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Context-Based Teaching Experiences of Chemistry Teachers: Expectations, Gains and Applicability Conditions

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ABSTRACT
This research aimed to investigate the expectations and gains of teachers who designed and used context-based teaching materials in their classes and to reveal their views on the applicability of this teaching approach. The methodology of this research was the case study. The research was carried out with two chemistry teachers who participated in the In-Service Training Course on Context-Based Chemistry Teaching performed by the researcher. Data collection tools used in the research were semi-structured interviews, field notes and evaluation reports. As a result, it was concluded that teachers believed that context-based instruction increased students' motivation, achievement and participation in the lesson. Also, both teachers stated that their competencies in context-based teaching had improved after practising it. However, it was revealed that teachers thought that in order to use context-based teaching, learning environments should be arranged in accordance with the approach and universities and Turkish Ministry of National Education should work in cooperation.

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Introduction

Science-related concepts, their meanings and the connections among them which students develop in their minds, go through constant change (Freyberg & Osborne, 1981). For this reason, it is necessary to ensure that the science teaching approaches used in schools are constantly adapted to making a positive contribution to the process (Osborne & Wittrock, 1983). In the last 40 years, many problems have arisen in teaching of chemistry (Gilbert, 2006; Mahaffy, 2018; Osborne & Dillon, 2008). Among these problems, a striking one is pupils' lack of interest in chemistry course (Becker, 1978; Gilbert, 2006); another is their unwillingness to choose a chemistry course if it is not compulsory, and yet another is their aversion to choosing a chemistry-related job in the future (Bulte et al., 2006; Gilbert, 2006). These problems have forced science teachers and researchers to use alternative approaches in teaching chemistry. One of the approaches they have developed is the context-based teaching approach (CBTA; Bennett & Lubben, 2006; Gilbert, 2006; Hofstein & Kesner, 2006; Lyons, 2006; Parchmann et al., 2006; Pilot & Bulte, 2006; Schwartz, 2006). The CBTA approach uses contexts derived from daily life as a starting point (Bennett et al., 2007; Gilbert, 2006; Van Oers, 1998; Wei & Long, 2021). The objectives of the CBTA are as follows:

- To demonstrate that science is relevant to everyday life, thereby increasing the attractiveness of the study of science (Bennett, 2016; Coştu et al., 2007; Gilbert, 2006; Kegley et al., 1996),
- To motivate students to learn science and thereby increase their involvement in lessons (Barker & Millar, 1999; Özay-Köse & Çam-Tosun, 2011; Schwartz, 2006),
- To encourage learners to develop positive attitudes towards science and thereby increase the number of students choosing science courses (Bennett et al., 2007; Kegley et al., 1996),
- To increase scientific literacy (Bennett, 2016; Yuliana et al., 2021).

In context-based teaching, teachers should have the necessary resources and be able to use context-based teaching strategies correctly (De Putter-Smits et al., 2012). In CBTA, teachers can use the materials developed by professionals, or they can develop the materials themselves. Bennett and Lubben (2006) argue that teachers who develop their own activities are more willing to use context-based teaching practices, adopt innovations more easily, and achieve better outcomes. In some countries, context-based teaching modules, books and materials have been prepared and embedded in curricula in projects developed within the context-based approach. (Bennett & Lubben, 2006; Hofstein & Kesner, 2006; Parchmann vd., 2006; Pilot & Bulte, 2006; Schwartz, 2006). However, since the high school chemistry curriculum in Turkey was not designed with the context-based approach in mind, there are no ready-made materials available. For this reason, based on the view that teachers do not have enough knowledge about the context-based approach, in this research, participating teachers were first provided with an in-service training course on developing and applying context-based teaching practices. Following the in-service training, the teachers were asked to apply the materials and practices they had developed in their lessons.

One of the purposes of context-based teaching is to help learners understand the topic by attracting their attention to the lesson through connecting with everyday life (Finkelstein, 2001). As a result of the study conducted by Ramsden (1997), it was concluded that context-based teaching did not make a significant difference in pupils' understanding of concepts, but it increased their interest in chemistry lessons. Overton and Potter (2011) developed context-based questions and examined the effects of these questions on pupils' attitudes towards problem solving. As a result of the study, it was concluded that open-ended context-based questions affected their attitudes towards problem solving positively and motivated them.

Since the context-based approach is a curriculum approach, context-based teaching activities can be carried out with many active teaching methods such as the 5E Teaching Model, the REACT model, and problem-based learning (İlhan, Yılmaz, Dede, Sözbilir & Yıldırım, 2015). Karslı and Yiğit (2017) state that the REACT strategy used in context-based teaching eliminates pupils' alternative concepts and enables them to learn new concepts by making connections between daily life and scientific concepts. It is recommended that context-based teaching be supported with appropriate learning materials in order to create positive effects on learning (Davis & Krajcik, 2005). Context-based teaching materials prepared for use with different teaching methods in which they have been shown to be supportive and effective for students (Van Dulmen et al., 2022). Koçak-Altundağ (2018) states that context-based teaching materials have positive effects on pre-service teachers' metacognitive thinking levels and achievements.

There are a number of studies examining the effects of context-based chemistry teaching on students' motivation, attitude and achievement (Demircioğlu, 2008; Gutwill-Wise, 2001; Ramsden, 1997; Sadi Yılmaz et al., 2022; Tsai et al., 2020; Ulusoy & Önen, 2014). There are also studies in which context-based chemistry teaching activities were developed and used in teaching (Baran & Sözbilir, 2018; Elmas, 2012; Koçak-Altundağ, 2018; Poerwanti & Istiyati, 2019; Ültay, 2012). In addition, there are studies which concentrate on relating science to daily life (Çepni et al., 2017; Koçak & Önen, 2012; Yadigaroğlu et al., 2021). Most of the studies on the CBTA have focused on learners. There have been very few studies in which context-based teaching was evaluated by teachers (Ayvacı, 2010; Topuz et al., 2013). To obtain successful results from novel approaches, it is surely important to determine the views of the teachers who use the approach. In this study, before the teachers' views on the approach

were determined, in-service training was given to them and they were asked to design and apply their own context-based teaching material. Before engaging in context-based practices, teachers' expectations regarding the approach were determined. Afterwards, the gains as perceived by the teachers were determined and compared with their initial expectations. In addition, the conditions required for the use of context-based teaching in learning environments were evaluated by teachers. Unlike studies in which the views of teachers who have knowledge without any practice about the CBTA have been gauged (Ayvacı, 2010; Topuz, 2013; Van Driel et al., 2005), in this study, teachers were given extensive in-service training and after designing and implementing their own materials, they were asked to evaluate the process, not just context-based teaching in principle.

Purpose of the Research

Throughout the research, an in-service training course on the context-based approach was delivered to chemistry teachers by the researcher. Within the scope of the in-service training, teachers designed their own course materials and practised context-based teaching in their classrooms. This research aimed to investigate the expectations and gains of the teachers who designed and used context-based teaching materials in their classes and to reveal their views on the applicability of this teaching approach. To this end, the research sought answers to the following questions:

1. What are the expectations of chemistry teachers from context-based teaching?
2. What are chemistry teachers' gains from context-based teaching?
3. What are the necessary conditions for practising context-based teaching according to chemistry teachers?

Methods

Research Design

This research employed a case study methodology. Yin (2003) argues that case studies investigate contemporary phenomena within their real-life context, especially when the boundaries between the phenomenon and context are not clear. Merriam (2013) described case studies as a detailed analysis of a bounded phenomenon to achieve a holistic understanding. Since case studies examine one phenomenon in detail, they do not aim to generalise research results (Yin, 2003).

Participants

The participants of this research were two chemistry teachers who attended the in-service training and later volunteered to participate in this research. The participants were selected, using the stratified purposive sampling method during the in-service training. The stratified purposive sampling method aims to show and describe the characteristics of the subgroups of interest (Patton, 2002). The researcher selected the participants through informal observation and interviews during the in-service training given to 21 teachers before this study. Some criteria were taken into account while determining the participants. These criteria are the voluntary basis, the diversity of the faculties they graduated from, year of their professional experience and their perspectives on teaching. More than two teachers were asked to participate however two of them were volunteered. Both participants had no knowledge of the CBTA before this study. They teach chemistry in high schools affiliated with the Turkish Ministry of National Education (MoNE). In this study, teachers are referred to as T1 (male with 29 years of teaching experience) and T2 (female with 30 years of teaching experience).

T1: Graduated from a Faculty of Education. He is interested in nature and is keen to reflect his experiences in this regard in his teaching. He stated that he participated in this study because he thought that context-based chemistry teaching would offer him an opportunity to integrate his ideas into his teaching. He prefers to choose contexts suitable for the culture of society.

T2: Graduated from a Faculty of Science with a teaching certificate. She prefers to choose contexts according to her own interests and that she believes pupils can understand better. She stated that she participated in this study because she wanted to learn how to use daily life examples in teaching.

Data Collection Tools

The data collection tools were semi-structured interviews, field notes and process evaluation reports. Semi-structured interviews and evaluation reports reflect teachers' views on themselves and their practices. The field notes were kept by the researcher. Another reason for keeping field notes is to follow the progress of teachers in the process. Due to the long interview times, two interviews were held with each teacher at different times in order not to bore the participants. The first interview included questions about teachers' expectations, and the second interview included questions about the implementation process. The interviews were recorded with a voice recorder with the consent of the teachers. Below are sample questions from the interviews:

1. What are your expectations from context-based chemistry teaching? (1st Interview)
2. What effects do you think context-based chemistry teaching will have on pupils? (1st Interview)
3. What gains do you think the context-based teaching process has provided for you? (2nd Interview)
4. Has there been a change in your way of teaching the lesson before and after the implementation process? If so, what kind of change do you think there has been? (2nd Interview)
5. Would you consider using the context-based teaching method in your classes? Why/Why not? (2nd Interview)

Field notes were taken by the researcher during the teaching practices (during classroom observation). The process was reflected in the field notes by focusing on the teachers. Evaluation reports contain notes taken by teachers throughout the implementation process. It was observed that teachers, in their evaluation reports, reflected their views about the applicability of context-based teaching and the contributions of context-based teaching practices.

Research Process

Prior to the teachers' practices, the researcher delivered a 30-hour in-service training course on the context-based approach for volunteering chemistry teachers working in Ankara, Turkey. For in-service training course, necessary permission was obtained from the MoNE General Directorate of Teacher Training and Development. the teachers were informed about the Context-Based Learning Approach, the strategies used with this approach, and the applications of the CBTA in chemistry education and the context-based teaching competencies. The teachers were furnished with examples of how context-based teaching materials should be prepared and applied. After the in-service training was completed, the implementation process was started with two teachers who volunteered. Firstly, a pilot study of the CBTA was conducted with each teacher. Based on the researcher's observations of teacher practice during the pilot stage, it was determined that the teachers had gained context-based teaching competencies (Mustafaoğlu, 2019). In their practices, each teacher first chose contexts suitable for the development levels of ninth grade pupils in line with their (teachers') own interests. Afterwards, the curriculum topics related to these contexts were identified. Worksheets were prepared by the teachers for each selected context and related topic. The preparation of the worksheets was carried out during the fall semester; and in the spring semester, the activities started to be implemented by each teacher. In order to learn the teachers' expectations regarding context-based teaching, the first interviews were held with each teacher one week before the actual implementations started (The interviews were divided into two parts because they were quite long). Each teacher then started to apply the context-based teaching activities they had prepared for their

lessons. Each teacher prepared three worksheets in total. Table 1 presents the contexts and topics chosen by teachers.

Table 1

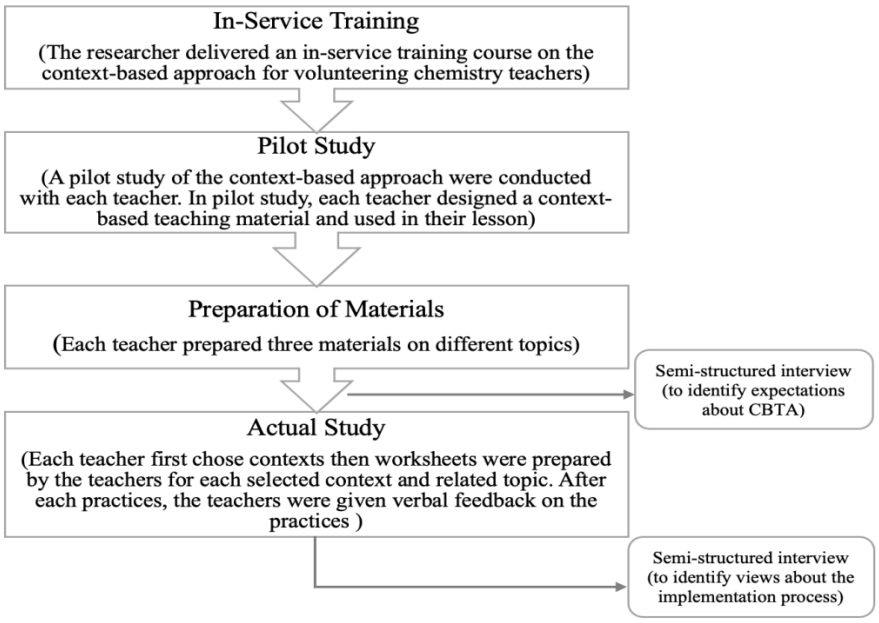
Contexts and Topics Used in Context-Based Teaching Materials

Teacher	Context	Topic
T1	Robots	Metallic bonding and properties of metals
	The effects of acid rain on heritage sites	Reaction equations
	The water cycle	Evaporation, boiling, condensation
T2	Chemical accidents	Our safety and chemistry
	Why does milk spoil in hot weather?	Physical/chemical changes
	The principle behind hot air balloons	Gases

After the implementation process was over, the second semi-structured interview was held, and thus the process was completed. Considering that the interviews would take a long time, it was decided to hold two interviews with the teachers at different times. During the practice phases, the researcher was present as an observer and collected data by taking field notes. After each practice session, the teachers were given verbal feedback on the practices and they were informed again about the context-based teaching by the researcher. After the implementations are completed, the teachers sent their process evaluation reports to the researcher via e-mail. It is worthy of mention that the participating teachers better understood the context-based teaching as it was evident from the pilot study in which observations and pilot practices were carried out. Their level greatly improved when we compared with their level prior to in-service training. In this research, the role of the researcher was to provide in-service training to teachers and guiding teachers in the material development process and being in the classroom as a participant observer during the practices. All of the materials and activities were prepared by the teachers themselves, and the researcher only helped in the source/literature review.

Figure 1

Research Process



Data Analysis

Content analysis was applied to the data obtained from semi-structured interviews, field notes and evaluation reports. Initial coding and focused coding techniques were used in content analysis. Initial coding and focused coding can be used for coding in all qualitative studies (Saldana, 2009). Data analysis started with the transcription of the data recorded with a voice recorder during the interviews. Following the detailed examination of the texts obtained from the interviews, field notes and evaluation reports, the coding was applied. The meaningful parts in the data were first coded line by line or paragraph by paragraph with the initial coding technique. The codes obtained through initial coding were classified according to their frequency and importance, and some codes were brought together according to their similarities-differences to form focused codes. In focused coding, the most frequent codes can be selected among initial codes to create the most prominent codes, or coding can be made by classifying initial codes (Charmaz, 2006). After the focused codes were created, they were grouped under categories based on their similarities. Table 2 presents an example of open and focused coding performed on a cross-section of semi-structured interview data.

Table 2

Sample of Initial Coding and Focused Coding

Data (Quotation)	Initial Coding	Focused Coding	Category
When you directly ask the pupils to "tell the reaction types and write an example on the board," the pupils fail to answer. But if you ask them to find examples of reactions from daily life, maybe they will be interested and they will answer the question.	Helps pupils to answer questions	Increases pupils' involvement in the lesson	Expectations
I hope that the activities we do will help pupils stop being interested in things outside the classroom and get involved in the lesson.	Gets students to be interested in the subject		
Only 10 pupils are really interested in the lesson. The others get involved in the lesson only rarely. Context-based teaching should ensure that more students get involved in the lesson.	Enables different pupils to get involved in the lesson again		

The categories and codes that emerged as a result of the content analysis are given in the Findings section. Attention was paid to including excerpts from the interviews when presenting the findings.

Validity and Reliability

The internal validity of the research was ensured by an expert review, participant control and triangulation. Research procedures, the collected data, and the results were shared with experts at an evaluation meeting. Moreover, the transcribed interviews were confirmed by the teacher participants. Triangulation was achieved by using more than one data collection tool, including observations, interviews and evaluation reports. To ensure the external validity of the research, the data were presented through quotation from the interviews. Internal reliability was provided by two experts who re-coded the data. Twenty percent of the data was re-coded by two experts. The inter-coder reliability coefficient was calculated as 0.83 with one expert and 0.87 with the other expert. Miles and Huberman (1994) suggest that inter-coder reliability of 80% is sufficient for the research to be reliable.

Ethical Issues

For the research, ethical permission was obtained from the Ministry of National Education and the Ethics Committee of our university. Since the interviews were recorded with a voice recorder, a consent form was obtained from each participant. Participants were informed of the right to abstain from participation in the research at any time. To protect respondent confidentiality, their real names and the schools they work at are not given.

Findings

As a result of the analysis of the data obtained from the semi-structured interviews and evaluation reports, the teachers' responses were gathered under three categories. These categories are expectations (about the context-based teaching method), gains (teachers' gains from the process), and applicability (conditions that must be met for the approach to be implemented). Table 3 presents the categories and codes.

Table 3

Categories and Codes Obtained From Participants' Responses

Category	Code
Expectations	To arouse interest and curiosity in pupils*
	To motivate pupils
	To increase pupils' involvement in the lesson
	To increase achievement in the chemistry lesson
	To help achieve meaningful learning
Gains	Helps learn to use different strategies, methods, and techniques
	Increases academic self-efficacy beliefs*
	Helps achieve proficiency in the context-based teaching method
	Raises awareness
Applicability Conditions	Course resources in accordance with the context-based approach
	Appropriate classroom environment
	Provides cooperation between the MoNE and universities
	In-service training and monitoring of teachers

Note. * Code from a single participant

The findings were explained under categories, supported by sample excerpts from the interviews.

Findings on Teachers' Expectations from Context-Based Chemistry Teaching

It is thought that teachers' pupil-related expectations from context-based chemistry teaching are mostly gathered around their complaints about pupils. T1 stated that he expected context-based chemistry teaching to arouse interest in pupils:

"Our pupils don't give importance to what they learn. They give importance to the subject only because there may be questions about the subject in the university entrance exam. They don't think that learning the subject may be important for their lives or their personal development. By using contexts, I want to be able to arouse curiosity in pupils and make them say "I should learn this".

As can be understood from T1's statements, students mostly give importance to the subjects about which there may be questions in the university entrance exam. Complaining that students do not study or undertake personal research into chemistry-related issues, T1 stated that he wanted context-based chemistry teaching to motivate pupils. A related excerpt from the interview with T1 is as follows:

"Students consider chemistry as merely questions they have to answer in the university entrance exam. They see involvement in the lesson as coming to class and taking notes. I hope that these activities will attract the attention of the pupils and provide them with the necessary motivation to research and study. "

T2, on the other hand, stated that pupils generally did not participate in the lesson and hoped that context-based teaching, which is a new approach for them, could motivate them. A related excerpt from the interview with T2 is as follows:

"I usually use traditional teaching methods. I see note above about editorial insertions into quotes teach subjects for the exam and have them take notes. But context-based teaching includes different teaching techniques. This is very important to keep the pupil awake in class. I hope to solve this problem [lack of involvement in the lesson] by keeping pupils active with experiments, interesting contexts. My biggest expectation is that it can motivate the pupil to participate in the lesson."

Both T1 and T2 mentioned that pupils perceived participation in the lesson as taking notes in class. The following is an excerpt from the interview with T1, regarding his expectations that pupils' participation in the lesson will increase:

"When the pupil takes notes, he/she thinks that he/she is participating in the lesson. But I want them to speak and share their ideas. Usually, they do not participate in the lesson for fear of giving wrong answers to questions. But with these activities, I have taught chemistry topics in context. So, I think this practice will make the pupils feel like they are doing something other than studying chemistry and I think that these activities will enable more pupils to participate in the lesson. "

T2 expressed that she expected more pupils would participate in the lesson:

"*Even if a part of the activity does not arouse interest in pupils, a question or an experiment as part of the activity will do. So, I think that more pupils will actively participate in the lesson."*

In the interviews, the teachers stated that context-based teaching would be used in classrooms with moderately successful pupils. They also said that they expected that context-based chemistry teaching would increase pupils' chemistry achievement. T2's statement regarding her expectation of an increase in chemistry success was reflected in the interview as follows:

"In our country, pupils are required to be successful. They have an exam to take, and there are chemistry questions in that exam. It means that pupils must be successful in chemistry to answer those questions. It is a fact. I volunteered for this training with many expectations. One (of my expectations) is to see pupils increase their chemistry achievement."

T1 stated that even though it was not his main expectation to increase pupils' achievement, he was still expecting an improvement in their achievement; he also stated that his main expectation from context-based teaching was to help pupils achieve meaningful learning. The dialogue between the researcher and T1 is important to understand his expectations:

T1: Since I think that this approach will attract pupils' attention, I expect its effects to be reflected in the exam results. The articles I have read also stated that context-based teaching increased chemistry achievement. Although it is not my main expectation, it is also my expectation.

Researcher: What is your main expectation?

T1: That it will help them to leave aside the memorisation technique.

From T1's statements, it is seen that context-based chemistry teaching met his expectations by increasing pupils' achievement in chemistry and by enabling them to achieve meaningful learning.

It can be said that the most striking among the teachers' pupil-related expectations from context-based chemistry teaching is meaningful learning. Both teachers expressed their expectations about meaningful learning many times in the interviews. Another excerpt from the interview with T1 about his expectations for meaningful learning is as follows:

"Pupils know the concepts, but when we ask questions that require them to synthesise, they cannot make a connection between the concepts. This is because they memorise everything. This is what bothers me the most. That's why I apply this method expecting that they will enable pupils to achieve permanent learning."

An excerpt from the interview with T2 about her expectations for meaningful learning is as follows:

"First of all, I want them (my pupils) to learn consciously. They should know why they have learned that which they have learned. They should relate their old knowledge with new knowledge. Carrying out the course with context-concept transfer in context-based teaching increases my expectation that it will be beneficial for students to make connections between subjects."

When the findings were examined, it can be said that all of the teachers' expectations were related to the effects of context-based teaching on pupils.

Findings on Teachers' Gains from Context-Based Chemistry Teaching

The "Gains" category includes the codes of "Helps learn to use different strategies, methods, and techniques," "Increases academic self-efficacy beliefs," "Helps achieve proficiency in the context-based teaching method," and "Raises awareness." The following dialogue was between T1 and the researcher, who stated that he had learned new methods as a result of the in-service training on context-based teaching:

Researcher: When you compare before and after the training, how did your teaching style change?

T1: Giving examples from daily life was something I already knew about, but now I can give examples using a method.

Researcher: Are you referring to the context-based teaching method?

T1: It's not just context-based teaching. I have learned many new methods. 5E Teaching Model, whisper groups, active learning, diagnostic tree preparation. These are the ones that I can think of now.

The researcher's field notes on the development of the techniques/methods used by T1 are as follows:

In the third practice session, T1 changed the classical seating arrangement of the class and switched to the U-type seating arrangement. Unlike the first practice session, a lesson period was spent conducting context-related discussions. He conducted a demonstration experiment using the predict-observe-explain strategy.

T1 stated that he had experienced and learned new methods at the end of the context-based teaching process. T2 also expressed learning to use new methods as an advantage of context-based teaching. She wrote in the evaluation report the following about the changes in his way of teaching:

"The context-based approach helped me a lot. So far, I have always used traditional methods. I have always wanted to try something new, but I needed a guide for this. While developing materials, I started to consolidate what I had learned. When using CBTA in the lesson, I also used models [e.g.5E Teaching Model] to progress in the lesson step by step." (Evaluation report)

In the interviews, T2 used many expressions that could be considered an indication of an increase in her academic self-efficacy beliefs. A related excerpt from the interview with T2 is as follows:

"These applications discouraged me a little at first. I was thinking to myself, "OK, I started this, but will I ever be able to handle it?' But then, as I saw pupils' interest, I became more self-confident that I could succeed in this. As I carried out the applications, I felt that I could do this."

When asked about the contributions of context-based teaching to their professional competencies, both teachers stated that their proficiency in context-based teaching had increased:

T1: "I learned what I need to do to be able to say I am using the context-based teaching method. Choosing the appropriate context for the learner, choosing the appropriate context for the subject, ensuring that the pupil participates actively in the lesson."

T2: "I tried to use in my lessons a teaching emphasis that I had never heard about before. I started writing context-based questions. I learned to develop materials suitable for the context-based teaching method. I became able to practise context-based teaching even with three materials."

The fact that the context is suitable for the development levels of the pupils, that the teachers use more than one teaching emphasis, and that the context attracts the attention of the pupils are accepted as indicators that the teachers have started to gain context-based competence. Researcher's views in the field notes regarding the context-based proficiency of T1 and T2 are as follows:

The way T1 handles the context is suitable for the development level of the students. The context-content relationship was also successful. T1 tries to transfer the content to other contexts through questions. The questions contain new contexts. (Field notes-II. Practice)

T2 used milk spoilage in hot weather as a context. T2 was able to engage pupils in the subject by associating the context with the molecular structure of substances contained in milk. T2 used a chemistry-technology-society emphasis as it prefers a focal event that describes how products are prepared industrially. (Field notes-II. Practice)

The following are T1's statements in his evaluation report about how context-based teaching raised his awareness of social events:

"I started to pay more attention to social and cultural events. I started to consider every news story in the newspaper and the events and articles on the Internet to be a context. Each event may be a context for me. I am not sure if this is selective perception, but now, when my teacher friends with different teaching specialties are telling something about their lessons, I immediately filter what they say through my own context. I constantly ask myself, "I wonder if I can relate this to a chemistry topic or not?" (Evaluation report)

An excerpt from the second interview with T2 regarding the increase in her awareness is as follows:

"Chemistry elements in daily life attract my attention more than before. Indeed, chemistry is everywhere. To be able to tell this to the pupils, we had to see for ourselves that chemistry is everywhere. This was the biggest change in me. I really gained awareness. For example, I wash and dry my hair every day, I have my hair dyed once a month, but I have never looked at these processes from the perspective of chemistry, even though I am a chemistry teacher. I used to say that dyeing damages the hair. I am now interested in the chemistry underlying these processes."

When asked about the gains from and the benefits of the context-based approach, they mostly mentioned their own gains and benefits. As a result, although the teachers' expectations from the approach were related to the pupils, the gains were related to themselves.

Findings on the Applicability of Context-Based Chemistry Teaching

It was revealed that teachers' views on the applicability of context-based teaching differed from the beginning to the end of the process. In the first semi-structured interview, both teachers stated that context-based teaching could be applied. The following is a sample dialogue from the interview with T1.

Researcher: What do you think about the applicability of context-based chemistry teaching?

T1: I think it's quite applicable with some experience. Normally, we already give examples of daily life in our lessons. Context-based learning is the next step.

When the same question was asked to the teachers in the interviews held during and after the implementation process, it was seen that there was a change in the teachers' views. They stated that context-based teaching could be applied when certain conditions were met as indicated by coded comments including "Course resources in accordance with the context-based approach," "Appropriate classroom environment," "Cooperation between the MoNE and universities," and "In-service training and monitoring of teachers."

Regarding the necessity of designing approach-supported course resources, on which both teachers agreed, T1 stated that a bank of teaching materials should be created which teachers can make use of as they are or after changing them. A related excerpt from the interview with T1 is as follows:

"If this approach is desired to be used by teachers, course materials must be available. I think a pool of sample materials should be created. Every teacher should use the materials in that pool. The teacher should then be able to edit the materials according to the characteristics of his/her pupils. The teacher should be able to edit the materials in the pool depending on the learning outcomes."

According to T2, teachers should be provided with context-based course resources to be able to use context-based chemistry teaching, otherwise it would be difficult for them to use this teaching

method. In the interview held after the implementation process, T2 stated the following about the applicability of context-based teaching:

"I spent so much time developing materials that I didn't have time to think about what to do in practice. If there were course resources that we can access, developed based on context-based teaching, we could implement this approach more successfully. As far as I know, there are sample course resources in other countries. We should have them in our country, too. An, for these sources to be reliable, they must be approved by MoNE".

It was observed that the teachers mostly complained about the characteristics of the classrooms in the context-based teaching process. Indeed, in the interviews, they often expressed the difficulties of using context-based teaching in crowded classrooms. T1 stated that small classrooms with a large number of pupils were not suitable for context-based teaching:

"Under current classroom conditions, it is a bit difficult to carry out these applications the way you want. Although the classroom is small, the class size is 36, so discussions in a narrow space can cause noise. You know, after the first application, we started using the laboratory. Since the laboratory is larger, it was easier to do group work or work in a U-shape seating arrangement. Because I have experienced the difference, I think that class sizes should be reduced for more effective implementation of context-based teaching."

T2 stated that, for the applicability of context-based teaching, the classroom environment should be arranged in terms of the class size, physical conditions, and technology. When asked about her opinion on the applicability of this approach, T2 replied as follows:

"For this approach to be used effectively, the class size should not exceed 20. Currently, class sizes are 35 pupils. I try to do the best by each pupil, but I do not think that I have achieved full efficiency. It is an approach that requires the pupils to be active, but I cannot get the ones sitting in the back row to participate in the lesson. There should be a suitable seating arrangement in the classroom. All classrooms should have smartboards or computers so that pupils and teachers can do research. This is because this approach is based on doing research."

Teachers also noted that there should be cooperation between MoNE and universities to implement context-based teaching effectively. T1 asserted that the Ministry should make use of resources produced by the universities. A related excerpt from the interview with T1 is as follows:

"Universities are constantly trying new things, but we are not given information about them. I didn't know that context-based teaching had been used in Turkey for years; I became aware of the existence of this approach only in 2015. If you want this approach to be used by teachers in lessons, you need to bring together teachers and academics. MoNE should inform us about the new products devised in universities. Also, universities should inform MoNE about the theses, articles, etc. about, for example, the context-based approach. We should be able to use the materials academics have developed. If context-based teaching is desired to be used, this cooperation needs to be achieved."

T2, on the other hand, stated that it was important that academics inform teachers in seminars to be held at schools. T2 expressed this idea in her evaluation report as follows:

"Academics can visit schools and inform us during seminar periods. If they tell teachers about the results of context-based teaching, this approach can be more easily adopted by teachers. For us to use context-based teaching, the MoNE and universities need to cooperate."

T1 noted that teachers could apply context-based teaching after they are given in-service training and monitored for a while after the training. A related excerpt from the interview with T1 is as follows:

"Teachers must be informed about context-based teaching. There should be nationwide in-service training. Afterward, the participants of in-service training should be monitored for at least five years and given feedback. If teachers are provided with opportunities to improve themselves (in context-based teaching), then they will happily apply this method in their lessons. Unless these conditions are met, this application, like many other applications, will have an expiry date."

The following dialogue between the researcher and T2 exemplifies T2's views on the necessity of in-service training to implement context-based teaching:

Researcher: Can context-based teaching be implemented through in-service training?

T2: In-service training alone is not enough. For example, some friends who attended your in-service training do not use this method in their schools at the moment. But I am using it. This is because you desired to see the result of the training you delivered. For this reason, in-service training about context-based teaching should be continued to be given but teachers who attend the training should be monitored, as well.

As a result, it was seen that the teachers evaluated the applicability of context-based teaching within the framework of certain conditions. Indeed, they argued that new practices could yield successful results only when the necessary conditions are met, otherwise, they will be no more than fruitless attempts.

Discussion and Conclusion

This research investigated the expectations of chemistry teachers who implemented the CBTA, the gains they perceived at the end of the implementation, and their views on the applicability of the approach. This section is presented under the headings aligning with the research questions.

Teachers' Expectations from Context-Based Chemistry Teaching

In the interview held before the practice phase, questions were asked to the teachers to determine their expectations regarding the adoption of the approach. As a result of the analyses, it was found that their expectations from the approach were all related to its anticipated effect on the pupils. It was seen that both teachers expected that, with context-based teaching, pupils' motivation, involvement in the lesson, and achievement would increase and they would achieve meaningful learning. Only T1 stated that he expected context-based teaching practices to arouse curiosity in the pupils. The results are consistent with the definition of expectation in the literature. Good (1987) defined teacher expectations as inferences made by teachers about students' future achievements and potential, based on students' current performance.

Among the purposes of the CBTA is to increase learners' interest and motivation in chemistry lessons (Barker & Millar, 1999; Habig et al., 2018; Kang et al., 2019; Özay-Köse & Çam-Tosun, 2011). T1 thought that relating chemistry topics to everyday life would increase pupils' interest in the lesson. He also stated that he expected context-based teaching to provide the learning environment where pupils would want to learn about chemistry topics not because they feel obligated but because they feel they need it. T1's pupils showed more interest in activities involving "robots" and "water cycle" contexts. T2, on the other hand, stated that context-based teaching, by attracting students' attention, will increase their motivation for the lesson.

After the practice sessions, both teachers said that they expected context-based teaching to increase pupils' motivation. In the research by Fey et al., (2004), chemistry teachers participating in the ChiK project reported that their main expectation from the CBTA was an increase in pupil motivation. In this research, T1 stated that he expected context-based teaching to motivate pupils to do research, while T2 stated that she expected the method to motivate pupils to listen to the lesson.

Most teachers want the new approaches or methods they use in their lessons to increase pupil achievement. Context-based teaching is one of the approaches that aims to increase students' motivation and success in the course (Avargil & Piorko, 2022; Bennett, 2016; Schwartz, 2006). In this research, too, both teachers expressed that they expected the use of the approach to increase pupils' achievement in the chemistry lesson. Teachers' pupil-related expectations from context-based teaching coincide with the goals of the CBTA and are the subject of many studies in this field. In the literature, there are many studies that reveal the accuracy of this aim and determine the effect of context-based teaching on students' motivation and achievement in chemistry lessons (Bortnik et al., 2021; Kesner et al., 1997; Kurbanoğlu & Nefes, 2016; Kutu & Sözbilir, 2011; Pavlin et al., 2019; Vogelzang, 2021). In this research, the fact that teachers' expectations for the approach are aimed at increasing students' motivation and success in chemistry coincide with the aims of the approach.

Research findings suggest that teachers expect context-based teaching to help students achieve meaningful learning. Meaningful learning occurs when the new information is related to prior knowledge (Ausubel, 1963). Context-based teaching is one of the approaches that help pupils to learn chemistry meaningfully (Avargil & Piorko, 2022; Broman et al., 2015; Demircioğlu et al., 2013; Dori et al., 2018; Stolk et al., 2016). In this research, the two teachers thought that they could contribute to students' meaningful learning by establishing a relationship between the context and the topic. In research by Gilbert (2006), one of the expected outcomes of context-based teaching was to provide learners with the ability to associate the newly learned context to other contexts. Topuz et al. (2013) concluded that teachers thought that context-based teaching would provide permanent learning. In the interviews with T1, he stated that he expected context-based teaching to arouse curiosity in pupils. In order for teachers to realize their expectations for arousing curiosity and meaningful learning, the contexts used should be appropriate for the development level and lives of the learners. Ültay (2012) argued that for students to create meaningful mental maps, scientific content should be given in contexts that will arouse the need to know.

The two teachers in this study also expressed that they expected from the process to increase student engagement in the lesson. One of the important reasons for the emergence of the context-based approach is pupils' indifference towards chemistry as a subject (Gilbert, 2006). Context-based teaching increases pupils' interest in the lesson, which, in turn, results in higher levels of pupil involvement than that obtained with traditional teaching methods (Lubben et al., 1996). In order for a chemistry lesson to be carried out effectively, teachers need to ensure that pupils actively participate in the lesson by using the contexts they choose from daily life and social events. In addition, it was determined that the teachers started this study with expectations for the development of the pupils, but when the practice sessions were completed, they realised their expectations regarding pupils' better learning as well. It can be concluded that the teachers' expectations were met after the study.

Teachers' Gains from Context-Based Chemistry Teaching

Rosenthal and Jacobson (1968) asserted that teacher expectations were very important as they affect teachers' performance and teaching methods. In this research, it was determined that the two participating teachers' expectations were related to the gains they wanted their students to achieve. They developed new teaching materials to help the pupils achieve these gains. They themselves benefitted from this. Van Dulmen et al. (2022) stated that designing and implementing context-based teaching materials supported teacher learning. In the current study the two participating teachers also stated that, at the end of the context-based teaching process, they had learned to use different teaching methods/techniques/strategies and saw this as a gain. İlhan (2010) concluded that teachers started to use different assessment and evaluation techniques thanks to context-based teaching practices which they described as a positive contribution of context-based teaching. Since the context-based approach is a curriculum approach, context-based teaching activities can be carried out with many active teaching methods, techniques and strategies such as the 5E Teaching Model, the REACT model, problem-based learning, experimentation, and discussion (İlhan et al., 2015). This dimension of context-based teaching enabled teachers to conduct their lessons using new methods and techniques.

At the end of the research, both teachers stated that their competencies in context-based teaching had improved. It was found that teachers who developed their own teaching materials and used them in their lessons applied context-based teaching successfully and gained the ability to use contexts in their teaching (George & Lubben, 2002). This is consistent with studies showing that teachers' competencies in context-based teaching improved as a result of context-based teaching (Avargil et al., 2012; De Putter-Smits, 2012; Van Dulmen et al., 2022). In addition, both teachers stated that they had gained awareness after implementing the CBTA, while one teacher stated that his academic self-efficacy beliefs had increased. Academic self-efficacy is defined as a person's belief in their ability to succeed in a particular situation (Bandura, 1997). High levels of academic self-efficacy in teachers can significantly affect their expectations of the results they will achieve and their

development of effective teaching behaviours; it is important to make arrangements to strengthen teachers' self-efficacy beliefs (Oğuz, 2012). In this study, teachers were supported throughout the implementation process and at the end of each practice session were given feedback on their competencies. It is thought that as a result of the support given to them in this process, the teachers improved in practice, their academic self-efficacy beliefs increased and they gained awareness through to the feedback given. In other words, as a result of supporting the teachers in the process, it became easier for them to reach the gains.

Applicability of Context-Based Chemistry Teaching

The teachers evaluated the applicability of context-based teaching within the framework of certain conditions. In this study, teachers prepared the teaching materials themselves. However, as a result of the research, it was concluded that both teachers thought that the approach could be applied more easily through the provision of resources containing activities suitable for context-based teaching. According to Roblin et al., (2018), providing teachers with teaching material support will facilitate the use of innovative curriculum approaches. On the contrary, Bennett & Lubben (2006) argued that teachers were more willing to use context-based teaching when they developed teaching materials themselves. Furthermore, in this research, teachers stated that necessary arrangements should be made in classrooms to encourage teachers to adopt context-based teaching practices. Walan et al., (2016) concluded that teachers thought that crowded classrooms limited the applicability of context-based teaching.

A view shared by the two participating teachers on the applicability of context-based teaching was the necessity of cooperation between universities and MoNE. the teachers thought that academics working on the CBTA at universities should give training so that teachers could gain competence in this new approach. The teachers stated that teachers could apply this approach more easily if resources produced by academics were made available for teachers through the MoNE. This view of the teachers is in line with the views of distinguished researchers working on the context-based approach. Studies by Parchmann et al. (2006), and Pilot and Bulte (2006) emphasised that, while developing context-based teaching materials, teachers should cooperate with academics working on context-based teaching at universities. Similarly, Nentwig et al. (2005) suggested that a network that will ensure cooperation between teachers and science educators at universities should be created to facilitate context-based teaching in chemistry classes. In this study, the researcher first provided in-service training to teachers, informed them about the context-based approach and development of context-based teaching materials, and then supported the practice of teachers in their own schools as a continuation of in-service training. In addition, the researcher tried to contribute to the development of teachers by giving feedback after each application. As a result of following these steps, it is thought that the teachers had successfully implemented the approach and the approach has become applicable.

As a result of the research, differences were observed in the way of applying context-based activities of T1 and T2. It was seen that T1 had more command of teaching methods/techniques/strategies than T2. This is thought to be due to the fact that T1 is a graduate of the Faculty of Education and T2 is a graduate of the Faculty of Science with a teaching certificate. CBTA is one of the approaches that supports the necessity of the pupils being active. T1 has fulfilled this necessity and has given more space to activities that will enable pupils to participate in the lesson. It was found that one of the conditions that teachers particularly emphasised for the implementation of context-based teaching was that teachers should be given in-service training and should be monitored after the training. Similarly, studies by Nentwig et al. (2005) and Ayvacı (2010) reported that teachers should receive in-service training to adapt to their roles in the context-based teaching process.

The current study shows this two chemistry teachers' expectations from context-based teaching, their gains from the process, and the conditions which they think are necessary for the implementation of context-based teaching. This study reveals that teachers with different

characteristics had similar expectations before context-based instruction and that they achieved similar gains after the practice sessions. In the interviews held before the applications, it was revealed that the teachers had some expectations about the approach. It is noteworthy that all the expectations of the teachers were for the students. These expectations were to arouse interest and curiosity in learners, to motivate them, to increase pupil involvement in the lesson, to increase achievement in the lesson, and to help achieve meaningful learning. When the teachers were asked about the positive effects of the approach at the end of the practice sessions, they expressed their opinions about the contribution of the approach to them as teachers. These positive effects are the gains that teachers gain from the approach. These gains were identified as helping to learn to use different strategies, methods, and techniques; increasing academic self-efficacy beliefs; helping achieve proficiency in the context-based teaching method; and raising awareness. When the process was completed, it was determined that the teachers thought that this approach would not be easy to use in lessons unless suitable conditions were provided. There were the availability of course resources in accordance with the context-based approach, an appropriate classroom environment, cooperation between MoNE and universities and in-service training and monitoring of teachers. In addition, it was concluded that the characteristics of the teachers were effective on the context-based teaching practices.

In this research, it was determined that teachers' expectations were related to the characteristics and behaviors they wanted their students to have. During the interviews, it became clear that the teachers were open to the idea of trying new teaching methods so that they could meet their expectations for students. They also stated that this new teaching method, which they thought provided significant benefits, could be used easily in teaching environments where the necessary conditions were met. It is one of the most important results of this study that teachers emphasise that universities and MoNE should work in cooperation in order to use context-based teaching. Based on this, it is recommended that future studies focus on meeting the conditions stated by the teachers and evaluating the CBTA from the perspective of both the teacher and the student. Since this research was carried out with a small number of participants, it does not have any generalisation concerns to the population.

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Appendix

Sample of Context-Based Teaching Material

Activity Plan For Teacher

Topic: Evaporation, boiling and condensation

Purpose: Recognizing, understanding and naming events that enable the liquid and gaseous states of matter to turn into each other

Learning outcomes (for students):

- ***Content outcomes:***
  1. Explain the concept of equilibrium vapor pressure through the evaporation-condensation processes in closed cups.
     - a- It is emphasized that the boiling depends on the external pressure/geographical altitude and examples of industrial applications of boiling / evaporation under low / high pressure are given.
     - b- It is implied that boiling and evaporation are different; phase diagrams are not explained.
  2. Uses concepts related to fluids and their properties to explain natural phenomena.
     - a- The presence of water vapor in the atmosphere is associated with the concept of humidity.
     - b- The concepts of real and felt temperature given in meteorology news are associated with relative humidity.

- ***Understanding Scientific Knowledge:***
  - Recognizes the specific terminology of chemistry and uses them in the communication process.
- ***Scientific Process Skills:***
  - Uses analytical and critical thinking skills developed within the scope of chemistry course in order to understand the phenomena.
  - Obtains data by observing; interprets these data and reaches generalizations.
- ***Life Skills:***
  - Students use what they learn in chemistry class to solve the problems they encounter in daily life.
  - Willing to work collaboratively.
- ***Attitudes and Values:***
  - Interested in science and its component, chemistry.

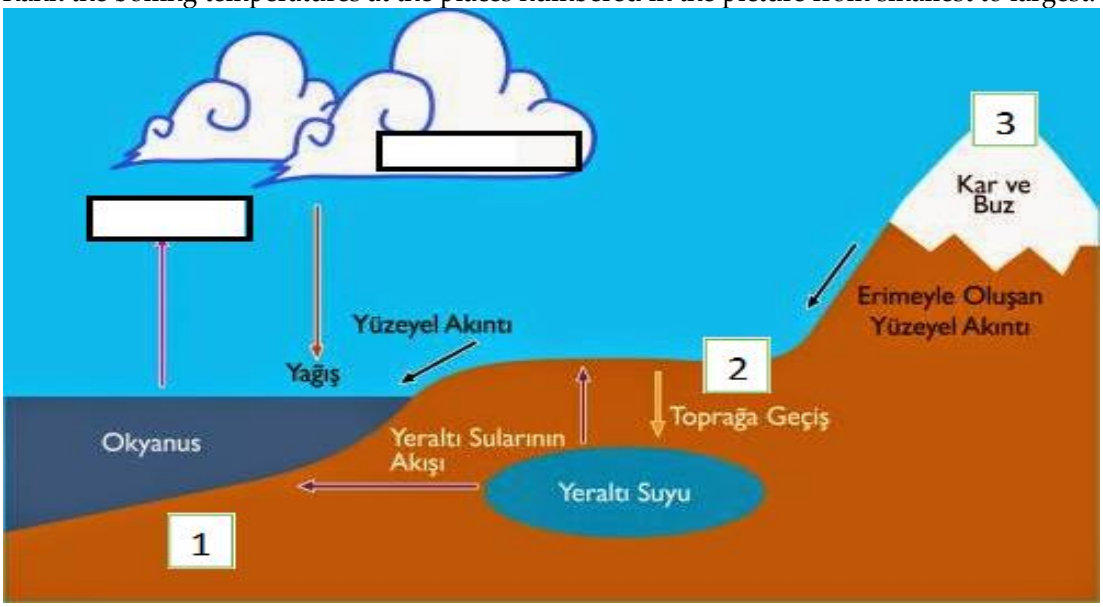
Teaching Material

Context: Watercycle
Topic: Evaporation, boiling and condensation

<u>Let's explore!</u>

2/3 of the Earth is covered with water. Oceans, seas, lakes and glaciers make up most of the water mass on Earth. In addition, some of the water is found in the atmosphere as vapor, while some of it is found in underground sources. The circulation of water between these different sources is called the water cycle. Living things also play a role in completing the water cycle. The picture below is a schematic of the water cycle. Using the picture;

1. 1. Write down the events that took place at that stage in the boxes left blank in the picture. Explain the formation of rain and snow using what you wrote in the boxes.
2. Explain the water cycle using the picture.
3. Rank the boiling temperatures at the places numbered in the picture from smallest to largest.



Groupwork

1. You may have seen that people who want to cook fast cook their meals in a pressure cooker to save time, and then cool the pot under the tap to open the lid. Starting from here, discuss about the working principle of the pressure cooker.
2. While the water boils at 95^0C on Mount Ararat, it boils at 100^0C in Antalya. How would you explain that water boils at different temperatures at sea level and in cities above sea level?
3. While the air temperature is 38^0C in Ankara in July, someone who complains only about the temperature of the air states that the temperature felt at 38^0C in Mersin is more than 38^0C. What do you think is the reason for this? Explain why the temperature felt in Mersin is high by associating the cause and evaporation you assumed.
4. You may have seen that the water you put on your bedside with a glass at night is missing when you get up in the morning and there are bubbles in the water. What do you think is the reason for this?

What Have We Learned?

Students are asked to make their predictions by asking the following question. Afterwards, the students run the experiment and the similarities and differences between the predictions and observations are discussed along with the reasons.

1. **Predict:** Suppose you have a vacuum jar in which you can control the air with the help of a tap. You put some water in a pet glass into the vacuum jar. What changes happen inside the glass jar when you open the faucet and start venting the air inside the jar? How do you think this change causes changes in the physical and chemical structure of water?
   Observe: Students are given an experiment on the subject.

   Explain: Do the results of the experiment agree with the predictions you made according to the problem situation? Compare your prediction and observation results and note the results that are compatible or contradictory with each other.

2. In Aydın, where the temperature is 30^0C, when the relative humidity is 55%, how many Torr is the water vapor pressure in the air? (The vapor pressure of water at 30^0C is approximately 32 Torr).
3. Which of the following examples are examples of evaporation and which of condensation?
   - Sweating of the soda bottle you took out of the refrigerator in hot weather
   - Cooling of your hand when you pour cologne on your hand
   - Cloud formation
   - Fog formation
   - Fogging of the bathroom mirror
   - Drying of wet hair
   - Visually seeing your breath when you exhale in cold weather
   - Rain formation