they are beyond my reach anyway. When this is the case, it feels like I am flogging a dead horse.

This study examined the development of teachers' context-based teaching competencies and the effect of feedback on this development. Teachers who participated in the study carried out

three context-based teaching practices. After each practice teachers were given feedback on their context-based teaching competencies. This feedback was based on the researcher's observations during the practice, and it emphasised teachers' lacking competencies. Feedback given in certain frame is more likely to affect positive change in behaviour compared to general feedback (White, 2007). At the end of the study, it was seen that teachers' context-based teaching competencies changed during the process. T1 showed improvement in three context-based teaching competencies and partial improvement in one competency; on the other hand, T2 showed improvement in two competencies. There were no findings of sub-competencies (codes) indicating that the teachers had context-based teaching competencies during the first practices. Although the teachers were unable to display these sub-competencies in their first practices, they managed to show that there is a change in their competencies after the first practice. It is thought that the reason for this change is the feedback the researcher gave to the teachers after the first practice. Fullan (1985) emphasises that learning is a developmental process and indicates that it is necessary for teachers acquiring a new skill to not only do practices but receive feedback. Similarly, a study by De Putter-Smits et al. (2020) conclude that the context-based competencies of the five teachers who participated in a vocational development programme prepared by the researchers because they benefitted from the feedback of the experts and their peers.

Even though the teachers received their feedback in the same manner and frequency, their context-based teaching competencies developed in different competency types and at different levels. During the practices, the most effectively responded competency for both teachers was the competency of context handling. A research by De Putter-Smits (2012) concluded that the competency of context handling was the most developed and developed competency for teachers.

At the end of the three activity practices, it was determined that T1's competency of regulating the learning environment was partially developed; and that of T2's was not developed. To use the context-based approach effectively in the learning environment, the teachers should reflect the "need to know" principle to their students (Pilot & Bulte, 2006). In order for the need to know to be formed, the most important priority is to create a learning environment in which students actively

participate in their own learning (Vos et al., 2016). It was found out that T2 imagined "active learning" as students raising their hands and participating in class and then asking the unclear points to the teacher. Although feedback was given for the development of this competency, both teachers explicitly indicated that they do not want to leave the regulation of the learning process to the hands of the students. Shute (2008) suggests that certain characteristics of the person receiving the feedback such as their motivation and skill level are effective on their way of responding to the feedback. Different from the findings of this study, Mikelskis-Seifert et al (2007) concluded that the regulation competencies of physics teachers developed significantly after the practices.

At the end of the process, there was improvement in both teachers' competency of emphasis in teaching. Responding to feedback, the teachers changed their emphasis in teaching from fundamental science to science-technology-society and development of knowledge in science. In a study De Putter-Smits (2012) carried out with the participation of 6 teachers, it was concluded that only two of them had a change in their emphasis in teaching. Although both teachers showed improvement in the competency of emphasis in teaching, only T1 developed in the competency of designing materials. In another study by Gräsel, Fussangel & Parchman (2006), it was found out that chemistry teachers who designed context-based materials for the ChiK project had developed competency of leading innovation. Teachers who were part of the material design team informed their peers at their own schools and they established a multifaceted collaboration with teachers.

In this study, it was concluded that feedbacks changed the teachers' competencies but did not have the same effect of their improvement of competency. In the literature, other studies on the improvement of context-based teaching competencies also concluded that different competencies of teachers developed (De Putter-Smits, 2012; De Putter-Smits et al., 2016; Kock et al., 2016; Roehrig et al., 2007; Vos et al., 2010). It is believed that the reason for teachers presenting different behaviours after the feedbacks stem from individual differences, academic proficiencies, and their experience in class during the practices, because teachers' beliefs about the education-teaching process are reflected in their actions and transformation (Pajares, 1992).

In the interviews held after the completion of practices, teachers were

asked questions to determine the factors affecting the development process of their competencies. It was concluded that the teachers' anxiety, lack of professional knowledge, difficulties in designing materials, and students' lack of interest in class all affect their development processes. The fact that teachers' anxiety of failure and the anxiety they feel in the face of new things (Bennett, 2003; Guillaume & Rudney, 1993; Gilbert, 2006; Valdmann et al., 2016) and their lack of professional knowledge (Luft, 2001; Taitelbaum et al., 2008) may affect their performance was supported by other studies. Context-based teaching is one of the approaches that increase students' interest in class (Baran & Sözbilir, 2018; Bennett, 2016; Broman et al., 2015; Van Dulmen et al., 2022). However, both teachers in this study indicated that lack of interest of some students negatively affected them. In a study by Habig et al (2018), it was concluded that students' interest may vary depending on their recognition-comprehension of the selected context. In this study, it is thought that the lack of interest of some students while others were interested could be due to their lack of interest in the context and focus cases.

CONCLUSION

At the end of this study, it was determined that receiving feedback was effective in the development of teachers' context-based teaching competencies; but this effect varied from one teacher to the other. Moreover, although teachers were not able to display their context-based teaching competencies in their first practices, they did show in the following practices that they developed on these competencies; this proves that in-service training is more effective when supported by feedback.

Context-based teaching approach is accepted as one of the approaches that motivates students and increases their success when used in learning environments. In order for context-based teaching approach to be applied effectively, it is necessary for teachers to have context-based teaching competencies. Therefore, teachers who participated in this study were given in-service training; this training was transferred to school environment and was supported by feedback given after practices. Despite this, it was determined that teachers had difficulties during practices and that one teacher did not have full improvement in all competencies. During the interviews carried out after the practices, it was concluded that several factors affected them, namely, teachers' anxiety, their lack of professional knowledge, their difficulty in designing materials, and students' lack of interest in class. Future

studies can focus on what could be done to get rid of these factors negatively affecting the teaching process.

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