An Investigation of Pre-service Middle School Mathematics Teachers' Discussion Skills in the Context of Microteaching Lesson Study

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Abstract: High quality discussions can enable students to understand complex mathematical concepts (Smith & Stein, 2011). Effective mathematics discussions occur when teachers engage the listening, thinking, inquiring, and applying skills of their students (Lobato, Clark & Ellis, 2005; NCTM, 1991). Studies show, however, that teachers face many challenges in orchestrating mathematics discussions (Stein, Engle, Smith & Hughes, 2008). Novice teachers, in particular, struggle to coach their students through the discussion process (Chazen, 2000; Wood & Turner-Vorbeck, 2001). Therefore, the study found that orchestrating mathematics discussions is a skill that pre-service teachers should be encouraged to develop. The aim of this study was to develop pre-service middle school mathematics teachers' mathematical discussion skills in the context of microteaching lesson study. Three senior pre-service teachers participated in and implemented three microteaching lesson study cycles. Data was obtained from lesson plans prepared by pre-service teachers, video recordings, observations, and field notes. Data was examined based on Smith and Stein's (2011) method of orchestrating productive mathematical discussions via anticipating, monitoring, selecting, sequencing, and connecting. Results showed that as microteaching lesson study proceed, pre-service teachers acquired skills about anticipate student thinking and select students' purposeful answers. In addition to that, pre-service teachers began successfully sequencing student thoughts and connecting important points related to big ideas.

Keywords: Discussion skills, Lesson study, Pre-service teachers

Introduction

The existing research emphasizes the importance of social interaction in learning knowledge and skills (Vygotsky, 1978; Lave & Wenger 1991). Learning environments based on social interaction mediate learning because it allows individuals to share their thoughts and see different ideas (Murphy, Wilkinson, Soter, Hennessey & Alexander, 2009; Piaget, 1928; Vygotsky 1978). One of the environments where social interaction is most intense in the learning process is discussion environments (Kelly & Stafford, 1993; LikhulailaNasution, 2017; Rasmussen, 1984). Discussion environments are distinguished from everyday conversations with their unique features (Chazan & Ball, 1999; Manouchehri & St. John, 2006; Sfard, Nesher, Streefland, Cobb & Mason, 1998). A mathematical discussion environment offers various opportunities for students to share their ideas, to think deeply about the arguments they defend and to evaluate these arguments from different perspectives (NCTM, 2000; 2014; Wood, 1999). It is argued that these discussion environments are one of the criteria required for the realization of effective learning (NCTM, 2000; 2014). Mathematical discussion is not just a conversation; students defend their mathematical ideas and also evaluate different ideas through a filter of reasoning. This whole process provides information about what students learn and how they learn in relation to mathematics (NCTM, 2007; 2014).

Discussion environments provide numerous benefits for both teachers and students. Students deepen their knowledge and exchange ideas with their peers (Stiles, 2016). These discussion environments also allow them to create arguments, test these arguments with their peers and make sense of these arguments (Alwarsh, 2018; Hattie, Fisher & Frey, 2017; NCTM, 2000; National Governors Association Center for Best Practices & Council

of Chief State School Officers [CCSSM], 2010; National Research Council, 2001). This supports their conceptual learning (Cobb, Boufi, McClain & Whitenack, 1997; Hatano, & Inagaki, 1991; Kazemi & Stipek, 2001; Manouchehri, 2007; Manouchehri & St. John, 2006, Michales, O' Connor & Resnick, 2008; Nathan & Knuth, 2003). Teachers gain important insights about the effectiveness of the learning process while working with their students on tasks by observing and interacting with them (Smith & Stein, 2011; Stiles, 2016). In fact, when the curriculum is evaluated, it can be said that emphasis is placed on the importance of discussion environments in the teaching process (MoNE, 2018). These positive contributions of the mathematical discussion environments in the teaching process have attracted the attention of researchers and have given rise to the need of defining which components these environments include (Smith & Stein, 2011). Stein et. al (2008) stated that a successful mathematical discussion environment passes through 5 main processes. It is stated that these processes are anticipating, monitoring, selecting, sequencing and connecting. Anticipating involves the teacher's ability to predict different solutions to a mathematical task. It involves the teacher's anticipating knowledge and skills such as how students will make sense of the task, how they will solve it, which strategies they will use, how they will interpret it and which ideas they will generate. Monitoring involves having a close look at; that is, considering students' mathematical thinking and solution strategies they use while working. One way of doing this is to observe students individually or in small groups. In the advanced steps of the monitoring process, the teacher can formulate the students' strategies before starting the lesson. What is remarkable here is that monitoring is more than watching and hearing. In the meantime, the teacher needs to ask questions to be able to reveal and classify students' thoughts. Selecting involves the teacher's selecting the student's important thoughts. These ideas are a precursor to the objectives intended to be achieved. In the sequencing stage, the purposefully selected student answers are sequenced by the teacher. In the connecting stage, the teacher directs students towards establishing connections between their solutions and establishing meaningful relationships between mathematical ideas. In this process, the teacher helps students to take decisions by providing different approaches to the problem solutions that are dealt with. Effective discussions allow students to solve the problem accurately and effectively. The critical role assumed by the teacher from the preparatory process to the end of the discussion also largely determines the quality of the mathematical discussion because the teacher determines which task is suitable for starting a discussion. This task should include higher order thinking skills, enable a solution with multiple strategies and support conceptual understanding of mathematics (Smith & Stein, 1998; Smith & Piggott, 2007; Jackson, Shahan, Gibbons & Cobb, 2012). The open-ended questions to be asked during the discussion process enhance the discussion as well as revealing students' thoughts (Boaler & Brodie, 2004; Kazemi & Stipek, 2001). In this context, the importance of developing teachers' knowledge and skills about mathematical discussion is once again revealed (Young, 2015). However, research has shown that teachers, especially novice teachers, have difficulty in creating and maintaining mathematical discussion environments (Bennett, 2010; Stein et al., 2008). Thus, various teacher training programs should be designed to support teachers and pre-service teachers' development (Garet, Porter, Desimone, Birman & Yoon, 2001). One of these training programs is the lesson study model (Stigler & Hiebert, 1999). In addition to some of its characteristics such as being cooperation-based and a great emphasis put on practice, the lesson study method also aims at life-long learning and holistic development, which makes it a reform in teacher training (Lee, 2008; Murata, 2010; Robinson & Leikin, 2012). Thus, in the current study, it is aimed to develop the pre-service middle school mathematics teachers' discussion skills through the micro-teaching lesson study.

Method

The current study employed the case study design, one of the qualitative methods. The case study design makes it possible to gather in-depth information about the case of interest and to explore the research questions from every aspect of it (Merriam, 2009). The participants of the current study are three senior students attending a state university in the city of Ankara. These three pre-service teachers participated in three micro-teaching study applications. In figure 1, the teacher training program process is defined. The pre-service teachers prepared the lesson plan in a group; this lesson plan was implemented by one of the pre-service teachers in the group in the university classroom environment. During the implementation, the other pre-service teachers took observation notes. After the completion of the implementation, the lesson was evaluated by the researcher, an expert and the other pre-service teachers.
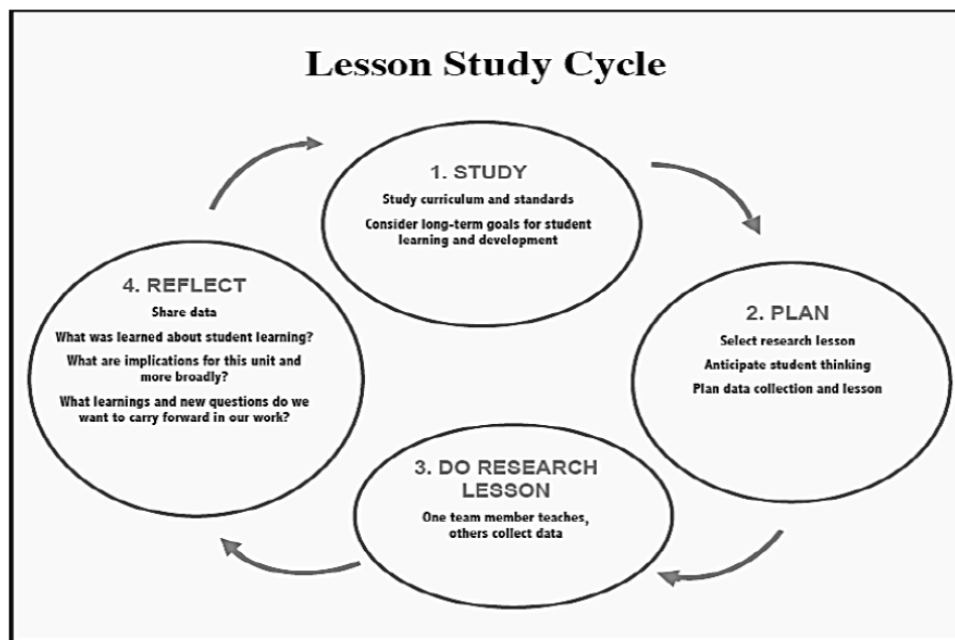
Figure 1. Lesson study cycle adapted from Lewis (2008)

The pre-service teachers conducted activities to address the 7th grade course objectives "Form the pie chart of a data set and then interpret it", "Form the line chart of the data and then interpret it", and "Depending on the type of the data collected for the research questions, select a pie chart, frequency table, bar chart or line chart to display the data and then make conversions from one chart type to another chart type", respectively (MoNE, 2018). As the data collection tools, the lesson plans prepared by the pre-service teachers, video-recordings of the lessons delivered by the pre-service teachers, observations and field notes were used. While analysing the collected data, the descriptive analysis method was employed and the data were analyzed on the basis of the Anticipating, Monitoring, Selecting, Sequencing and Connecting components used by Smith and Stein (2011). The collected data were examined in terms of the number and content of the discussions.

Results and Discussion

In the current study, it was aimed to develop the discussion skills of the pre-service math teachers by means of the micro-teaching lesson study method. To this end, the collected data were analyzed in terms of the number and content of the discussions. When the data were evaluated in terms of the number of the discussions developed by the pre-service teachers, it was found that at first they were inadequate in forming the discussion environment; yet, then in the advanced stages of the process they paid greater attention to forming the discussion environment. The number of the discussion environments created by the pre-service teachers is shown in Table 1.

Tablo 1. The number of the discussions conducted by the pre-service teachers throughout the micro-teaching lesson study

	1st Micro lesson study	2nd Micro lesson study	3rd Micro lesson study
The number of the discussions	3	4	7

As can be seen in Table 1, the number of the discussion environments created by the pre-service teachers increased in the second and particularly in the third micro lesson studies. When compared to the second and third lesson study cycles, it is clear that the pre-service teachers had difficulty in creating discussion environments in the first lesson study cycle. Moreover, the discussion environments formed by the pre-service teachers were inadequate in terms of including the processes they were expected to have. For instance, it was

observed that the pre-service teacher could not establish a discussion environment in the first micro-teaching lesson study (see the 1st Micro lesson study teaching)

1st Micro lesson study implementation
"…
Student: Teacher, why do we draw a pie chart; we have already known the bar chart.
*Gamze: Yes, we know the bar chart. **A different type of display."***

Here, it is seen that the pre-service teachers could not create a discussion environment and were inadequate in anticipating questions to ask. This prevented the pre-service teacher from establishing a discussion environment. However, in the second lesson study application, it was observed that the pre-service teachers increased their knowledge and skills in anticipating students' answers and thoughts and they reflected this into discussion environments. In addition, they were found to be successful in performing monitoring and selecting stages while they had difficulties in the stages of sequencing and connecting (see the 2nd Micro lesson study teaching)

2nd Micro lesson study implementation
"……
*Şirin: **Why do you think we did these connections (points of change)?***
Student: Did we do it to see, teacher? That is, it seems to have decreased like this or to have increased as well
*Şirin: **Yes, we can see the increase and decrease more easily in this way, can't we? From Monday to Tuesday, for example, it decreased in you** [Shows the activity of this group]*
*Student: **It can also be shown in a bar, so why are we drawing it?***
*Şirin: **Yes, then we could talk about it later…."***

Here it is seen that the pre-service teacher could start a discussion on a point in which she expected her students to experience difficulties, could address important points by observing the students' works yet couldn't perform the stages of sequencing and connecting. In the last micro-teaching lesson study, the pre-service teachers were observed to be able to create more discussion environments and to include the expected characteristics in these discussions (see the 3rd Micro lesson study teaching)

3rd Micro lesson study implementation
"….
*Beyza: **Ok, can you give me some examples? If someone gives me such an example, wants this, then I use this graph.***
Student: Teacher, for example, when it is a temperature change or population change, then I can use the line chart.
*Beyza: Hımm. **Only temperature or population? What is the important thing, temperature data or change?***
Student: Change.
*Beyza: **Isn't it, a change of something is wanted to be emphasized.***
…….
*Student: **For instance, if we are all given a frequency table showing the numbers of our siblings, then we can show it in a bar chart.***
*Beyza: **Okay. You can show it in a pie chart.***
Student: We can show.
*Beyza: **Which one do you select and depending on what?***

When the discussion environment presented here is evaluated, it can be said that the pre-service teacher was able to establish a discussion environment in relation to depending on what the suitable graph was selected. In the discussion environment created, it was observed that the pre-service teachers monitored the works of students, selected the emerging answers and then sequenced them. Then, she was observed to be able to connect the important points in determining the suitable type of graph. A similar situation was observed in another notable discussion environment (see 3rd Micro lesson study teaching).

3rd Micro lesson study implementation
"…
*Beyza: **He/she has received a higher number of votes. What is your comment about the 2nd question?***
Student: Teacher, students enjoy the physical education and sports course the most because its line is higher; it is as high as the sum of two courses.
*Beyza: **Okay, what about the percentage, have you found it? What is its ratio?***
Student: 25 percent.
*Beyza: **What else?***

Student: The pie slice of the English course is equal to that of the social studies course.
*Beyza: **Then, what does this mean?***
Student: Equal.
*Beyza: **Okay, what else will you tell?***
Student: We realized that the least liked course is painting. Its pie slice is very small
*Beyza: **In general, do you look at the slice. You are finding the percentages; can you make your comments on the basis of these percentages?***
Student: Yes, the percentage also indicates the slice. As it shows the percentage.

When the discussion environment presented here is evaluated, it is seen that similar to the previous one, the pre-service teacher conducted the discussion on the basis of the students' answers and got the students to think about the important ideas; thus, supported them to establish connections.

Conclusion

It can be argued that the pre-service teachers' participation in the lesson study contributed to the development of their discussion skills. The development of their anticipating skills positively affected the other stages of the discussion process. When the reasons for this development are examined, the specific features of the lesson study approach come to the fore. The pre-service teachers' planning their lessons together and their conducting applications in compliance with their plans provided important insights for the pre-service teachers about what students think, how they will act and what difficulties they will encounter. This allowed them to revise their lesson plans, to implement them again and to reflect what they learned to their classroom environment (Chassels & Melville, 2009; Iksan, Aishah Mohd Nor, Nordiyana Mahmut & Zakaria, 2014; Saito & Sato, 2012). In the literature, similar findings have been reported. Auliah, Anwar and Hardin (2018) conducted a study on the chemistry students at university and found that as a result of the lesson study, the students' communication skills improved. In light of the research findings, it can be suggested that such teacher training programs that can support the development of discussion skills of pre-service teachers should be integrated to undergraduate programs.

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