



## An Investigation of the Role of In-Service Middle School Mathematics Teachers' Epistemological Beliefs for Designing the Learning Environment\*

İlhan Karataş<sup>1</sup>, Nurbanu Yılmaz Tıgılı<sup>2</sup>

*Zonguldak Bülent Ecevir University, Education Faculty of Education, Zonguldak, Turkey*

### ABSTRACT

The aim of the study was to determine the epistemological beliefs of in-service middle school mathematics teachers and to examine the role of these beliefs in designing learning environments. The study is a descriptive study using qualitative research technique. Since the aim of this study is to explain the results of a specific situation, the case study design was used. 14 middle school mathematics teachers with different teaching experiences participated in the study. Semi-structured interviews were used as data collection tools. Interview consisting of seven questions were taken from the study of Luft and Roehrig (2007). The data obtained from the teachers were analysed qualitatively according to the teacher models in the study conducted by Luft and Roehrig (2007). Teacher models were explained in five main themes. Interview data obtained from teachers were analysed according to experience of teachers and models and presented as percentages and frequencies. It was observed that teachers had transitional and teacher-centered epistemological beliefs in general. Moreover, epistemological beliefs of a particular teacher might be different from one question to another within the interview. The results have shown that the curriculum and examination system were one of the most important factors affecting the views and decisions of teachers related with teaching.

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### 1. Introduction

The investigation of epistemological beliefs in the field of education and psychology started with Piaget's research with university students in the 1950s (Hofer and Pintrich, 1997) and Perry in the 1960s (Schommer-Aikins, 2004). Epistemology is a philosophical study that studies the nature and development of knowledge. Personal epistemology or epistemological belief refers to "individuals' beliefs about the nature of knowledge and the processes of knowing" (Hofer and Pintrich, 1997, p. 117). In recent years, there has been an increasing interest in epistemological beliefs in studies in the field of education (Conley, Pintrich, Vekiri, and Harrison, 2004; Gill, Ashton, and Algina, 2004; Luft and Roehrig, 2007).

Epistemological belief is expressed as an individual's belief in the nature of any science (Schraw and Olafson, 2002). It has been stated that teachers' epistemological beliefs affect learning-teaching processes in different ways and they have important effects on the formation of the educational philosophies that teachers have (Biçer, Er and Özel, 2013). A teacher's different belief in learning,

<sup>1</sup> Corresponding author's address: Zonguldak Bülent Ecevir University, Education Faculty of Education, Zonguldak, Turkey  
e-mail: ilhankaratas@beun.edu.tr

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teaching, knowledge or acquisition of knowledge plays an important role in defining the teacher (Chan, 2003). Therefore, it can be said that epistemological beliefs of teachers are effective in shaping the teaching and learning processes.

Epistemological beliefs of mathematics teachers about mathematics are seen as an important determinant in terms of revealing their classroom activities, teaching processes and how they learn to teach (Philippou and Christou, 1999). As studies illustrated, individuals with developed epistemological beliefs have higher academic achievement than individuals with less developed epistemological beliefs. Moreover, individuals with developed epistemological beliefs have more effective learning and teaching methods, and they are more successful in controlling their new knowledge comprehension level. (Hashweh, 1996; Schommer, 1990; Schommer et al., 1992). In addition, many studies examined the relationship between teachers' epistemological beliefs and their classroom practices (Brickhouse 1989; Hashweh, 1996; Kang and Wallace, 2005; Lederman, 1992; Luft, 2001). Studies have shown that teachers' epistemological beliefs affected their teaching practices in the classroom (Hashweh, 1996; Lee, Zhang, Song and Huang, 2013). To illustrate, Hashweh (1996) examined epistemological beliefs of 35 science teachers and the teaching methods they preferred. According to the results of those studies, it was revealed that teachers who have constructivist beliefs perform constructivist behavior. Tsai (2002) also studied with 37 Taiwanese science teachers and categorized teachers' teaching, learning, and science based beliefs as traditional, process, and constructivist. Tsai investigated that most of the teachers had traditional beliefs. Furthermore, it was found that most of the teachers' view of science were closely aligned related with teaching, learning, and science therefore they were called as nested-epistemologies by the researcher. The study suggested that teachers who had more experience in teaching tended to have nested-epistemologies which affected teachers' perceptions related with teaching practices. However, in some studies, it has been argued that the relationship between teachers' beliefs and teaching practices has a more complex structure (Kang and Wallace, 2005; Mellado, 1997). For example, Kang and Wallace (2005) investigated how science teachers' epistemological beliefs and teaching goals are related to their teaching practices, in particular use of lab activities. Based on the results, primary instructional goal of teachers who have naive epistemological beliefs is delivering information and using more demonstrations in order to show-and-tell. In contrast, the teaching practices of teachers with sophisticated epistemological beliefs are rarely predicted by their epistemological beliefs since their practices in actual classroom are affected by several factors of schooling. As Kang and Wallace suggested diverse teaching practices of teachers are synthesized from three different components, namely ontological beliefs, relational aspects of epistemological beliefs, and instructional goals. Furthermore, they declared that epistemological beliefs are multidimensional since different combinations of ontological and relational aspects of epistemological beliefs generate various teaching practices (Hofer, 2000; Kang and Wallace, 2005). In addition, they included that various teaching practices of teachers depend on their perceptions of student needs which stand for their primary goals. Mellado (1997) also stated that teachers' pedagogical views about teaching science and their behavior in the classroom may not show integrity in general. Luft (2001) conducted a study with experienced and novice teachers and she found that, while learning inquiry, novice teachers were more likely to change their beliefs however they are less likely to change their teaching practices. In contrast, experienced teachers were less likely to change their beliefs and more likely to change their teaching practices. As Luft stated, these differences might be resulted from types of beliefs investigated and the central or peripheral nature of beliefs. In their study with pre-service teachers, Cheng, Chan, Tang, and Cheng (2009) also investigated some inconsistencies between epistemological beliefs and conceptions of teaching. As they resulted, pre-service teachers' conceptions of teaching could not always be reflected by their epistemological beliefs. That is, although most of the pre-service teachers with constructivist approach to teaching had sophisticated epistemological beliefs and those who believe in mixed conceptions of teaching (constructivist-traditional) had mixed epistemological beliefs (sophisticated-naive), some inconsistencies were also detected. Brownlee, Purdie, and Boulton-Lewis (2001) stated that these inconsistencies might have been caused by the transition stage of pre-service teachers from naïve to sophisticated beliefs. As they asserted, pre-service

teachers might have been struggling between their pre-existing beliefs and the new information which resulted with confusion and disequilibrium. In a similar way, Kember (1997) stated that teachers' underlying beliefs and observable teaching approaches does not always produce an automatic relationship. As Kember implied, this did not mean that their underlying beliefs have changed. Rather, there might be some situations like being under the pressure to follow a scheduled teaching program. Therefore, teachers might face with conflict between their beliefs in knowledge acquisition and learning and the realities of teaching.

In order to investigate the development of science teachers and examine the effectiveness of teacher education programs, Luft and Roehrig (2007) developed maps to describe and define the beliefs of pre-service, novice in-service and experienced in-service teachers. Researchers had conducted semi-structured interviews with more than 100 pre-service and in-service teachers for five years. Therefore, they developed teacher models in a structural map based on epistemological beliefs of science teachers (See Table 1). Teacher models are explained in five main themes described as traditional teacher model instructive teacher model, transitional teacher model, responsive teacher model, and reform-based teacher modal. Furthermore, based on the categorization of teacher beliefs, researchers provided detailed maps for each interview question they used in their study.

**Table 1.** Teacher Beliefs Interview (TBI) model (Luft and Roehrig, 2007)

	Sub-category	Descriptions
Student-focused	Reform-based	Responses focused on mediating student knowledge or interactions
	Responsive	Responses focused on collaboration, feedback, or knowledge development
Transitional	Cognitive/Affective	Responses focused on teacher/student relationships, subjective decisions, or affective response.
Teacher-focused	Instructive	Responses focused on providing experiences, teacher-focus, or teacher decision.
	Traditional	Responses focused on information, transmission, structure, or sources.

In the literature, it is emphasized that there is a need for studies examining the relationship between beliefs of teachers and classroom practices (Tsai, 2002). In addition, epistemological beliefs of mathematics teachers were also worth studying since the nature of their epistemological beliefs based on their experience level in teaching profession also might contribute to the literature. In this context, the aim of the study is to investigate the nature of epistemological beliefs of in-service middle school mathematics teachers and to examine the role of those beliefs in designing learning environments.

## 2. Methodology

The research was conducted as a descriptive study by using a qualitative research methodology. Brantlinger, Jimenez, Klingner, Pugach, and Richardson (2005) stated qualitative research provides a systematic approach in order to understand qualities, or the nature, of a phenomenon in a particular context. Therefore, a qualitative research methodology was preferred in the current study, in order to explore the epistemological beliefs of in-service mathematics teachers as there are multiple realities but similar forms of reality shared across different groups of individuals (Guba and Lincoln, 1994). Creswell (2007) identified that case study research is one of the types of qualitative research which provides an in-depth analysis and description of *a case* or *multiple cases* over time. Also, case study design provides rich descriptions about contexts by investigating particular cases in their natural settings (Yin, 2009). Since the aim of this study was investigation of a particular situation, the case study design was adopted in the study.

## 2.1. Sample

The sample of the study was constituted by using purposeful sampling methods based on the principle of maximum diversity. With this method, 14 middle school mathematics teachers working in public schools in a district in the Western Black Sea Region were determined in order to have a maximum variety based on their professional experiences.

**Table 2.** Teaching experience of participants

0-5 years	6-10 years	More than 10 years	Total
6	4	4	14

## 2.2. Data collection tool

Within the scope of the study, semi-structured interviews were done by one of the researchers by meeting with the participants in the faculty of education. Interviews were lasted approximately 15-20 minutes with each teacher and each interview was recorded by the researcher by using an audio recorder after the permission of each participant was taken. Interviews consisting of seven questions were taken from the study conducted by Luft and Roehrig (2007) to investigate the beliefs of teachers. Interview questions were as follows: “How do you maximize student learning in your classroom?”, “How do you describe your role as a teacher?”, “How do you know when your students understand? (How do you know whether your students understand the topic or not?)”, “In the school setting, how you decide what to teach and what not to teach (knowledge)”, “How do you decide when to move on to a new topic in your class?”, “How do your students learn mathematics best?” and “How do you know when learning is occurring in your classroom?”.

## 2.3. Data analysis

The data obtained from the teachers were analysed qualitatively according to the Teacher Beliefs Interview (TBI) model within the study of Luft and Roehrig (2007) and results were presented in consideration of the teaching experiences of the teachers. (See Table 1). In addition, the data gathered from the semi-structured interviews were analysed through the detailed maps, including sample teacher views for each category, produced by Luft and Roehrig, 2007) for each interview question. The analysis of answer of Burak for the interview question “How your students learn mathematics best?” is given in Table 3.

**Table 3.** Analysis of Burak’s answer for the interview question “How your students learn mathematics best?”

Category-Subcategory	The answer of Burak
Student-focused (Responsive)	<i>They need to experience mathematics not only in school but also in their daily life (responsive). For example, I teach percentages, when the child goes somewhere he/she has to say that I learned it in school and it will work (responsive). He also needs to do some math.</i>

Burak (pseudonym) highlighted the usage of mathematical knowledge not only in the school but also in daily life (encountering and interpreting the phenomena). Therefore, “they were challenged to create their own understanding to explain their generated data” (Luft and Roehrig, 2007, p. 62). For this reason, his views were coded as student-focused (responsive). The analysis of answer of Çağrı for the interview question “In the school setting, how you decide what to teach and what not to teach?” was given in Table 4.

Çağrı stated that he used guidelines and the curriculum prepared by MoNE. Also, he claimed that he did not decide what to teach and what not to teach. Rather, as he declared, he depended on the curriculum. Therefore, since Çağrı was limited by the curriculum and strictly depended on the book, those views were coded as teacher-focused (traditional).

Analyses of the interviews were done by both of the researchers. Initially, researchers discussed on the coding process and carried out the coding process for the 25% of the data together. Then, remaining

part of the data were coded by two researchers separately. The interrater reliability was calculated about %90. At the end of the analyses, frequencies for each category were determined based on teaching experience of teachers and the categories and sub-categories. A detailed summary of the results of the analyses gathered from the semi-structured interviews were given in the forthcoming section.

**Table 4.** Analysis of Çağrı’s answer for the interview question “In the school setting, how you decide what to teach and what not to teach?”

Category-Subcategory	The answer of Çağrı
Teacher-focused (Traditional)	<i>There are guidebooks of Ministry of National Education (MoNE). We already have lesson plans, therefore our teaching plans are also ready (traditional). In the past, there were more guidebooks but now they are not used gradually. Therefore, teaching plans need to be done. There are also curriculum, if you follow them, you can decide which concepts will be given and which concepts will not be given. I do not decide whether or not a concept will be taught specifically. Therefore, I usually follow the curriculum_(traditional).</i>

### 3. Results

In this chapter, the results of the analysis of the data captured from the semi-structured interviews were given. The analysis were conducted based on the framework of Luft and Roehrig (2007), namely Teacher Beliefs Interview (TBI) model, in order to investigate the role of epistemological beliefs of in-service mathematics teachers on designing the learning environment. The answers of teachers for interview questions were analysed by the use of descriptive analysis and the results were given separately for each interview question.

**Table 5.** The results of the first interview question (How do you maximize student learning in your classroom?)

Professional experience	Teacher-focused			Student-focused	
	Traditional	Instructive	Transitional	Responsive	Reform-based
0-5 years		1	4	1	
6-10 years		2	2		
More than 10 years	3		1		

Based on the analysis of the answers of teachers for the first interview question, the statements of 6 teachers were coded as teacher-focused, 7 teachers were coded as transitional, and merely the statement of 1 teacher was coded as student-focused (See Table 1). Some of the answers of teachers given to the first interview question were summarized in Table 6.

**Table 6.** Samples of the answers of teachers for the first interview question and categorization of them based on the teacher belief inventory

Teacher	Professional experience	Category-Subcategory	Samples to teachers’ answers
Derya	more than 10 years	Teacher-focused-Traditional	<i>“First of all, I come to classroom providently. If a teacher comes to classroom not preparing well for the teaching, the performance of him will be poor. And, he loses favor of students. A teacher should plan the instruction before the lecture and should come with the materials to the classroom.”</i>
Murat	6-10 years	Transitional	<i>“I have students prepare the course materials themselves in order to get learning permanent. Also, I want to make students active participants of the courses. For example, by doing homework.”</i>
Ahmet	0-5 years	Student-focused-Responsive	<i>“I get students achieve the goal. That is, I use the discovery learning technique. Also, I have students make transition of information to each other by doing group working.”</i>

As Derya explained the teachers as the source of the information and as he expressed that the information should be given to students in a planned and structured way, the answer of him was coded

as *traditional* subcategory of teacher-focused category. Also, Murat identified that he used some methods in order to get students active in the learning environment. For this reason, the answer of him was coded as *transitional* subcategory. The expression of Ahmet was coded as *responsive* since she encourages the interaction of students by doing group working and since she thought that knowledge was a phenomenon which can be discovered and developed by students also rather than just transferred from teacher to students.

The analysis for the second interview question “How do you describe your role as a teacher?” is given in Table 7.

**Table 7.** The results of the second interview question (“How do you describe your role as a teacher?”)

Professional experience	Teacher-focused			Student-focused	
	Traditional	Instructive	Transitional	Responsive	Reform-based
0-5 years		3	2	1	
6-10 years			3	1	
More than 10 years	2		2		

The analysis of the answers of teachers for the second interview question showed that the statements of 4 teachers were coded as teacher-focused, 7 teachers were coded as transitional, and merely the statements of 2 teachers were coded as student-focused (See Table 8). Some of the answers of teachers given to the first interview question were summarized in Table 8.

**Table 8.** Samples of the answers of teachers for the second interview question and categorization of them based on the teacher belief inventory

Teacher	Professional experience	Category-Subcategory	Samples to teachers' answers
Derya	more than 10 years	Teacher-focused-Traditional	“A teacher should be the leader of the classroom. Students should be active in the classroom, but the teacher certainly must establish the classroom management.”
Tarik	0-5 years	Transitional	“I see myself as a counsellor teacher. I can stand a directive role in the classroom since we have more knowledge than students.”
Kemal	0-5 years	Student-focused-Responsive	“The role of the teacher is a director or guider in order to get students discover in modern education system. We get students conceptualize and discover the phenomenon by presenting them a concept through the use of examples and problems. That is, we get students discover, rather than explaining the concept. We may say that there is learning here rather than teaching.”
Murat	6-10 years	Student-focused-Responsive	“I try to get students active participants of the classroom rather than doing a direct teaching. For this reason, I get students be aware of which objectives will be done in the following lecture, therefore they come to the classroom in a more well-prepared way.”

Since Derya focused on the role of the teacher as a leader and focuses on the management of the classroom as a routine that should be held by the teacher, the expression of her was coded as *traditional* subcategory of teacher-focused category. As Tarik focused on the relationship of him as a teacher with his students and he identified himself as a counsellor in the classroom, the answer of him was coded as *transitional*. Kemal also stressed the role of a teacher as a counsellor in the classroom. However, he also stressed the importance of getting students learn by the use of different methods by making students active participants of the learning process. Therefore, the expression of Kemal was coded as *responsive*. Similarly Murat points out the importance of getting students active participants of the classroom and he also tried to get students responsible for their own learning by sharing with them the objectives of the following lectures. Therefore, the answer of Murat was also coded as *responsive*. Next, the analysis for the third interview question “How do you know when your students understand?” was given in Table 9.

**Table 9.** The results of the third interview question (How do you know when your students understand?)

Professional experience	Teacher-focused			Student-focused	
	Traditional	Instructive	Transitional	Responsive	Reform-based
0-5 years		2	1	1	2
6-10 years	1	1	2		
More than 10 years		4			

The analysis of the answers of teachers for the third interview question showed that the statements of 9 teachers were coded as teacher-focused, the answers of 2 teachers were coded as transitional, and the answers of 3 teachers were coded as student-focused (See Table 5). Some of the expressions given by the teachers for the third interview question were presented in Table 10.

**Table 10.** Samples of the answers of teachers for the third interview question and categorization of them based on the teacher belief inventory

Teacher	Professional experience	Category-Subcategory	Samples to teachers' answers
Bulut	More than 10 years	Teacher-focused-Instructive	<i>"I ask questions to students. Then, I walk around the classroom to see whether or not they can solve the questions. If they cannot understand, I ask one more question for them."</i>
Elif	0-5 years	Transitional	<i>"I can see whether a student understand or not by looking at their eyes. If they give me a blank stare, I consider that they do not understand. Also, we may understand it whether they are willing to solve the questions written on the blackboard."</i>
Kemal	0-5 years	Student-focused-Reform-based	<i>"When a student understands the concept, they ask the correct question at the right point since all the concepts are related with each other. They pose questions related with the following topics... Also, we can see it by giving students unfamiliar examples. We may also understand it by investigating the solutions of students and their works."</i>

As Bulut stated that he checked whether students can solve the questions after he taught the topic, the expression of him was coded as *traditional* subcategory of teacher-focused category. That is, the teacher analyses how students demonstrated what they have learnt. The statement of Elif was labelled as *transitional* since she was interested in students' affective reactions in order to understand whether they understand. Lastly, the expression of Kemal was coded as reform-based sub-category of student-focused category since he focused on how students apply their knowledge in a novel or unfamiliar situation. Moreover, he stressed out the importance of students questions for understanding of their understanding of the concept. The following table gave the analysis of the answers of fourth interview question "In the school setting, how you decide what to teach and what not to teach?" was given in Table 11.

**Table 11.** The results of the fourth interview question (In the school setting, how you decide what to teach and what not to teach?)

Professional experience	Teacher-focused			Student-focused	
	Traditional	Instructive	Transitional	Responsive	Reform-based
0-5 years	3		2	1	
6-10 years	1	2	1		
More than 10 years	1	1	2		

According to the analysis of the answers for the fourth interview question, the statements of 9 teachers were coded as teacher-focused, 2 teachers were coded as transitional, and 3 teachers were coded as student-focused (See Table 11). Some of the expressions identified by the teachers for the fourth interview question are demonstrated in Table 12.

**Table 12.** Samples of the answers of teachers for the fourth interview question and categorization of them based on the teacher belief inventory

Teacher	Professional experience	Category-Subcategory	Samples to teachers' answers
Derya	More than 10 years	Teacher-focused-Instructive	"We teach based on the curriculum and textbooks. We have one hour group working with our colleagues for each week. We discussed on how many hours we spent on each topic and on which topics we should put more emphasis."
Burak	0-5 years	Transitional	"First, I analyse our curriculum, and then explore the characteristics of the classroom...sometimes, it is more appropriate to teach the topic in a simpler way by adapting it to the students. In some classes, we may not teach all of the concepts whereas we may teach all the concepts in another classroom based on students' levels."
Murat	5-10 years	Responsive	"To illustrate, I change the order of the patterns and algebraic expressions topics. Therefore, students could learn better since the topic of algebraic expressions already exists in the topic of patterns. That is, in order to find the rule of a pattern, a student should know the concept of algebraic expression."

Since Derya stated that they took into consideration the decisions of teachers while deciding on the teaching plan, her statement was coded as *instructive* subcategory of teacher-focused category. Secondly, Burak was focused on the ability levels of students while deciding on the teaching plan in addition to the curriculum. Therefore, the expression of Burak was coded as *transitional*. Lastly, as Murat changed the order of topics based on his experiences and students' knowledge, he made his decision based on student feedback and other possible factors. For this reason, the expression of the teacher was coded as *responsive* sub-category of student-focused category. Next, the analyses of the answers of teachers for the fifth question "How do you decide when to move on to a new topic in your class?" was given in Table 13.

**Table 13.** The results of the fifth interview question "How do you decide when to move on to a new topic in your class?"

Professional experience	Teacher-focused		Student-focused		
	Traditional	Instructive	Transitional	Responsive	Reform-based
0-5 years		4	2		
6-10 years		2	2		
More than 10 years		4			

The analysis of the answers for the fifth interview question showed that the statements of 10 teachers were coded as teacher-focused and 4 teachers were coded as transitional. There were no teachers whose statements were coded as student-focused (see Table 13). Some of the expressions identified by the teachers for the fifth interview question were illustrated in Table 14.

Murat stated that he conduct tests and in-class activities at the end of the unit in order to decide to move on a new topic. Therefore, his statement was coded as *instructive* subcategory of teacher-focused category. Since Kemal took into consideration the feedback gathered from students in order to move on a new topic, his expression was coded as *transitional*. Similarly, Bulut also took into consideration the feedback gathered from students in order to move on a new topic; therefore his expression was also coded as *transitional*.



**Table 14.** Samples of the answers of teachers for the fifth interview question and categorization of them based on the teacher belief inventory

Teacher	Professional experience	Category-Subcategory	Samples to teachers' answers
Murat	5-10 years	Teacher-focused-Instructive	<i>"We conduct tests for assessment of objectives and do in-class activities at the end of the units."</i>
Kemal	0-5 years	Transitional	<i>"Making extension or shortage in time changes based on the students. If students learn fast, we do not extend the learning time. Rather, we teach the topic deeply."</i>
Bulut	More than 10 years	Transitional	<i>"After teaching the topic, I ask questions to students. I think if successful students cannot solve the question, then I decide that the topic cannot be understood well. That is, if successful ones cannot do it, others already become unsuccessful. Also, I conduct 10-15 minutes short examinations to students."</i>

**Table 15.** The results of the sixth interview question "How do your students learn mathematics best?"

Professional experience	Teacher-focused			Student-focused	
	Traditional	Instructive	Transitional	Responsive	Reform-based
0-5 years		2	1	2	1
6-10 years		1	2		1
More than 10 years		2	2		

The analysis of the answers for the sixth interview question presented that the statements of 5 teachers were coded as teacher-focused and 5 teachers were coded as transitional. There are 4 teachers whose statements were coded as student-focused (See Table 15). Some of the expressions identified by the teachers for the sixth interview question were illustrated in Table 16.

**Table 16.** Samples of the answers of teachers for the sixth interview question and categorization of them based on the teacher belief inventory

Teacher	Professional experience	Category-Subcategory	Samples to teachers' answers
Derya	More than 10 years	Teacher-focused-Instructive	<i>"They should solve problems. Also, students should study more by taking extra courses and solving questions."</i>
Kemal	0-5 years	Student-focused-Responsive	<i>"Each student has a different learning procedure. By restricting students, we decrease the learning of successful students and we make unsuccessful students learn nothing. Nowadays, we focus on a test-based teaching; therefore we make students solve more and more questions. That is, we solve several problems and focus on different types of examples. However, at the end, students cannot answer completely when we get them explain for example the meaning of "line"? They do not know the meaning of concepts and the problem goes on even at university."</i>
Çağrı	0-5 years	Student-focused-Reform-based	<i>"Children learn best when they are active participants of learning procedure. Also, they do not like learning by a unique teaching method. For example, they are more interested on the topic when the teaching is done by games, by videos on smart board, or by using materials. Moreover, projects are also an opportunity for learning. They learn concretely when you ask students "I want you to complete such a project, do you study or do you like to study on this topic?"</i>

As Derya declared that she make her students solve problems by conducting extra studies, her statement was coded as *instructive* subcategory of teacher-focused category. Kemal explained different

types of teaching activities and the problem of students' lack of conceptual understanding, his statement was coded as *responsive* sub-category of *student-focused* category. Similarly, Çaǧrı took into consideration the importance of students' ownership over their learning. He mentioned different types of methods for teaching mathematics and highlight the importance of students' being active participants of learning and teaching process. Therefore, his expression was coded as *reform-based* sub-category of *student-focused* category.

**Table 17.** The results of the seventh interview question "How do you know when learning is occurring in your classroom?"

Professional experience	Teacher-focused			Student-focused	
	Traditional	Instructive	Transitional	Responsive	Reform-based
0-5 years		4	1		1
6-10 years		2	1		1
More than 10 years		4			

Based on the analysis of the answers of teachers for the seventh interview question illustrates that the statements of 11 teachers were coded as teacher-focused, 1 teacher was coded as transitional, and the statements of 2 teachers were coded as student-focused (See Table 17). Some of the answers of teachers given to the first interview question were summarized in Table 18.

**Table 18.** Samples of the answers of teachers for the seventh interview question and categorization of them based on the teacher belief inventory

Teacher	Professional experience	Category-Subcategory	Samples to teachers' answers
Bulut	More than 10 years	Teacher-focused-Instructive	<i>By conducting quizzes and tests, I can see that learning occurs. Also, you may conclude that learning is occurred if students can give correct answers for most of the questions.</i>
Firat	0-5 years	Transitional	<i>"I decide that learning is occurred when most of the students hands up in the classroom."</i>
Murat	5-10 years	Student-focused-Reform-based	<i>"I see it by the help of students' questions or their answers for given questions. If a student understands the topic, he/she asks questions about the forthcoming topic before we teach it. Also, we get students responsible for each other by making them groups of 4 or 5. In these groups students are responsible for the home works of each other, especially the successful ones. Therefore, their interaction and cooperation become increased and also homeworks of all students are being controlled."</i>
Kemal	0-5 years	Student-focused-Reform-based	<i>"Sometimes, a student asks a question and you see that he/she has understood the concept and ready for learning the forthcoming topic. We may understand it by investigating the answers for our questions or the questions posed by the students."</i>

Bulut stated that he conduct quizzes and tests. If students could give correct answers for most of the questions, he would understand that learning occurs. For this reason, his statement was coded as *instructive* subcategory of teacher-focused category. As Firat stated that learning occurs when most of the student hands up, his expression was coded as *transitional*. Murat declared that he decide on the understanding of students by looking their questions and by making them responsible for their works. Therefore, his expression was coded as *reform-based* sub-category of *student-focused* category. Similarly, Kemal stated the answers or questions of students are indicators for understanding learning of students. Therefore, the statement of Kemal was also coded as *reform-based* sub-category of *student-focused* category (See Table 18).

Results showed that most of the in-service teachers gave generally *instructive* (*teacher-centered*) and *transitional* responses. Analysis of the results illustrated that in-service teachers with more than 10 years experience gave no student-focused response while the others gave rarely. Moreover, we could see

traditional responses for each teaching experience category, not only from the responses of experienced teachers but also from the less experienced ones. Based on the analysis of the second interview question *"how do you describe your role as a teacher?"* most of the answers were coded as transitional for all teaching experience categories. In addition, teachers' responses were mostly teacher-centered with respect to the questions of *"how do you decide what to teach and what not to teach?"* and *"how do you decide when to move on to a new topic in your class?"* Results showed that in-service teachers gave mostly teacher-centered responses for the question of *"how do you know when learning is occurring in your classroom?"* whereas they gave different types of answers for the question of *how do your students learn science best?"* That is, they used generally a teacher-focused method for understanding the learning of students although they gave different types of responses (teacher-centered, transitional, and student-centered) related with how they learn best.

Based on the analysis of the answers of a particular teacher for different questions in the interview, it was explored that teachers' answers for different questions might have been placed to different categories of the Teacher Beliefs Interview (TBI) model. For example, the answer of a teacher for the third interview question might have been coded as traditional while the fifth one might have been coded as reform-based. There were no teacher whose answers were coded as the same category for the interview questions. However, it was observed that if one of the answers of teachers with teaching experience of more than 10 years was coded as traditional or instructive, remaining parts were also in a similar manner. Moreover, it is investigated that teachers were likely to give such answers which were coded as transitional, responsive, or reform based to the questions related with students learning such as *"how do your students learn science best?"* and *"how do you know when learning is occurring in your classroom?"*. On the contrary, teachers usually gave answers which were coded as traditional or instructive to the questions related with their teaching such as *"how do you decide what to teach and what not to teach?"* and *"how do you decide when to move on to a new topic in your class?"*. Lastly, it is observed that teachers answers for the remaining questions usually might have been predicted by the answers given to the question of *"how do you describe your role as a teacher?"*. If a teacher gave such an answer for this question, in 'traditional or instructive' category, other answers of the teacher were also in traditional, instructive, and transitional categories. In contrast, if a teacher expressed an answer for that question, in 'transitional or responsive' category, the remaining answers were coded as transitional, responsive, or reform-based. Therefore, the answers given to that question might have been accepted as a precursor for the remaining questions. In the next section, a detailed analysis and interpretation of the responses of teachers will be done based on Teacher Beliefs Interview (TBI) model.

#### **4. Discussion and Conclusion**

As the results of the analysis showed, epistemological beliefs of teachers presented various clues about teachers' views on learning of students and teaching mathematics. In the current study, which examined the role of in-service middle school teachers' epistemological beliefs in designing learning environments, it was determined that novice teachers reflected more transitional and student-centred beliefs, based on their descriptions of the teachers' role in the classroom, while teachers with more than 10 years teaching experience had teacher-centered epistemological beliefs in general.

Teachers' answers to the questions related with learning of students, such as *"how do your students learn science best?"*, were mostly categorized into transitional or student-focused categories whereas, when it comes to teaching related question such as *"how do you know when learning is occurring in your classroom?"* the answers of the teachers were categorized into teacher-focused or transitional categories. Although both of questions were related with the learning of students, the first one was asking about students' learning while the second one was asking about the conceptions of teachers about students' learning. This conflict might be caused by either the factors related with the teachers themselves or the extrinsic factors affecting teachers. Participants of the current study stated that the pressure to carry out a scheduled teaching program in a limited time and being opposed to an examination system were the main reasons for conducting such a teacher-focused education, as Kember (1997) expressed this the conflict between beliefs of teachers in knowledge acquisition and learning and the realities of teaching.

Similar to the study of Tsai (2002), teachers were usually likely to express traditional (teacher-focused) epistemological beliefs. However, teachers' beliefs based on learning and teaching, were not closely aligned which were mentioned as nested epistemologies in the study of Tsai (2002). Therefore, the current study also supported that the relationship between teachers' beliefs and teaching practices has a more complex structure.

Teachers who have teacher-focused epistemological beliefs had such instructional goals, delivering information and using more examples and problems. On the contrary, the instructional goals of teachers with transitional or student-focused epistemological beliefs were rarely predicted by their epistemological beliefs since there were several factors affecting their decisions. This result was in a similar manner with the study of Kang and Wallace (2005) which investigated the instructional goals of teachers with naive and sophisticated beliefs.

In their study with pre-service teachers, Cheng, Chan, Tang, and Cheng (2009) also investigated some inconsistencies between epistemological beliefs and conceptions of teaching. As they resulted, pre-service teachers' conceptions of teaching could not always be reflected by their epistemological beliefs. That is, although most of the pre-service teachers with constructivist approach to teaching had sophisticated epistemological beliefs and those who believe in mixed conceptions of teaching (constructivist-traditional) had mixed epistemological beliefs (sophisticated-naive), some inconsistencies were also detected. Brownlee, Purdie, and Boulton-Lewis (2001) stated that these inconsistencies might have been caused by the transition stage of pre-service teachers from naive to sophisticated beliefs. As they asserted, pre-service teachers might have been struggling between their pre-existing beliefs and the new information which resulted with confusion and disequilibrium. In a similar way, Kember (1997) stated that teachers' underlying beliefs and observable teaching approaches does not always produce an automatic relationship. As Kember implied, this did not mean that their underlying beliefs have changed. Rather, there might be some situations like being under the pressure to follow a scheduled teaching program. Therefore, teachers might face with conflict between their beliefs in knowledge acquisition and learning and the realities of teaching. Moreover, the teachers who were new to the profession displayed such beliefs that gathering student feedback was important while designing the learning environment. As Olapson and Schraw (2006) were also declared, such views which were taking into consideration the views of students while planning instruction were observed on novice teachers in general.

Finally, although there were some exceptions, we observed that teaching experience was one of the precursors of epistemological beliefs of in-service middle school mathematics teachers. Furthermore, epistemological beliefs of teachers had a complex nature. Therefore, a teacher could have different types of epistemological beliefs related with different aspects of education. In summary, considering the results obtained from the current study, further studies could be conducted in order to unpack the underlying reasons of having different types of epistemological beliefs and their educational outcomes.

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