From Traditional To Reform-Based Teaching Beliefs and Classroom Practices of Elementary Science Teachers

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Abstracts

The purpose of this mixed-methods study was to examine the relationship between teachers' beliefs about their teaching and their classroom practices based on interviews and classroom observations across eight elementary science teachers. A quantitative research analysis showed there was a statistically positive correlation between their beliefs and practices. However, only three teachers' belief categories were coherent with classroom practices. We argue that there is a complex understanding of tension between the two entities. Those teachers with traditional teaching profiles noted that centralized exams and a strict curriculum limited their classroom practices. Implications for this study about the practice of reform-based teaching are discussed.

Introduction

With the advent of modern technology, science education has gained a greater importance all over the world (Hurd, 1998) and science and technology literacy has become one of the main requirements of modern life (UNESCO, 1994). It is now a common concern for all politicians and educators to train science literate individuals who can keep up with the developments of the modern age and compete with the members of other nations. In many countries, the functionality of science and technology education is improved through educational reforms that aim to alter the traditional approach to science teaching to educate individuals in science literacy (McCollum, 2004). Such reforms have resulted in the formation of a new, constructivist approach, which promotes students' active participation in their learning with the teacher assuming the role of a guide helping students to seek information and encouraging them to construct new ideas and concepts based on prior knowledge (Hmelo-Silver & Barrow, 2006; Ben-Ari, 2001; Hsu, 2004; Öztürk, 2002; Erişen, 2007; Şişman, 2007). In Turkey, this transition has been reflected since 2004 in the revision of science-teaching programs and textbooks based on a constructivist approach. However, the new standards in the education field defined by politicians and educators could not be strictly adopted in practice in actual school settings (Özden, 2005). This is supported by the results of the Trends in International Mathematics and Science Study (TIMMS). Although the average score of Turkey in the TIMMS science exam was higher than the previous years, it was still below the average of international score (Yıldırım, Yıldırım, Yetişir, & Ceylan, 2013).

The role of teachers is critical for the successful implementation of educational reforms (Çakıroğlu & Çakroğlu, 2003). Teachers serve as implementers, directors and shapers of

change since they determine how the curriculum is implemented. It is their educational beliefs and experience that have a critical role in the creation of a classroom environment that allow students to acquire the profound understanding of how scientists make sense of the occurrences taking place in their world (Pomeroy, 1993; Roth, McGinn, & Bowen, 1998). Teachers' beliefs about which methods should be adopted and how they should be applied mediate their classroom practice (Pajares, 1992); thus the revised program is itself reconstructed by the teacher (Keys & Bryan, 2001).

Another important element affecting the extent to which teachers are successful in science instruction is their content knowledge (Alonzo, 2002). Although mastery of content knowledge is considered a primary requisite for teaching information related to any specific subject area to others, several researchers have suggested that content knowledge comes secondary to teachers' beliefs in determining their classroom practices (Nespor, 1987; Pajares, 1992; Hashweh, 1996; Gess-Newsome, 1999; Lederman; 1999; Minor, Onwuegbuzie, Witcher, & James, 2002). According to Enochs and Riggs (1990), investigating teachers' beliefs is of vital importance for understanding their behaviours. Similarly, Luft and Roehrig (2007) emphasized that in recent years, teachers' beliefs about instruction have taken a prime position in educational research. Therefore, before evaluating teachers' classroom practices, their beliefs should first be explored (Zheng, 2009). It is necessary to elicit the degree to which science teachers in Turkey believe in the principles of the new program and the extent to which they reflect their beliefs in their practice. Thus, the purpose of the current study was to determine elementary school science teachers' beliefs about teaching, learning, and pedagogical practices and then to explore the relationships between these beliefs and their classroom practices. To this end, the following research questions were formed;

(1) What are science teachers' beliefs about science teaching, learning and pedagogical practices?

(2) To what extent does the teachers' classroom practice conform to the reform-based curriculum?

(3) İs there a significant correlation between science teachers' beliefs about teaching, learning, pedagogical practices and their classroom practices?

Method

This mixed-methods (Tashakkori & Teddlie, 1998), multi-case study was conducted with eight elementary science teachers in Turkey. The qualitative research method was used for the in-depth evaluation of the teachers' beliefs and classroom practices and the quantitative research method was chosen to explore the relationship between the teachers' beliefs and classroom practices. A semi-structured interview method was used as proposed by Fishbien and Ajzen (2011) to evaluate the teachers' beliefs. The teachers' classroom practice was evaluated by means of an observation protocol. A case study design was used to explore and analyse few specific cases (Creswell, 1998). In the quantitative part of the study, the relationship between the teachers' beliefs and observed classroom practices were analysed by converting them into numerical data (Brown & Melear, 2006).

Participants

The population of the study comprised science teachers working in elementary schools in the city of Kırıkkale, in Anatolian Turkey. First of all, ethical approval to conduct the study was obtained from the committee in governorship. In sampling method, firstly, twenty schools were randomly selected in the study. Secondly, information was collected about adequacy of the

school structure for supporting reform-based implementation in terms of class size, and the quality of the science laboratory and technology equipment with teacher participation form. The total number of teachers who agreed to voluntarily participate in the study was 28 teachers. Finally, eight out of 28 teachers were purposefully selected teacher had chance to implement laboratory application and use technology integration to classroom practice.

The study was conducted in the 2012-2013 school year with the voluntary participation of eight science teachers following appropriate disclosure of human-subjects research considerations. For ethical reasons, a code was assigned to each teacher. Information about the teachers' gender, professional experience and higher education background is provided in Table 1 under these codes.

Table 1. Demographics of the participants

Teacher	Gender	Experience (years)	Undergraduate program
T1	Female	19	Chemistry Department, Faculty of Science and Letters
T2	Female	9	Science Teaching, Education Faculty
T3	Female	21	Chemistry Department, Faculty of Science and Letters
T4	Male	38	Physics-Chemistry-Biology Department, Education Institute
T5	Male	12	Physics Teaching, Education Faculty
T6	Female	2	Life Sciences Teaching, Education Faculty
T7	Male	12	Chemistry Teaching, Education Faculty
T8	Male	13	Life Sciences Teaching, Education Faculty

Data collection and analysis

In the current study, the participants were observed for two-class hours per week for a total of six to eight weeks. The reasons for the difference in the observation period were exams taking place and some teachers taking leave. In order for the participants not to be affected by the interview questions during the observations, the interviews were held after all the observations were conducted. All the observations and interviews were conducted by the researcher.

Interview

In this study, a seven-item semi-structured *Teacher Beliefs Interview* (TBI) form developed by Luft and Roehrig (2007) was used to determine the teachers' beliefs. The interview items were translated into Turkish by two language specialists and a subject-area expert, and piloted on eight pre-service science teachers to determine the compliance of the translated version to the original form. Through this semi-structured interview form of 20-30 minutes, the teachers were encouraged to express their opinions. Audio-recordings of the interviews were transcribed and the transcribed texts were confirmed with the participants.

Using the rubric of the scale (Luft & Roehrig, 2007), the teachers' responses to each interview question were grouped into the following five categories: Traditional, Instructive, Transitional, Responsive and Reform-based. Two researchers independently categorized the responses and the inter-rater reliability was found to be 0.82. The codes constructed by the researchers were compared and conflicts in categorization were discussed until reaching an agreement. Table 2 presents the criteria for the categorization of the participants' beliefs (Luft & Roehrig, 2007).

In order to conduct a statistical analysis on the teachers' beliefs and classroom practice, the belief categories were converted into points as follows: traditional, 1; Instructive, 2; Transitional, 3; Responsive, 4; and Reform-based, 5 points (Roehrig & Kruse, 2005). Thus, the belief scores varied between 7 and 35. In order to construct the teachers' belief profiles, mean score intervals were used. Teachers with a mean score of 1.0 to 2.3 were considered to have teacher-centred beliefs, those with a mean score of 2.4 to 3.7 were considered to have transitional beliefs and those with a mean score between 3.8 and 5.0 were considered to have student-centred beliefs.

Table 2. Description of the categories of teachers' beliefs (Luft & Roehrig, 2007)

Categories	Description
Traditional	The teacher is focused on knowledge and transfer of knowledge. The role of the teacher is to convey information. There is no emphasis on the student.
Instructive	The teacher is focused on the construction of learning environments and organization of teacher-centred classes. The most important elements involved are the teacher's activities and means of teaching. Though some importance is attached to the observation of students, the testing of the accuracy of any information is performed under the direction of the textbook or the teacher.
Transitional	The teacher is focused on students' self-evaluation of their comprehension. Though not much emphasis is put on the students' contribution to the learning environment and their communication with each other, some emphasis is put on the organization of the classroom environment in line with students' needs. There is a limited amount of student feedback.
Responsive	The teacher is focused on the organization of the classroom environment to foster cooperation, feedback, enhancement of information and students' taking responsibility for their own learning. In this category, the teacher should indicate how the interactions between students, individual learning or students' responses affect his/her decisions. The teacher reorganizes the class according to student feedback.
Reform-based	The teacher is focused on the promotion of student interactions, helping students to have access to information, and organization of the class according to student learning. In this category, great emphasis is put on the students' constructing their learning environment and individual learning. Students are encouraged to transfer the learned information into new settings and different disciplines. The class is organized according to students' abilities and feedback.

Observation of classroom practice

Teachers' classroom practices were determined using *the Reformed Teaching Observation Protocol (RTOP)* developed by Sawada and colleagues (2002). RTOP is a reliable and valid observation protocol developed to evaluate reform-based instructional practices in order to identify teachers' shortcomings in their teaching, and help them to compensate for these shortcomings. RTOP consists of 25 items each scored on a five-point Likert-type scale. In the

current study, observation scoring was performed in accordance with the *RTOP Reference Manual (*Piburn et al., 2000*)*. Table 3 presents sample scoring of the teacher's behaviour when a student asks a question. The scoring interval for RTOP is between 0 and 100, with high scores indicating reform-based practice and low scores representing traditional teaching behaviours. Scores equal to or below 30 shows teacher-centred practices, 31-49 indicates students' activities and dialogues under the guidance of the teacher, and 50 and above indicate student-centred activities (MacIsaac & Falconer, 2002). The observation protocol was adapted to Turkish by Topçu and Uygun-Temiz (2012). A factor analysis was performed to calculate the validity of each sub-scale included in the scale, and the results were satisfactory in that the exploratory and confirmatory factor analyses showed that the 25-item scale comprised three dimensions as proposed by Sawada et al. (2002).

Prior to the observation, two researchers watched sample video activities of Sawada et al. (2002) and analysed them with two specialists of pedagogical content knowledge to establish inter-rater reliability. In this way, the researchers gained experience about the use of RTOP.

The researchers observed the classroom practices of eight teachers for two weeks and independently scored them. In order to determine the scoring reliability of the researchers, the RTOP scores were compared and the compliance ratio was found to be 88%. The data were shared with two pedagogical training experts. The experts' opinions were sought for the categorization of the teachers' beliefs and scoring of their classroom practices. Through the exchange of opinions and re-evaluation of observation notes, 100 percent agreement was reached. Furthermore, the reliability and validity of the study was improved by extending the study time and sharing the data with the participants (Merriam, 1990; Maxwell, 2005). More than one data collection tool and analysis method was used to establish both internal validity and reliability. Moreover, in order to establish the reliability of the study, the findings obtained from the interviews and observations were supported with the statements of the teachers.

Table 3. Sample scoring of RTOP items (MacIsaac & Falconer, 2002)

Score		Teacher behaviour
0	The behaviour never occurred	The teacher states that the problem is related to a future topic or ignores it.
1	The behaviour occurred at least once	The teacher gives a short answer.
2	Occurred more than once; very loosely describes the lesson	The teacher directs the question to other students and waits for them to respond. After receiving a few answers, provides the correct answer.
3	A frequent behaviour or fairly descriptive of the lesson	The teacher directs the question to other students and wants them to work and discuss in groups.
4	Pervasive or extremely descriptive of the lesson	The teacher directs the question to other students. By integrating the topic taught in the class with the question, presents the information in an integrated way to students and in light of this information makes them reach the answers in groups.

Relationship between beliefs and practices

In order to compare teachers' beliefs with their classroom practices, the data in both groups were categorized as Traditional, Transitional or Reform-Based and the relationships between them were analysed. Furthermore, in order to determine whether there was a statistically significant correlation between the teachers' belief scores and the observation scores, teachers' beliefs and classroom practices were converted into numerical data. Spearman's rho coefficient was calculated to evaluate the relationship between the variables

Results

Teachers' beliefs

Each teacher's pedagogical beliefs were separately analysed. The teachers defined their roles as 'conveying information', 'providing students with materials and opportunities to improve their learning and gain experience', 'guiding students towards learning', 'establishing close relationships with students', 'imparting a critical perspective of the topic', and 'showing ways of accessing information.

Below is the response of T2 to the question: *"How do you describe your role as a teacher?"*

> *She should be the one offering guidance. For example, after giving the necessary information, she can help students engage in experiments to confirm and reinforce the information. These can be experiments requiring students to find specific information on their own. That is, you may not give the information first, and involve students in an experiment so that they can access the required information on their own with the guidance of the teacher. You may ask some questions to direct students* (T2).

T2 emphasized the importance of allowing students to find information on their own; yet, she also referred to the time issue involved in this process as follows:

> *This may result in experiencing time problems because it may take some time for students to reach the required information. To save time, you can provide some of the information. You can explain what they [the students] should do* (T2).

When explaining their opinions about how to achieve maximum learning, the teachers stated that this can be accomplished through 'out-of-school communication', 'different activities', 'computer-assisted activities', 'providing up-to-date examples from daily life', 'group work', 'discussions', 'students exchanging opinions', 'discovering information' and 'conducting activities according to the learning styles of students'. For instance, T3 mentioned the construction of classroom settings to meet the individual needs of students, and T4 emphasized the importance of establishing a positive classroom environment that will draw the attention of students.

> *You first need to determine how students understand and learn in order to achieve maximum learning. When we know how our students learn, we can organize the class accordingly. For this, we need to be a good observer and listener. Every student is different. While some students learn better through visual materials, some others prefer to take notes, as in the theory of multiple-intelligence* (T3).

> *We need to make the subjects interesting; we need to make our students wonder. That is, if a student becomes curious about something, he can learn about it.....Using different activities, you need to draw students' attention* (T4).

The teachers stated that when making decisions about the content to teach, they consider various issues such as 'time and materials', 'students' interests', 'activities that will allow students to reach information on their own', and 'examples from real life that will demonstrate students why these activities are necessary'. On the other hand, many teachers stated that the curriculum restricts their classroom practices:

> *There are two important points to be considered; first, it is not actually the teacher that decides what to teach and not to teach; we are given a program prepared in advance. We have to follow this program. The second issue is related to the exams. … Sometimes we may adopt different approaches to make learning easier for students* (T8).

Holding a belief categorized in the transitional category, T4 stated that he includes activities he believes will draw the attention of the students.

> *We have to teach the topics given in the curriculum, so we teach them. Of course, we sometimes teach different topics we believe are necessary for students* (T4).

> *Researcher: Do you perform all the activities stipulated in the curriculum?*
> *I skip some of the experiments given in the book …. I have some experiments and information of my own; I use them instead of what is given in the book* (T4).

> *Researcher: What is you criterion for selecting experiments to skip?*
> *If I think that an experiment is not interesting for the students, I try to find original experiments that will be more interesting for students* (T4).

The majority of the teachers decided when to start a new topic according to the schedule provided in the curriculum. Having a student-centred belief, T5 remarked that when students discuss a topic and explain it using their own words, this is an indication that they have learned and internalized that topic. When this happens, the teacher can move on to the next topic. With giving a chance to students to share their ideas end of the lesson, the one enhances students' scientific argument development in oral presentations (Bugarcic, Colthorpe, Zimbardi, Su, & Jackson, 2014).

> *At the end of each topic, I ask the students questions to check their comprehension. They can also ask questions. It is like a discussion platform. Students explain the topic with their own words, not as I explained in the lesson; that is, without memorizing. If they can discuss the topic, then there is no problem; this shows that students have learned the topic* (T5).

T2 stated that she can understand when students have internalized a topic from their facial expressions and the questions they ask, which indicates his/her transitional belief. T3 stated that students approaching a topic from a different perspective, one that had not previously been discussed in the class is an indication that they have grasped the topic.

> *It is clear from their facial expressions and looks. They ask questions related to the topic and this shows that they are interested in the lesson* (T2*).*

> *[I know it] when I get answers to my questions from the students; but these answers should not be direct quotes from the textbook. The students should use their own expressions. We can also understand whether they have understood the topic from the*

> *questions they ask ….. Some students can even express opinions about topics we have not discussed yet* (T3).

In the teachers' responses to the question, "*How do students best learn science?",* there is great emphasis on conducting experiments. However, while underlining the importance of learning by doing and experience, most teachers did not pay attention to students collecting data and interpreting the collected data on their own, which indicated the existence of a transitional belief. Only one teacher, T3, put a great emphasis on students' active participation in data collection and evaluation processes:

> *Teacher should conduct activities the students can relate to daily life. Students should conduct experiments and collect data on their own. When necessary, the teacher should offer guidance* (T3).

While the teachers that held a teacher-centred belief considered that students' participation in class and getting high scores from tests showed that they have learned the topic, those with a student-centred belief viewed students exchanging opinions and conducting discussions as an indication of their learning.

Below are the responses of T5 and T2 to the question, "*How do you know when learning is occurring in your classroom?"*

> *I try to provide opportunities for my students to talk to see whether they have learned about the topic. Each group explains their findings and compares them with the other groups. During this process, some groups question or change their data asking questions to find out how it should be. They question their own findings. If any of the students is not certain about his/her findings, they may be inclined to change them during discussions with peers, but students who know the topic well tend to strongly defend their position* (T5).

> *I sometimes give a short pop quiz to my students or I use the question-answer technique. If several students are willing to answer the questions, I can conclude that they have learned the topic. If their answers to the questions or quiz are correct, I believe that it is enough* (T2).

In light of the data collected from the interviews with the teachers, it can be argued that most teachers are far from adopting reform-based beliefs. Only two teachers, T3 and T5, held beliefs that were close to the reform-based end of the scale. Table 4 presents the belief categories for learning and teaching by the teachers' responses to the interview questions also shown in the table.

Table 4. Teachers' beliefs

Q1. How do you describe your role as a teacher?
Q2. How do you maximize student learning in your classroom?
Q3. In school setting, how do you decide what to teach and what not to teach?
Q4. How do you decide when to move on to a new topic in your classroom?
Q5. How do you know when your students understand?
Q6. How do your students learn science best?
Q7. How do you know when learning is occurring in your classroom?

	Teacher-centred <----------> student-centred					
	Traditional	Instructive	Transitional	Responsive	Reform-based	Teacher Beliefs Interview Score
T1		Q3,Q4,Q5,Q7	Q1,Q2	Q6		18
T2	Q1,Q3	Q4,Q7	Q2,Q5,Q6			15
T3			Q3,Q4	Q1,Q6,Q7	Q2,Q5	28
T4	Q4	Q7	Q1,Q2,Q3,Q5,Q6			18
T5			Q1,Q5	Q2,Q4,Q6,Q7	Q3	27
T6		Q1,Q3	Q2,Q5,Q6	Q4,Q7		21
T7		Q4,Q7	Q1,Q5,Q6	Q2,Q3		21
T8	Q1,Q3,Q4	Q7	Q2,Q5,Q6			14

Observation of classroom practice

The teachers' RTOP scores are presented in Figure 1. The mean RTOP score was found to be approximately 44. The results show that three teachers, T3, T5 and T7, used student-centred practices (score: above 50), and three teachers, T4, T6 and T8, adopted a teacher-centred approach (score: below 30). The remaining teachers, T1 and T2, scoring between 35.6 and 33.6, respectively seemed to allow students active participation in activities while at the same time retaining control of the class. In the following section, the classroom practices of the teachers will be demonstrated by category using excerpts from the teachers' statements.

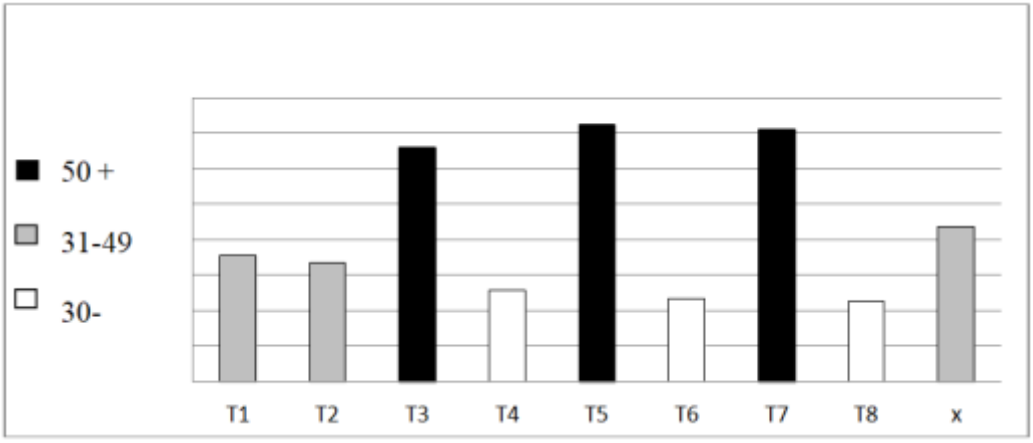

Figure 1: Teachers' RTOP scores

Teacher-centred

Since T6 adopted a traditional approach to classroom practices, she experienced problems in establishing discipline in the classroom, thus failed to create an interactive classroom environment. Most of the time was taken up by teacher talk with the students usually being quiet. The communication between the teacher and students was only one direct, from teacher to students and the students could not actively participate in the class. The teacher frequently increased his/her voice to maintain discipline in the classroom, which prevented the creation of a tolerant classroom environment.

In his/her class, T6 frequently used interactive activities based on the question-answer technique, which gave him/her control over the activity. Even though using interactive programs in science teaching that has positive impact and can improve the students' understanding (Çelik, Sarı, & Harwanto, 2015) is a reform-based activity the aim of T6' interactive activities is a traditional. In addition, T6 gave samples from daily life and provided visual materials through the projector so that the students could make positive contributions to the determination of his/her conceptual information score. Throughout the observations, T6 did not conduct any experiments in the class but utilized online materials. The questions used by T6 in the question-answer technique were at a lower level according to Bloom's Taxonomy (Huitt, 2011). Moreover, the teacher did not give the students time to think about the questions and provided the answers immediately after asking the questions. This may have stemmed from the teacher having difficulty managing the class. The traditional approach adopted by T6 in his/her teaching practices is indicated by the students being passive in receiving information, the teacher always trying to retain control of the classroom, and the transfer of information only through lecturing.

Another teacher using the traditional approach in his/her teaching practices was T8, who assumed the role of conveying information in the class. Similar to T6, T8 also mostly used the question-answer technique. When the teacher uses this technique in a correct-answer-oriented manner, the classroom interaction is weakened. Most of the time, T8 wrote questions similar to those included in the central exams on the board and answered them. The students only copied the answers into their notebooks. When the students gave an answer before T8 provided the solution, he only gave corrective feedback without further explaining why the student's answer was right or wrong. Since T8 assumed the role of the conveyor of information and the students were passive in his/her class, his/her teaching practices were considered to be traditional.

Transitional

The observation score for T1's classroom practices was 35.6. The 31-49 interval represents student activities and dialogues conducted under the control of the teacher (MacIsaac & Falconer, 2002). T1's instructional practice was the combination of teacher-centred and student-centred activities. T1 frequently used the question-answer technique in his/her class. She presented the solution of the problems on the board. T1 relied on the textbooks to assess the learning of the students and performed activities directed at succeeding in the central exams. The teacher only conducted three experiments throughout the observation period (density experiment, lifting force of liquids and force). Two of these activities were performed as group work but the force experiment had to be in the form of demonstration due to the lack of equipment. All of these experiments were directed towards the reinforcement of already-taught information rather than discovery. While relating the class to daily life positively contributed to T1's RTOP score, his/her misconception about the lifting force of liquids and modern atom model negatively affected the score. When teaching about the lifting force of liquids, T1 used

objects with different densities, demonstrating their floating and sinking behaviour. She explained that in floating, the lifting force of the liquid is greater than the weight of the object. The actual dialog is given below.

> *The same object is put in three different containers including liquids with different intensities. What is the relationship between the lifting force affecting the object and the weight of the object?* (T1)

After collecting the responses of the students, the teacher wrote the answer on the board and explained that the weight of the floating object is smaller than the lifting force of the liquid.

> *If the lifting force is greater than the weight of the object, wouldn't the object be flying?* (Student)
>
> *We just accepted that they were equal because of the liquid density* (T1).

T1 had a similar misconception related to the models of the atom. She stated that electrons travel in defined orbits.

T1 stated that she frequently used the question-answer technique in the class. She asked questions at the beginning of the lesson to remind the students about information given in previous classes, and during the lesson, she preferred to ask higher level questions to encourage students to take active part in their learning.

At the beginning of the lesson:

> *How is volume measured? What is volume? What is the unit of weight?* (T1)

During the lesson:

> *How do you think a ship floats?* (T1)

Although T1 tried to encourage students to participate in the class through the question and answer technique, she did not get the expected response from the students, thus a discussion could not be started. Moreover, she did not answer some of the students' questions related to the topic.

> *[the topic: covalent bond] How do the commonly used electrodes circulate?* (Student)

T1 gave no answer. However, T1 provided some examples from daily life to make the learning permanent:

> *We go to the market and do some shopping. When we come home, we want to wash the fruit we have bought. When we put a mandarin in water, it floats; but when we put a peeled mandarin, it sinks. Why?*(T1)

In brief, T1 generally included group work in his/her lessons but she could not create classroom discussions and she left the students' questions unanswered; thus, she was engaged in transitional practice.

Student-centered

T5 was one of the teachers with a high RTOP score. Having a total score of above 50 indicates that he adopted a student-centred approach in the classroom. T5 included real life examples and reinforced conceptual understanding in his/her class, and the lessons covering basic topics indicated that he was engaged in reform-based classroom practices. Furthermore, he attached priority to experiments in the classroom.

The experiments carried out were related to heat transfer between a candle and water, melting of ice and friction force between different surfaces. During the instructional activities, T5 greatly encouraged students to collect data, share it with other students and exchange opinions. Moreover, he made effective use of the case study method. One of the sample cases related to the unit of heat and temperature is presented below:

> *For the winter holiday, Fatma goes to his grandfather's house in a village. It is very cold outside; the taps are frozen. The lake outside is also frozen. She needs to make tea for her grandfather. What would you do, if you were her?*(T5)

Students' responses:

- *The lake is dangerous; the tap must be heated.*
- *I would take ice from the lake.*
- *The lake is dangerous, but to heat the tap, a lot of energy is needed; water can be obtained by melting the ice.*
- *The lake is dangerous but it might take a lot of time to get water from the tap.*
- *Ice in the lake might melt when taking it home.*
- *Tap water is cleaner. Water should somehow flow from the tap.*

Here, both the correct and incorrect statements of the students should be discussed. By means of this sample case, the teacher was able to achieve a high level of student participation in the lesson.

The student-centred practices of T5 included referring to events from daily life, attaining the active participation of students in the class, being reflective on students' learning and encouraging students to think in different ways through asking questions. As a result, it can be said that T5 adopted a reform-based approach in his/her class.

Relationship between teaching beliefs and practice

The teachers' belief and observation scores are given in Table 5. According to Spearman's Rho coefficient, a statistically significant correlation was found between the two scores (Spearman's rho=0.707, p=0.050, n=8). This shows that there is a positive and strong correlation between the teachers' beliefs about learning and their classroom practices.

Table 5. Comparison of the teachers' belief and observation scores

	T1	T2	T3	T4	T5	T6	T7	T8
Belief score	19	15	28	18	27	21	21	14
Observation score	35.6	33.6	65.9	25.7	72.6	23.2	71.2	22.6

To compare the categories of belief and classroom observations, the teachers' belief scores were classified according to three intervals as follows: scores from 7 to 16 as traditional, 17 to 26 as transitional and 27 to 35 as reform-based. According to this classification, T3 and T5 had reform-based instructional practices; T1, T2 and T8 had a belief profile in favour of traditional and student-centred practices; and T4, T6 and T7 had beliefs representing a combination of teacher-centred and student-centred practices. The observation (RTOP) scores were classified as explained earlier in this paper. A RTOP score equal to or lower than 30 represents teacher-centred practices, 31-49 represents student activities and dialogues carried out under the control of the teacher and a score that is equal to or greater than 50 indicates student-centred practices (MacIsaac & Falconer, 2002).

Figure 2 presents the comparison of the teachers' belief and RTOP scores. T3, T5 and T8's beliefs about learning and teaching were parallel to their classroom practices. However, while T1 and T2 demonstrated traditional beliefs in the interviews, their classroom practices were at the transitional level. T4 and T6 demonstrated transitional beliefs in interviews but they seemed to adopt a traditional approach in their classroom practice. Finally, T7 combined teacher-centred and student-centred beliefs and adopted reform-based educational and instructional practices in his/her classroom.

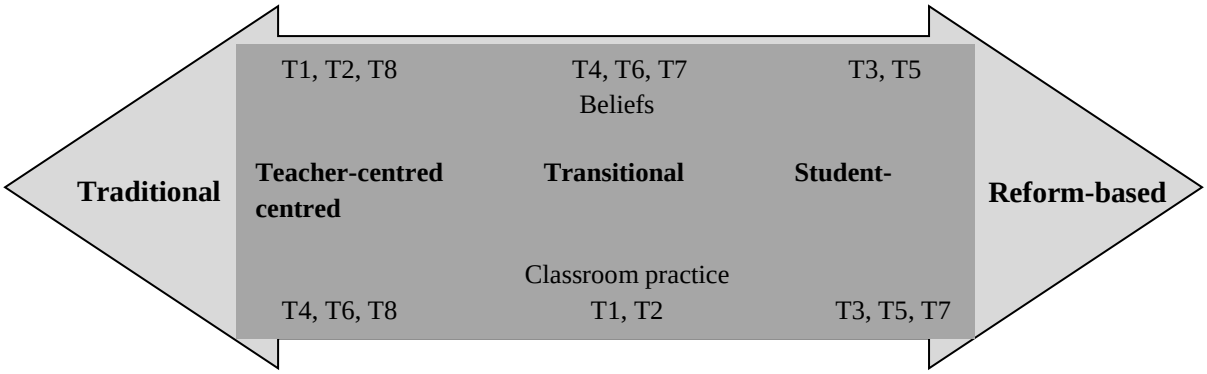

Figure 2: Teachers' beliefs and classroom practices by category

Discussion

The interview data shows that while most of the teachers used terms such as guide and assistant when defining their role, they did not refer to students' needs, learning styles and student-teacher cooperation, which suggests that they have teacher-centred beliefs. For instance, during the interview with T2, she stated that due to lack of time, she prefers to transfer the information to students, which can be interpreted as the reflection of his/her traditional beliefs. This attitude in favour of the direct transfer of information to students is one of the main obstacles to the adoption of inquiry-based teaching as a reform-based method (Tobin & McRobbie, 1996). Another important obstacle is the priority the teachers attach to classroom management (Pajares, 1992). The participants of the current study viewed classroom management as the establishment of discipline and overlooked student-teacher interaction, which are the indication of the presence of a traditional approach. According to Turan (2007), classroom management is a process of effective organization and maintenance of classroom activities in a learning-centred manner and providing guidance for students' learning.

Almost all the teachers involved in the current study referred to the curriculum when deciding what to teach and not to teach. The teachers felt obliged to adhere to the curriculum and the program. Many studies have reported that the curriculum and time constraints limit the adoption of reform-based instruction by teachers (McRobbie & Tobin, 1997; Muire, 1997; Wallace & Kang, 2004; Carroll & Appleton, 2007; Yore, Henriques, Crawford, Smith, Zwiep, & Tillotson, 2008). Moreover, the participants of the current study stated that they could not conduct all the activities proposed in the curriculum due to time constraints. It seems to be difficult for teachers to carry out reform-based instructional practices since such strategies, e.g., inquiry-based teaching, requires more time (Tobin & McRobbie, 1996). Furthermore, the teacher's adherence to the objectives and activities stated in the curriculum negatively affects the students. Since the teachers want their students to be more successful in the centralized exams, they may easily choose to implement the curriculum imposed on them overlooking the students' interests and needs (Ogawa, Sandholtz, Martinez-Flores, & Scribner, 2003;

Cherubini, 2009). This general attitude may have been adopted particularly by T1 and T8 since they taught eight-graders who were about to take a centralized exam. In systems in which centralized exams must be taken by students, the school management and parents exert pressure on both students and teachers for the students to be successful in these exams (Anderson & Helms, 2001). As a result, instead of determining the content according to students' conceptual development, teachers feel obliged to follow the formal curriculum. Thus, the main priority of teachers becomes the curriculum and centralized exams rather than students' interests and needs.

During the interviews, one of the participants, T1, stated that she would recommend test books to his/her students as supplementary material. Such pressure is reflected in the school environment and particularly novice teachers are affected by this school culture. Even if the teacher has a reform-based conception of education having taken pre-service training complying with a reform-based approach, they may tend to organize their classroom instruction in such a way to prepare their students for centralized exams (Saka, Southerland, & Brooks, 2009). Therefore, it is quite possible for T6, who had started to teach two years before the time of the study to experience this situation. She may have attached greater importance to classroom management and thus demonstrated a traditional instructional behaviour. Even though T6 had received pre-service training favouring reform-based implementations, she chose to follow the curriculum to determine the content of the lessons. This can lead us to think that T6 was also under the pressure of the centralized exam system. McGinnis, Parker, and Graeber (2004) obtained similar results from the study they conducted with five teachers that had graduated from reform-based teacher training programs. Similarly, Roehrig and Kruse (2005) reported that influenced by other teachers, novice teachers tend to follow the curriculum. Adopting a traditional conception, the teachers emphasized the role of the curriculum, time constraints and exams in deciding when to proceed to the next topic.

The observations made in the current study revealed that the teachers' classroom practices are different from one other. T4, T6 and T8's classroom practices were at the traditional level, T1 and T2's classroom practices were at the transitional level and T3, T5 and T7's were at the reform-based level.

During the observations sessions, T1, T2, T4, T5 and T6 conducted their class in a laboratory environment. The teachers may have preferred the laboratory environment due to the better physical conditions and availability of materials. For example, T4 and T6 used the projector in the laboratory. In addition, classes conducted in the laboratory are believed to increase students' interest in the topic. In order to attain the desired outcome from a laboratory, the students should be provided with opportunities to make discoveries and actively take part in lessons so that they can learn by doing and experiencing. However, in this study, except for T5, the teachers did not perform activities to impart scientific process skills to students.

The teacher's classroom management positively affects the efficiency of classroom practices (Stronge, Ward, Tucker, & Hindman, 2007). Similarly, for reform-based practices to be conducted effectively, the teacher needs to successful in classroom management (Moore, 2003). In the literature this success has been closely associated with the teacher's teaching experience. For example, having only two years of teaching experience, T6 had difficulty in managing his/her class. This may be the reason why T6 demonstrated a traditional approach in his/her classroom practices though his/her belief profile was at the transitional level. When novice teachers begin their professional career and face the real classroom environment, they tend to give up student-centred practices and embrace teacher-centred practices (Simmons,

Emory, Carter, Coker, Finnegan, Crockett, & Brunkhorst, 1999). This may be because, when novice teachers start teaching, they are more concerned about timing and classroom management than learning outcomes (Moore, 2003), and they cannot find opportunities to apply the theoretical knowledge they gained during their pre-service training to the classroom environment (Hewson, Tabachnick, Zeichner, & Lemberger, 1999). Roth and Tobin (2001) reported that pre-service teachers do not have enough opportunities to put their theoretical knowledge into practice during their pre-service training; thus, they do not gain the necessary experience. One of the teachers participating in the study conducted by Fortney (2009) stated that before starting teaching, he was not very concerned about classroom management; however, during the initial years of his/her career, he put great efforts to manage the class. In the literature, it is also reported that the more experienced the teacher is, the more activities he incorporates into his/her classes (McGlamery & Fluckiger, 2001). For instance, McEwan (2002) argued that for a complete mastery of the profession of teaching, three-to-eight-year teaching experience is necessary.

Being experienced may not always mean that the teacher will find it easy to adopt a reform-based approach. For example, starting his/her career a long time ago, T4 did not have the chance to get familiar with or gain experience about the relatively new teaching practices. As argued by Manouchehri and Goodman (2000), the teaching styles of teachers do not immediately change when they are confronted with reform-based programs. On the contrary, teachers need to develop pedagogical conceptions and skills required by the teaching style emphasized by the new program. In addition, teachers need to see the demonstrations of instructional activities to understand which teaching style is suitable for the vision and philosophy of the new program. According to Melear, Goodlaxson, Warne and Hickok (2000), teachers should possess knowledge and experience necessary to follow inquiry-based teaching practices. Lacking the necessary experience, the teacher may not be willing to adopt reform-based teaching approach (Borko & Putnam, 1996).

In this study, all the teachers demonstrated a traditional approach in terms of the curriculum and used textbooks as the primary source of instruction. According to Wood William (2009), the process of planning teacher-based lessons starts with selecting activities from the textbook followed by preparing notes, supplementary materials and finally choosing the methods for assignments and assessment without considering students' need. The process of planning student-centred lessons, on the other hand, involves taking into account the objectives and learning outcomes and then performing activities without any concern for student grades. Therefore, in traditional practices, the teacher mostly depends on textbooks and overlooks students' needs and interests. International Association for the Evaluation of Educational Achievement reported that in Turkey, 93% of fourth-grade teachers and 89% of eight-grade teachers used textbook as the main source of instruction (Yıldırım et al., 2013).

Although content knowledge was not directly measured in the current study, the data obtained from the observations revealed its importance for classroom practices. The negative effects of lacking content knowledge on the implementation of reform-based instruction have also been reported in the literature (Roehrig & Kruse, 2005). This may also have been the reason why T1 and T6 could not use reform-based practices in their class. During the observations, it was observed that T1, who had graduated from the chemistry department, had some misconceptions about certain topic of physics. Similarly, T8 had misconceptions about some topics. According to Appleton and Asoko (1996), one of the most serious obstacles to adopting reform-based instruction is teacher not being well equipped with necessary knowledge. Alonzo (2002) argued that those with poor content knowledge prefer transferring information to students rather than

inquiry teaching. Even if a teacher is eager to use student-centred practices, he may not be successful in their implementation due to the lack of high-level content knowledge (Friedrichsen, Abell, Pareja, Brown, Lankford, & Volkmann, 2009).

In this study, all the teachers mostly utilized the question-answer technique to ensure the active participation of their students in the class; however, the teachers used this technique differently. For example, T1, T6 and T8 opted for test questions for this purpose. T2 and T8 asked students to take notes and write the questions and as soon as one student found the correct answer, the teacher solved the problem on the board. T4 presented the questions on the projector screen at the end of the lesson and received responses from the students. The questions used by T2, T4, T6 and T8 were mostly at the levels of remembering and understanding according to Bloom's taxonomy. The main characteristic differentiating T3, T5 and T7 from the other teachers is that they asked higher-level questions to direct their students to different paths of thinking, and encouraged them to be reflective on their learning. Another significant observation was about the wait-time. T1, T2, T4, T6, T7 and T8 did not give their students enough time to think about the questions. Furthermore, these teachers chose to provide the correct answers themselves rather than engaging the students in discussions to search for possible answers to the questions. This shows that it is difficult for many teachers to wait for students to come up with the correct answer, so they tend to give the correct answer themselves (Lyons, Hoffman, Krajcik, & Soloway, 1997). Therefore, the teachers may have used question-answer technique to save time by presenting the correct answer immediately without having to give students time to think. T1, T6 and T8 might have demonstrated this attitude due to the pressure of preparing their students for centralized exams. Similarly, in the literature, it has been reported that such pressures result in teachers spending more time on showing their students how to solve test questions (McNeil & Valenzuela, 2001).

What differentiates T5 and T7 from the other teachers most is that they included group work, experiments, discussions and information exchange in their classrooms. These two teachers spent considerable time on their students' information sharing and discussion. These teachers demonstrated reform-based classroom practices by providing opportunities for their students to actively participate in the lesson and discover information (Maclsaac & Falconer, 2002) rather than directly giving this information. T5 performed a drama activity for students to better understand the granular structure of the matter, and when studying the topic of heat and temperature, the students worked in groups to collect data. Similarly, T7 guided his/her students during the friction force experiment and other experiments to determine melting and boiling points and throughout the data collection process.

When the teachers' beliefs and classroom practices were compared, two teachers, T4 and T6, were found to have beliefs at the transitional level although their classroom practices were at the traditional level. T1, T2 and T7, on the other hand, demonstrated classroom practices that are more reform-based than their beliefs. According to Spearman's rho coefficient, there was a correlation between the beliefs and classroom practices only in three teachers, T3, T5 and T8. As this test is less sensitive than parametric tests, correlation coefficient can be found higher (Büyüköztürk, 2007). Therefore, the data collected from the study were interpreted by making categorical comparisons in this section.

Research on teachers' beliefs has revealed that beliefs play an important role in shaping instructional behaviours (Thompson, 1992; Handal, 2003). When the classroom practices of T3 and T5 were examined, it was determined that they conducted their classes based on learning objectives. They gave priority to learning through active participation and discovery.

T3 and T5 had student-centred beliefs that were parallel to their classroom practices. Similarly, Roehrig, Kruse and Kern (2007) reported that teachers with student-centred beliefs use more reform-based practices in their classes.

The current research showed that while teachers may have student-centred beliefs, they may adopt a traditional and teacher-centred approach in their classroom practices. For example, T1, T2, T4, T7 and T8. Similarly, considerable research in the literature has reported an inconsistency between teachers' beliefs and their classroom practices (Raymond, 1997; Kılcan, 2006). The reason for the inconsistency between teachers' beliefs and classroom practices may be pressures of the exam system, parents and schools, timing and curriculum, and the teacher's lack of content knowledge and experience. Fang (1996) stated teachers' responses during an interview may sometimes be different from their actual classroom practices. Simmons et al. (1999) also reported that teachers did not include student-centred activities in their practices although they exhibited student-centred instructional beliefs. Although T4 and T6's responses during the interviews indicated beliefs at the transitional level, their classroom practices were observed to be at the traditional level. This may have been due to the difficulty of managing the classroom, and the pressures of the centralized exam system and achievement expectancy (Baştürkmen, 2012).

The inconsistency between the reported beliefs and observed classroom practices of more than half of the teachers may also have resulted from their misconceptions about reform-based practices (Spillane & Zeuli, 1999). Moreover, the teachers may be unaware of this inconsistency, or despite being aware of it, they may prefer to continue using the method with which they feel comfortable (Raymond, 1997).

Although there was considerable inconsistency between the teachers' beliefs and classroom practices, it is known that beliefs are more effective in shaping classroom practices. It should also be noted that, in this study, no direct causal relationship was found between teachers' beliefs and classroom practices.

In light of the findings of the current study, it is clear that further research is needed to elicit the complex relationship between teachers' beliefs and classroom practices. To gain a better understanding of the effect of teachers' experience and content knowledge, and school culture on their classroom practices, future research should also be conducted with larger samples.

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