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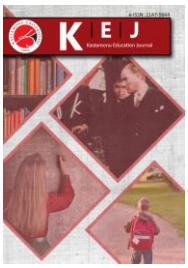

| Research Article / Araştırma Makalesi |

Examining Development Prospective Mathematics Teachers Measurement and Evaluation Knowledge and Curriculum Knowledge through Lesson Study Method

Matematik Öğretmeni Adaylarının Ders İmecesi Yöntemiyle Ölçme-Değerlendirme ve Program Bilgilerinin Gelişiminin İncelenmesi[1]

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Keywords

1. Lesson Study,
2. Measurement - Evaluation Knowledge,
3. Curriculum Knowledge
4. Prospective Teacher

Anahtar Kelimeler

1.Ders İmecesi
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Abstract

Purpose: The purpose of this study is to examine the development of prospective mathematics teachers' knowledge on measurement-evaluation and curriculum through lesson study method.

Design/Methodology/Approach: In this study, a qualitative paradigm was adopted, and among designs, a case study method was used. The participants of the study were five senior students of the Secondary Mathematics Teacher Training program, who had already taken the teaching practice course. The data of the study were collected within a teaching practice course. In this process, observation and semi-structured interviews were done, and descriptive analysis techniques were used for the analysis of the data. Observations were used to collect data related to measurement and evaluation knowledge the observation form developed by Gökkurt (2014) and were to collect data related to curriculum knowledge the observation form developed by Şahin and Soylu (2017). Semi-structured interviews with prospective teachers as for were done upon the effectiveness, usability, etc. of lesson study method.

Findings: When the data were analyzed, it was seen that the measurement - evaluation knowledge and curriculum knowledge of the prospective teachers were developed by the of the lesson study method. When interviews with prospective teachers were examined, it was observed that they were aware of this. When the explanations of the prospective teachers were examined, it was seen that discussions made in the process of lesson planning, discussions and evaluations during the evaluation of the applications after observation made a contribution to their pedagogical knowledge.

Highlights: Measurement - Evaluation Knowledge and Curriculum Knowledge are significant due to the role of instruction. With this study, it is provided to develop this two pieces of information which have important roles in the development of pedagogical knowledge of prospective teachers. This situation is important for the prospective teachers to perform the appropriate teaching to learning outcome in the program and also to develop the skills of measuring and evaluating to the extent that the program predicts. This study, carried in real life context, provides valid and reliable results

Öz

Çalışmanın amacı: Bu çalışmanın amacı matematik öğretmeni adaylarının ölçme – değerlendirme ve program(müfredat) bilgilerinin ders imecesi yöntemiyle gelişiminin öğretmenlik uygulaması dersi kapsamında incelenmesidir.

Materyal ve Yöntem: Nitel araştırma yaklaşımının benimsendiği bu çalışmada durum çalışması yöntemi kullanılmıştır. Çalışmanın katılımcılarını ilköğretim matematik öğretmenliği programının, son sınıfta öğrenim gören ve öğretmenlik uygulaması dersini hali hazırda alan 5 öğretmen adayı oluşturmaktadır. Çalışmanın verileri gözlem ve yarı yapılandırılmış mülakat teknikleri ile öğretmenlik uygulaması dersi kapsamında toplanmıştır. Toplanan verilerin analizinde betimsel analiz tekniği kullanılmıştır.

Bulgular: Veriler incelendiğinde öğretmen adaylarının ölçme - değerlendirme ve müfredat bilgilerinin ders imecesi yöntemiyle geliştirildiği görülmüştür. Öğretmen adayları ile yapılan görüşmeler incelendiğinde bunun farkında oldukları görülmüştür. Öğretmen adaylarının açıklamaları incelendiğinde ders planlama sürecinde yapılan tartışmaların, uygulamaların gözlem sonrası değerlendirilmesi sırasında yapılan tartışma ve değerlendirmelerin pedagojik bilgilerine katkı sağladığı görülmüştür.

Önemli Vurgular: Ölçme-değerlendirme ve müfredat bilgisi öğretimin rolü açısından önemlidir. Bu çalışma ile öğretmen adaylarının pedagojik alan bilgisinin gelişiminde önemli roller olan bu iki bilginin gelişimi sağlanmıştır. Bu durum, öğretmen adaylarının programda öğrenme kazanımlarına uygun öğretimi gerçekleştirmeleri ve programın öngördüğü ölçüde ölçme ve değerlendirme becerilerini geliştirmeleri açısından önemlidir. Gerçek hayat bağlamında yürütülen bu çalışma, geçerli ve güvenilir sonuçlar vermektedir.

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INTRODUCTION

Lesson study method can be expressed as a system of teachers' learning which involves basic research processes in which a small group of teachers work in collaboration and aim at solving problems related to teaching, developing educational practices and improving learning (Perez Gomez, Soto Gomez, & Servan Nunez, 2015). A qualified lesson study method includes certain characteristics such as "assisting in improving teaching in the classrooms by developing the teachers' content knowledge and pedagogical content knowledge, providing them with the skills to monitor and analyse students' learning, getting them to develop perspectives, and finally ensuring better student learning" (Fernandez & Yoshida, 2012, p. 141). In the lesson study process, teachers come together, plan a lesson collaboratively so as to ensure effective student learning, implement, observe, and evaluate it, repeat the lesson in its revised form, and collect data in the process in order to understand the role of the lesson in the learning of the students (Murata, 2011; Takahashi, Lewis & Perry, 2013).

Within this context, it has been reported that this method gives teachers the opportunity to observe their colleagues and contributes to their mutual professional development culture and the development of their pedagogical knowledge that plays a role in transferring their special field competence (Akiba & Wilkinson, 2016; Boran & Tarım, 2018; Dotger & Walsh, 2015; Güner & Akyüz, 2017).

One of the fields where the lesson study method is used the most frequently is mathematics education (Fernandez, Cannon & Chokshi, 2003). This situation may be stemming from the fact that mathematics is one of the fields in which students have the most difficulty (Baklacı, 2017; Van de Walle, Karp & Bay-Williams, 2014), and therefore ensuring the professional and pedagogical development of teachers in mathematics teaching is gaining importance each passing day. Within this context, teachers' development in their knowledge of teaching strategies, subject and content, measurement and evaluation, curriculum and understanding the learning process of students occupies an important place in their professional and pedagogical development (An, Kulm, Wu, 2004; Shulman, 1986; Tamir, 1988). In this framework, many models related to the components of pedagogical content knowledge (PCK) have been developed, and these models are summarized as in Table 1 (Gökkurt, 2014).

Table 1. Models developed in relation to the components of pedagogical content knowledge

Researchers	Teaching Knowledge	Purposes knowledge for teaching	Understanding students learning	Curriculum knowledge	Teaching methods and presentation	Evaluation	Content knowledge	Context knowledge	Pedagogical knowledge
Shulman (1987)			X		X				
Tamir (1988)			X	X	X	X			
Smith and Neale (1989)		X	X		X				
Marks (1990)			X	X	X		X		
Grossman (1990)		X	X	X	X				
Cochran et al. (1993)			X				X	X	X
Geddis (1993)			X	X	X				
Fernandez-Balboa and Stiehl (1995		X	X		X		X	X	
Gokbulut (2010) as cited in Tuan (1996)			X	X	X		X	X	
Magnusson et al. (1999)		X	X	X	X				
Carlsen (1999)		X	X	X	X				
Hashweh (2005)		X	X	X	X	X	X	X	X
An. Kulm and Wu (2004)	X			X			X		
Loughran et al. (2006)		X	X		X		X	X	X
Kaya (2009)			X	X	X	X	X		
Gokbulut (2010)			X	X	X		X		

When Table 1 was examined, it was seen that researchers examined different components of PFK. In this context, Shulman (1987) stated in the model he developed that the pedagogical content knowledge had two key components. One of these components is the knowledge of understanding student learning (knowledge of understanding students), and the other one is the knowledge of teaching strategies (teaching presentation knowledge). Tamir (1988) expanded this model expressed by Shulman (1987) and added curriculum knowledge and evaluation knowledge to PFK. In the model developed by Smith and Neale (1989), a content knowledge component was included for the first time. When the models developed for PFK by other researchers were examined, it was seen that they actually mentioned similar components, and that the names for some components were expressed differently by various researchers. Still, a skeletal structure was formed for PFK.

It has been emphasized that these knowledge types included in the pedagogical content knowledge are related to the experience gained by the teacher while teaching a certain subject again and again, and that they do not develop by studying with

traditional methods (Hashweh, 2006). Therefore, using appropriate methods such as lesson study methods that lend themselves to gaining experience by teaching repeatedly is effective in terms of development of these knowledge types (Ni Shuilleabhain, 2016). When studies conducted on this issue were examined, it was found that regarding the pedagogical content knowledge, mostly teaching strategies knowledge, understanding student learning knowledge, and subject/content knowledge were emphasized (Csíkos & Szitány, 2020; Cumhur & Korkmaz, 2020; Delgado-Rebolledo & Zakaryan, 2020; Didiş Kabar & Amaç, 2018; Güven & Gökdağ Baltaoğlu, 2017; Gökkurt, Şahin, Soylu, & Doğan, 2015; Kula Ünver, Özaltun Çelik, & Bukova Güzel, 2020), and that studies including measurement and evaluation knowledge and curriculum knowledge were limited and neglected (Alvunger, 2018; Deng, 2018; Koçak, Gökkurt, & Soylu, 2017; Remillard & Kim, 2017; Şahin & Soylu, 2017).

Measurement-evaluation knowledge is defined as the teachers' knowledge of the purposes and functioning of measurement-evaluation methods, and their skill to create and implement them (Baştürk & Dönmez, 2011). Measurement and evaluation is important in the constructivist learning approach as it is a part of the teaching process (Gelbal & Kelecioğlu, 2007), and all evaluations that adopt aims such as evaluation of the curriculum, determining learning gaps, determining the effectiveness of teaching, analysing students' development, guidance, and evaluation of students' achievements are obtained from measurement results (Baykul, 2014). It is obvious that in order for teachers to make effective measurement and evaluation, their knowledge of this issue must be sufficient and rich, but when the literature is examined in this context, it is seen that measurement and evaluation knowledge is not attached the importance it deserves (Şahin & Soylu, 2019). Curriculum knowledge, which similarly did not receive the importance it deserves, was defined by Shulman (1986) as the capability of dealing with the association of the subject the teacher is teaching with the other subjects of mathematics and handling the subjects of mathematics in a holistic framework. In this context, curriculum knowledge is important in terms of the appropriate management of the teaching process, as it includes the teacher's strong knowledge of curriculum and concept (Akkuş, Akkaş, & Yıldırım, 2018). Accordingly, prospective teachers' knowledge of curriculum can be regarded as important and necessary in terms of achieving the outcomes targeted in the curriculum and implementing effective teaching.

Teaching practices play a key role in prospective teachers' attainment of these competences and in the process of educating qualified teachers. This is because prospective teachers can assume the teacher's role and responsibility in a real classroom environment within the scope of teaching practices (Gökçe & Demirhan, 2005). However, the lecturers' observing the lessons of prospective teachers 1 or 2 times in a 14-week semester and giving them feedback within the scope of teaching practice course is not sufficient for the development of the prospective teachers' pedagogical knowledge (Baki & Arslan, 2015). At this point, the lecturers' being on the content more frequently, having a stronger communication with the teaching practice teachers at schools (Bay, Şeker, & Alisinanoğlu, 2020; Saka, 2019), assisting prospective teachers more in the lesson planning process (Paker, 2008), and giving feedback on the practices will significantly contribute to the development of prospective teachers' pedagogical knowledge (Baki & Arslan, 2015). This method is seen as a method that enables the lecturer to be in the content and to cooperate with the teacher and the prospective teacher. Thus, in the study, it was aimed to examine the development of the prospective teachers' knowledge of measurement-evaluation and curriculum, which are among the components of pedagogical content knowledge that are usually neglected in the literature, through lesson study method within the scope of teaching practice course. It is important for the study to achieve its aims in terms of getting the prospective teachers to gain the skills required to realize teaching in accordance with the learning outcomes specified in the curriculum prior to starting the teaching profession, and the skills to make measurement and evaluation as specified in the curriculum. Considering pedagogical content knowledge as a whole, it is believed that measurement-evaluation knowledge and curriculum knowledge are as important as other components and should not be neglected.

Sub-problems of the research:

1. How is the impact of lesson study method on the development of mathematics prospective teachers' measurement and evaluation knowledge?

2. How is the impact of lesson study method on the development of mathematics prospective teachers' curriculum knowledge?

METHOD

In this study which adopted the qualitative research approach, the case study method was used. Qualitative research is a research approach in which the research process is flexible, the data are analysed in-depth in this process and explicitly expressed at the end of the research (Kohlbacher, 2006). The case study method is defined as the examination of a current phenomenon within its real life framework without interfering with the circumstances by directing the questions of "how" and "why", and it is stated that the data in a case study can be collected through interviews with the individuals involved in a directly observed event or events (Yin, 2014). In the current study, case study method was used as "how" the knowledge levels of the prospective teachers about measurement-evaluation and curriculum were analysed in a real classroom environment as the natural environment without interfering with the circumstances. In this process, in line with the logic of case study, the data of the study were collected through observation technique, and at the end of the process, semi-structured interviews on the lesson study method used were held.

Participants

Criterion sampling, one of the purposeful sampling methods, was used in selecting the participants of the study. The main principle in this sampling method is studying all cases that meet a series of predetermined criteria (Yıldırım & Şimşek, 2011). The criteria that were studied in this research were determined as the prospective teachers being senior students in the department of primary school mathematics teaching and currently taking teaching practice course. Within this context, the participants of the study consisted of 5 prospective teachers who were in the fourth year of the primary school mathematics teaching department of the faculty of education at a state university in Turkey and currently taking teaching practice course. Accordingly, the students taking teaching practice course were randomly distributed into groups of five, and the group that came across the researcher was included in the study. The reason why the fourth year prospective teachers were included in the study was that they had taken most of the education courses (Measurement and Evaluation, Principles and Methods of Teaching) and content education courses (Special Teaching Methods I-II, School Experience, Educational Technologies and Material Design), and therefore, they were deemed appropriate for the purpose of the study. Besides, these prospective teachers were chosen in order to ensure a real classroom environment so that the curriculum that was prepared in accordance with the logic of lesson study method could be applied, as they had already taken the teaching practice course.

While reporting the findings of the research, instead of the real names of the students, codes such as S1, S2, S3, S4, S5 were used in line with ethical principles.

Data Collection Tools and Data Collection Process

The data of the study were collected through semi-structured observation techniques. In the study, the observation technique was preferred, because it provided the opportunity to do direct observation of the prospective teachers' teaching the subject of geometric objects as well as enabling the participants to be thoroughly examined in all aspects and obtaining more realistic information (Yıldırım & Şimşek, 2011). In the observation process regarding measurement-evaluation knowledge, the observation form developed by Gokkurt (2014) was used, while in the observation process regarding curriculum knowledge, the observation form developed by Sahin and Soylu (2017) was employed without making any changes (see Appendix 1). In this process, the prospective teachers were informed about the lesson study method, and it was explained to them that lesson observation would be done in this context, and that they would be a part of this process. One lesson hour (40 mins.) per each prospective teacher was allocated for the observation process.

In this process, it was considered important and necessary to receive opinions and recommendations of the practice teachers related to the lesson study process in terms of contributing to the professional development of the prospective teachers. Accordingly, semi-structured interviews were held with the prospective teachers at the end of the process. These interviews were held in order to take the views of prospective teachers and to understand their perspectives related to the effectiveness of the lesson study method used and its contribution to the prospective teachers (Creswell, 2017, p.126) Prior to the semi-structured interviews, the prospective teachers were informed about the types of questions to be directed to them in the interview, and how long the interview would last. In addition, the prospective teachers were also informed that a voice recorder would be used in the interview so as to prevent loss of data, and their consent was taken. A quiet environment was chosen for the interviews, and the interviews took around 5-10 minutes each. In the interviews, the prospective teachers were asked how lesson study method affected their lesson teaching and what the positive and negative effects of this method were from their own perspectives, and attitudes evaluating and judging the prospective teachers were avoided in the interviews. The data collected through observations and interviews were conveyed clearly and in a detailed manner.

In the data collection process, within the scope of lesson study method, each prospective teacher was asked to prepare an individual lesson plan in accordance with the curriculum applied by the Ministry of National Education (MNE) and to teach a lesson to 7th grade students in line with the plan they had prepared. These lessons taught by the prospective teachers were observed by 2 researchers (expert lecturer, practice teacher) in the real classroom environment within the scope of observation forms, and observation notes were taken.

In the next stage, as required by the lesson study method, the researchers and 5 prospective teachers came together and prepared a common lesson plan under the guidance of the expert lecturer. This common lesson plan was implemented by a prospective teacher who was randomly selected from the group. This lesson taught by the prospective teacher was observed by 2 researchers (expert lecturer, practice teacher) and other prospective teachers in the real classroom environment, and observation notes were taken. The observations done at this stage were aimed at identifying whether the lesson plan worked effectively or not, and observation forms were not used. Using the observation notes taken, the aspects of the plan that worked well, the aspect that worked poorly, what the problems stemming from the plan were, what the problems stemming from the prospective teacher, and the reactions of the students in the classroom were discussed, and the lesson plan was revised. The lesson plan revised according to the observation notes was implemented in another class by another prospective teacher, and 2 researchers (expert lecturer, practice teacher) and the other prospective teachers (4 prospective teachers other than the one teaching the lesson) observed the lesson and took observation notes. The plan was revised again by using the observation notes

taken and was given its final form. The prospective teachers were allowed to benefit from various resources while preparing the lesson plan so as to ensure that they would develop the most effective plan.

In the last stage, each prospective teacher was asked again to prepare an individual lesson plan in accordance with the curriculum applied by the Ministry of National Education (MNE) and to teach a lesson to 7th grade students in line with the plan they had prepared. These revised lessons taught by the prospective teachers were observed by 2 researchers (expert lecturer, practice teacher) in the real classroom environment within the scope of observation forms, and observation notes were taken.

By evaluating the observation notes taken before and after the implementation of the lesson study method, it was determined whether the prospective teachers showed any development in terms of their measurement-evaluation knowledge and curriculum knowledge. A brief summary of the data collection process is presented in Figure 1.

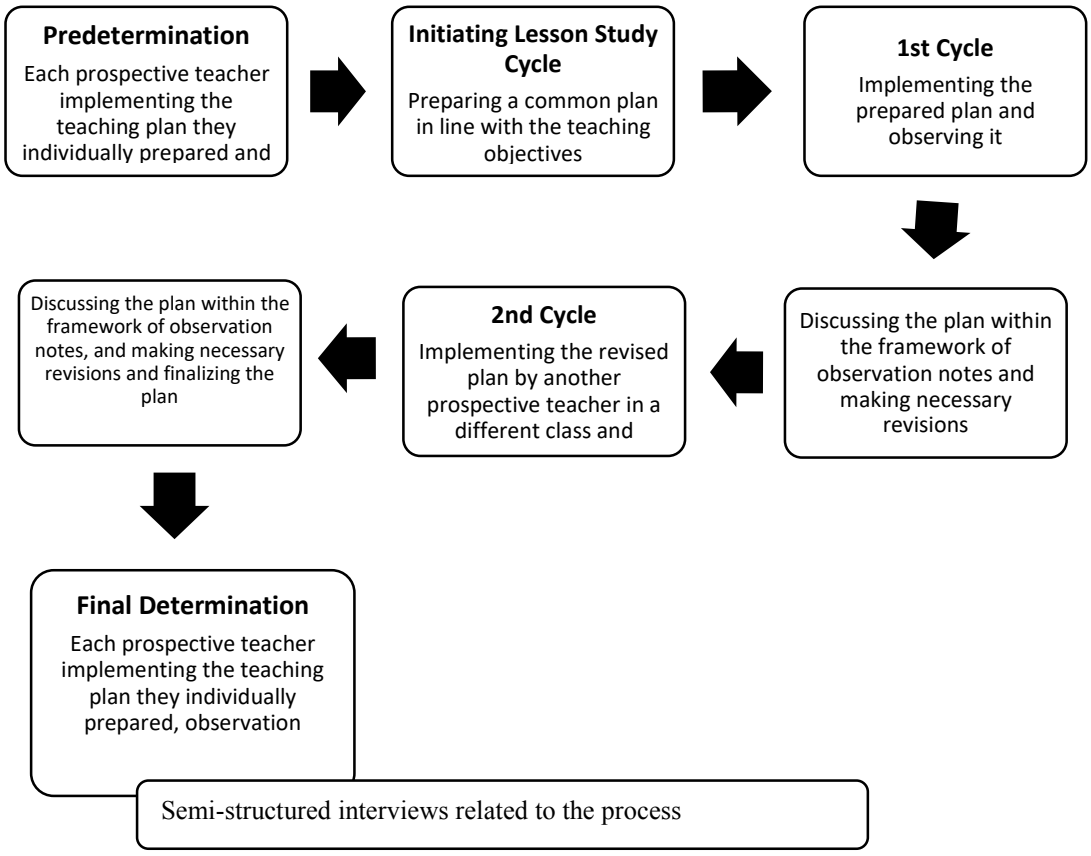

Figure 1. Data collection process

Data Analysis

The data were analyzed by using the descriptive analysis technique. In a descriptive analysis, the data are presented and evaluated according to predetermined conceptual frameworks and themes (Bogdan & Biklen, 2007; Creswell, 2019, p.319). Accordingly, in the present study, codes were formed out of the data included in the prearranged observation form and observed during the lesson teaching of the prospective teachers. In this process, the data were analysed, identified and interpreted within the framework of the codes determined for the descriptive analysis. At the end of the process, the obtained data were presented to the reader in an arranged and interpreted manner. In this context, the items included in the observation form were evaluated under the codes of "*Insufficient*", "*Partially Sufficient*", and "*Sufficient*", and it was determined whether there was any development or not. Accordingly, it was assumed that the prospective teachers who displayed development from "*Insufficient*" code to "*Partially Sufficient*" or "*Sufficient*" code in any observation item showed development within the scope of that item. Similarly, it was also assumed that the prospective teachers who showed development from "*Partially Sufficient*" code to "*Sufficient*" code displayed development within the scope of the relevant item. The observation process was carried out by one expert and one practice teacher, and the observation forms were filled in by these observers independently from each other. Consistency between the researchers in the observation forms was examined, the points that were evaluated differently were discussed, and a common ground was established.

In this process, direct quotations can be given to strikingly reflect the views of the individuals interviewed or observed. The data can be presented in consideration of the questions asked or dimensions used in the observation or interview processes (Yıldırım & Şimşek, 2011). Accordingly, direct quotations from the interview data were presented in the study so that the prospective teachers' measurement-evaluation knowledge and curriculum knowledge could be described and presented in more detail.

In order to ensure the validity of the study, the data were independently processed, interpreted and reported in detail by the researchers. In order to ensure the reliability of the study, the characteristics of the participants as the data source of the research, research process, data collection and analysis methods, how the data obtained were compiled and presented were explained in detail.

FINDINGS

In the present study, in which it was aimed to develop the measurement-evaluation and curriculum knowledge of prospective teachers through lesson study method, the teaching of a lesson by the prospective teachers was observed before and after the application of lesson study method, and semi-structured interviews were held. The data were described in detail by presenting the analysis of the observation data obtained in this scope and direct quotations from the semi-structured interviews below.
Within the scope of the first sub-problem of the research, the observation data for the prospective teachers' measurement-evaluation knowledge before and after the application of lesson study method are presented in Table 2.

Table 2. The distribution of the prospective teachers' measurement and evaluation knowledge according to codes and categories

Category	Codes	Before the Application Criteria			After the Application Criteria		
		Insufficient	Partially Sufficient	Sufficient	Insufficient	Partially Sufficient	Sufficient
Measurement and Evaluation Knowledge	The prospective teacher gave feedback and made corrections in order for the students to notice their mistakes and misconceptions.	$S_{1,2,3,4}$	S_5			$S_{1*,4*,5}$	$S_{2*,3*}$
	The prospective teacher was able to determine the mistakes and misconceptions of students through in-class dialogues and written documents.	$S_{1,2,3,4,5}$				$S_{2*,3*,4*,5*}$	S_{1*}
	The questions and problems that the prospective teacher used in class were appropriate for the level of students.		$S_{1,2,3,5}$	S_4		$S_{2,3}$	$S_{1*,4,5*}$
	The questions and problems that the prospective teacher used in class were at a level that could assess the targeted concepts.		$S_{1,2,3,4,5}$			$S_{1,3,5}$	$S_{2*,4*}$
	The prospective teacher did enough measurement activities to measure the students' prior knowledge of the concepts.	$S_{1,2,3,4,5}$			S_3	$S_{2*,4*,5*}$	S_{1*}
	The prospective teacher did enough measurement activities to measure the students' levels of understanding the concepts.	$S_{3,5}$	$S_{1,2,4}$			$S_{2,3*,4,5*}$	S_{1*}
	The prospective teacher made measurement and evaluation in line with the contemporary approaches.	$S_{1,2,3,4,5}$				$S_{1*,2*,3*,4*,5*}$	

Sx* represents a prospective teacher who showed development.

When Table 2 was examined, it was seen that the prospective teachers mostly displayed development in their measurement and evaluation knowledge as a result of the observations carried out. In this context, when the observation data of the prospective teachers coded as S_1, S_2, S_3, S_4 before the application were examined, it was determined that they were not sufficient in terms of their skills "*to give feedback and make evaluations in order for the students to notice their mistakes and misconceptions*", which play an important role in measurement-evaluation. In the lesson study process carried out together with the prospective teachers while preparing a lesson plan for each subject, ideas were exchanged on topics such as what the mistakes and misconceptions of students related to the subject might be, how to determine their mistakes and misconceptions, and what precautions could be

taken in order for the mistakes and misconceptions not to occur. For this reason, the prospective teachers came to the meetings for lesson plan preparation by preparing from various sources. At this point, by using the experiences of the practice teacher, it was discussed how the process in the mistakes and misconceptions dimension should be managed, and a consensus was reached. Hence, when the observation data related to the prospective teachers following the application of the lesson study method were examined, it was seen that they developed in the mistakes and misconception dimension in a general sense. Accordingly, it was determined that regarding the skill "*to give feedback and make corrections in order for the students to notice their mistakes and misconceptions",* S_1 and S_4 showed partially sufficient development, S_2 and S_3 showed sufficient development, and S_5 was evaluated as partially sufficient both before and after the application and therefore did not show any development at all. Similarly, it was determined that the prospective teachers' skills "*to be able to determine the mistakes and misconceptions of students through in-class dialogues and written documents of students*" developed after the application of the lesson study method. In this context, while all of the prospective teachers were evaluated to be insufficient in terms of displaying these skills in their first applications, after the application, it was seen that S_1 developed to the sufficient level,and that S_2, S_3, S_4, and S_5 showed development to be partially sufficient. This situation may have resulted from the prospective teachers' being prepared in accordance with the lesson study method, as explained above. This is because when the prospective teachers prepare for the lesson, their content knowledge related to the subject also develops, and therefore, they have knowledge about the potential mistakes and misconceptions of students in relation to the subject. In this respect, the explanation made by S_2 is quoted below.

"When I have to attend lesson plan preparation, I feel obliged to do research about the subject at least for 1-2 hours. This is because I have to make a contribution to the group. And this contributes to my development in the teaching profession. Observing a lesson is also effective in this sense."

When the explanation made above is examined, it is seen that prospective teachers feel obliged to make some preparations while coming to prepare a lesson plan so as to make a contribution, and that lesson observations are expressed to be effective in this process. Another observation item in which lesson observation comes to the foreground can be said to be about the skill of "*the appropriateness of the questions and problems that the prospective teacher uses in the lesson for the levels of students".* Regarding this observation item, it was determined that S_1, S_2, S_3, S_5 were at the partially sufficient level prior to the application, while S_4 was at the sufficient level. After the application, it was seen that S_1 and S_5 showed some development and were evaluated to be at the sufficient level, but that the other prospective teachers could not display any development. Similarly, another skill in which all prospective teachers were found to be partially sufficient before the application is "*the questions and problems used in class being at a level that can assess the targeted concepts."* Regarding this observation item, it was determined that S_2 and S_4 showed some development after the application and reached the sufficient level. It is believed that the reason why the prospective teachers were not at the insufficient level before the application regarding the observation item "*the questions and problems used in class being at a level that can assess the targeted concepts"* could be that the content specific education courses such as Special Teaching Methods I-II and Educational Technologies and Material Design that they had taken in their undergraduate studies had an effect in this matter. This is because in these education courses, measurement and evaluation approaches included especially in the teaching of the subjects in the secondary school mathematics curriculum are carried out in an applied manner. Therefore, lesson teaching and problem solutions at the secondary school student level are especially emphasized for each subject. All prospective teachers not being able to reach the sufficient level regarding these observation items after the application may have stemmed from the fact that the prospective teachers had to teach lessons to different classes as required by lesson study method. This is because the levels of the students and their interests vary in each class. Similarly, when the observation data of the prospective teachers regarding the observation item of "*doing enough measurement activities in order to measure the students' levels of understanding the concepts*" before the application were examined, it was seen that S_1, S_2 and S_4 were at the partially sufficient level, while S_3 and S_5 were at the insufficient level. When the observation data of the prospective teachers were examined again after the application, it was determined that S_3 and S_5 developed to the partially sufficient level, and S_1 displayed development to the sufficient level.

On the other hand, it was also observed that there were observation items in which all prospective teachers were evaluated as insufficient before the application. One of these observation items was "*doing enough measurement activities to measure the students' prior knowledge of the concepts."* It was determined that after the application of the lesson study method, S_2, S_4 and S_5 developed to the partially sufficient level within the scope of this observation item, S_1 showed development to the sufficient level, and S_3 did not show any development. Similarly, in the observation item "*prospective teachers making measurement and evaluation in accordance with contemporary approaches",* all prospective teachers were evaluated as insufficient before the application, and when the observation data after the application were examined, all prospective teachers showed development to the partially sufficient level. In addition to the great effect of the prospective teachers coming to lesson planning session in a prepared manner as required by the logic of lesson study method on their being insufficient before the application regarding these observation items and developing to the levels of partially sufficient and sufficient, it is believed that the experiences and ideas of the expert and the practice teacher significantly contributed to this development. Because both the measurement and evaluation information of prospective teachers about measuring the preliminary knowledge of students and the measurement and evaluation information in accordance with modern approaches were supported by experts in the theoretical and practical field, and the course process was advanced.

To summarize, it was seen that the measurement-evaluation knowledge of prospective teachers positively developed in a general sense after the application of lesson study, and when the interviews held with the prospective teachers were analysed, it was determined that they expressed they were also aware of this development. In this regard, it was seen that as the prospective teachers came prepared to the lesson planning session as required by lesson study method, they were involved in the discussion by listening to the expert views while preparing the lesson plan, and they followed the application process of the prepared lesson plan in the real classroom environment from the perspective of a researcher, there were some developments in their professional knowledge, and that they noticed these developments. Regarding this issue, the dialogue between S_1 and the researcher is given below as it is.

R: *What contributions did the use of the lesson study method make to you in terms of teaching practice?*

S_1: *Especially in the process of the plans we prepared with you and my peers by discussing before the teaching of the lesson, I learned many new things. Also, while the notes taken by my peers while observing my lesson were being discussed after the lesson, we could make up for our lacking points. Particularly preparing a lesson plan and discussing this plan with my peers were very effective in my development. In addition, they were very effective in my adjustment to time and my experience.*

When the statements of the prospective teachers were examined, it was seen that the discussions made and the exchange of ideas in the process of making the lesson plan, evaluating the plan after application, and revising it as a part of the lesson study method contributed to their pedagogical content knowledge. In this regard, it was determined that S_1 showed development in six of the items consisting of measurement and evaluation knowledge, that S_2, S_4 and S_5 displayed development in five items, and that S_3 developed in four items.

The data related to the development in the curriculum knowledge of prospective teachers as a result of the observations done before and after the application of lesson study method within the scope of the second sub-problem of the research are presented in Table 3.

Table 3. The distribution of the curriculum knowledge of prospective teachers according to codes and categories

Category	Codes	Before the Application Criteria			After the Application Criteria		
		Insufficient	Partially Sufficient	Sufficient	Insufficient	Partially Sufficient	Sufficient
Curriculum Knowledge	He/she taught in line with the philosophy of the primary school mathematics curriculum.	$S_{4,5}$	$S_{1,2,3}$			$S_{2,3,4*,5*}$	S_{1*}
	He/she used activities appropriate for the basic skills that the primary school mathematics curriculum targeted for the students to gain.	$S_{1,2,4,5}$	S_3		$S_{3,5}$	$S_{1*,2*,4*}$	
	He/she made measurement and evaluation in line with the philosophy of the primary school mathematics curriculum.	$S_{1,2,5}$	$S_{3,4}$		S_3	$S_{1*,2*,3,5*}$	S_{4*}
	He/she managed the time effectively.		$S_{1,5}$	$S_{2,4,3}$		$S_{1,2,4}$	$S_{3,5*}$
	He/she effectively implemented the teaching activities that were targeted in the lesson plan.	S_5	$S_{2,3,4}$	S_1		$S_{2,3,5*}$	$S_{1,4*}$
	He/she stayed within the boundaries of the learning outcomes specified in the primary school mathematics curriculum.	S_3	$S_{1,4,5}$	S_2		$S_{2,3*,5}$	$S_{1*,4*}$
	He/she used content appropriate for the learning outcomes targeted in the primary school mathematics curriculum.	$S_{2,4,5}$	$S_{1,3}$		S_3	$S_{1,4*,5*}$	S_{2*}
	His/her teaching was appropriate for the levels of students .	$S_{2,5}$	$S_{1,4}$	S_3		$S_{1,2*,3,4}$	S_{5*}
	He/she created an appropriate classroom atmosphere in line with the philosophy of the primary school mathematics curriculum and enabled the roles of teacher and students to be realized.	$S_{1,2,4,5}$	S_3		S_3	$S_{1*,2*,4*,5*}$	

Sx* represents a prospective teacher who showed development.

When Table 3 was examined, it was seen that the observation item in which the prospective teachers showed the least development was *"managing the time effectively"*. When the competence of the prospective teachers regarding this observation item was examined, it was determined that S_1 and S_5 were partially sufficient before the application of the lesson study method, while S_2, S_3 and S_4 were at the sufficient level. When the developments of the prospective teachers were examined after the application of the lesson study method, it was determined that S_5 developed in this regard and was evaluated to be sufficient, S_1 and S_3 showed no development, and S_4 displayed development in a negative direction. Another observation item in which the prospective teachers did not show development at a desired level was *"effective implementation of the teaching activities targeted in the lesson plan"*. In this regard, it was observed that before the implementation of the lesson study method, S_5 was insufficient, S_2, S_3 and S_4 were partially sufficient, and $S_1$was sufficient. After the application of the lesson study method, it was seen that S_5 developed to be partially sufficient, and S_4 developed to the level of sufficient. It was determined that S_1, S_2 and S_3 did not show any development and were at the same level before and after the application. In a similar way to this observation item, regarding the observation item *"teaching at a level appropriate for the students' levels*", S_2 and S_5 were insufficient before the application, S_1 and S_4 were partially sufficient, and S_3 was found to be sufficient. When the observation data of the prospective teachers were examined after the application, it was determined that S_2 developed to the partially sufficient level, and S_5 displayed development to the level of sufficient. In this regard, it was determined that S_1 and S_4 did not show any development, while S_3 developed in a negative direction. The lack of development at the desired level in these observation items may have resulted from the prospective teachers being insufficient as well before the application. This is because the prospective teachers had adopted a teaching approach that emphasized these points during their teaching that was carried out for predetermination purposes.

It was seen that one of the observation items in which the prospective teachers showed relatively better development in their curriculum knowledge compared to the observation items above was "*teaching in line with the philosophy of the primary school mathematics curriculum".* In this context, it was observed that regarding this item, while S_4 and S_5 were at an insufficient level of knowledge before the application of lesson study method, they developed to the partially sufficient level, S_1 developed from partially sufficient level before the application to the sufficient level after the application, and S_2 and S_3 were at the same level of partially sufficient before and after the application, showing no development. In the observation item " *using appropriate activities for the basic skills targeted in the primary school mathematics curriculum*", it was seen that S_1, S_2, S_4 and S_5 were insufficient before the application, and that S_3 was partially sufficient. After the application, it was determined that S_1, S_2 and S_4 developed to the partially sufficient level, while S_5 did not show any development, and S_3 showed development in a negative direction. Similar to these observation items, the prospective teachers showed development at similar levels in the observation items "*staying within the boundaries of the learning outcomes specified in the primary school mathematics curriculum"* and *"using appropriate content for the learning outcomes specified in the primary school mathematics curriculum."* In this regard, in the observation item "*staying within the boundaries of the learning outcomes specified in the primary school mathematics curriculum"*, it was seen that before the application, S_3 was insufficient, S_1, S_4 and S_5 were partially sufficient, and S_2 was sufficient. After the application, it was determined that S_3 developed to the partially sufficient level, and S_1 and S_4 displayed development to the sufficient level. It was seen that S_5 did not show any development, while S_2 displayed development in a negative direction. In the observation item "*using appropriate content for the learning outcomes targeted in the primary school mathematics curriculum*", it was seen that S_2, S_4 and S_5 were insufficient before the application, and S_1 and S_3 were partially sufficient. When the prospective teachers were examined after the application, it was seen that S_4 and S_5 developed to the partially sufficient level, and S_2 displayed development to the sufficient level. In this regard, it was determined that S_1 did not show any development, while S_3 developed in a negative direction.

It was seen that the observation items in which the prospective teachers showed the most development in their curriculum knowledge were "*doing measurement and evaluation activities in line with the philosophy of the primary school mathematics curriculum"* and *"creating a classroom atmosphere appropriate for the philosophy of the primary school mathematics curriculum, and enabling the teacher and student roles to be realized*". In this context, it was determined that S_1, S_2 and S_5 were insufficient before the application of the lesson study method, while S_3 and S_4 were at the partially sufficient level of knowledge. It was determined that after the application of the lesson study method, S_1, S_2 and S_5 developed to the level of partially sufficient, S_4 showed development to the level of sufficient, and S_3 regressed to the insufficient level. In the observation item "*creating an appropriate classroom environment in line with the philosophy of the primary school mathematics curriculum and enabling the teacher and student roles to be realized*", it was seen that S_3 was at the partially sufficient level before the application, and all prospective teachers other than S_3 were at the insufficient level. When the observation data of the prospective teachers were examined again after the application, it was determined that all prospective teachers other than S_3 developed to the partially sufficient level, but that and S_3 again regressed to the insufficient level.

It should be noted that S_3 regressed in 4 observation items within the scope of curriculum knowledge after the application of lesson study method. When the interview data of the prospective teacher were examined, it was seen that in contrast to the observation data, the prospective teacher himself/herself expressed that s/he developed. The dialogue between S_3 and the researcher in this regard is given below.

R: *What contributions did the use of the lesson study method make to you in terms of teaching practice?*

S_3: *You prepare a lesson plan together, and it becomes an excellent plan. After this stage, the work of the teacher becomes easier. These processes contribute to knowledge and experience. I felt more comfortable compared to previous applications. You have a guide at your disposal, and you teach the lesson according to it.*

When the statements of the prospective teacher were examined, it was seen that the lesson study method contributed to the development of his/her knowledge, and that it facilitated his/her teaching significantly. When the observation data of the prospective teacher were examined, it was seen that s/he showed development in terms of measurement and evaluation knowledge, as s/he expressed during the interview, but that s/he could not display any development in terms of curriculum knowledge. In this context, the observation data of the prospective teacher regarding curriculum knowledge and the data from the interview are not consistent. On the other hand, it was seen that there were four prospective teachers who showed development in the process and whose observation data and interview data were consistent. In this regard, the dialogue between S_4 and the researcher is given below as it is.

R: *What contributions did the use of the lesson study method make to you in terms of teaching practice?*

S_4: *Since I had to come prepared to prepare the lesson plan, I checked the curriculum and the materials; therefore, I may have developed in this regard.*

When the statements of the prospective teachers were examined, it was seen that they expressed they had to come prepared due to the lesson plans and discussions made in accordance with lesson study method, and therefore, they gained experience after some time when they had to research questions such as "what is in the curriculum?", "what kind of teaching is recommended?", and "what philosophies are adopted?" In this regard, it was determined that S_4 and S_5 showed development in seven of the items consisting of curriculum knowledge, that S_1 and S_2 displayed development in five items, and that S_3 showed development only in one item. Hence, it can be claimed that the curriculum knowledge levels of prospective teachers were mostly developed through lesson study methods.

DISCUSSION, CONCLUSION AND SUGGESTIONS

In the light of the study findings, it was concluded that the measurement-evaluation knowledge and curriculum knowledge of prospective teachers were enriched and developed through lesson study methods. In this context, it can be said that success was achieved in all prospective teachers in terms of developing, especially their measurement and evaluation knowledge. Within the scope of the measurement and evaluation knowledge of prospective teachers, it was determined that the lesson study method had the prospective teachers study on what they should consider while preparing for the lesson, choosing questions, evaluating students, etc. and created the need for preparing before the lesson. This result is similar to the result obtained in the study conducted by Budak, Budak, Bozkurt and Kaygin (2011), in which they reported that lesson study method got the prospective teachers to believe more in the necessity to come to the lesson in a prepared manner, to learn to make objective comments and think critically, and to develop their empathy skills. At this point, it was seen that the lesson study method caused the prospective teachers to study on the issues of checking the curriculum, and preparing materials and doing activities in line with the objectives of the curriculum, which is evaluated within the scope of the curriculum knowledge of prospective teachers. As a matter of fact, it was seen that this preparation process carried out through the lesson study method significantly contributed to the development of the curriculum knowledge of prospective teachers. In this context, the results of the study are similar to the results obtained in the studies conducted by Baki and Arslan (2015), and Butun (2012) in terms of lesson study method guiding the practitioners to teach by studying and researching and developing their lesson plan preparation skills, and similar to the study of Ozaltuncelik and Bukova Guzel in terms of lesson study method improving the skill of asking questions. In addition, it was seen that the discussion of the ideas and observation data of prospective teachers in the discussion environments created in accordance with the lesson study method contributed to the development of their professional knowledge. In this regard, many studies have been encountered in the literature which reported that the pedagogical content knowledge of prospective teachers within the scope of professional knowledge developed (Budak, Budak, Bozkurt & Kaygın, 2011; Fernandez & Yoshida, 2012; Leavy & Hourigan; 2016; Serbest, 2014).

When the results of the study were examined in this context, it was seen that the prospective teachers were aware of their own professional development, and that in regard to lesson study method, they stated that especially the evaluations of their teaching by prospective teachers with the same status significantly contributed to their development. The results of the current study are in parallel with the results obtained in the study conducted by Eriyanti (2018), in which it was reported that professionalism of teachers in terms of performing real evaluations was increased through collaborative lesson study, and that from a pedagogical point of view, teachers' ability to evaluate the learning processes and results and to use the results of the evaluation for learning contributed to the realization of reflective activities in order to improve quality learning. Furthermore, the results are similar to those of the study conducted by Boran and Tarım (2016) in terms of lesson study method enabling peer evaluation, teachers and prospective teachers benefiting from each other's experiences and forming new ideas together, creating the lesson plan by which the student can learn in the best way, gaining the skill to analyze a subject in a multidimensional way, and developing skills to form common emotions.

In line with the logic of the lesson study method, prospective teachers' participating in consecutive cycles enabled them to focus on the pedagogical content such as teaching and learning mathematical content and therefore the professional knowledge of the prospective teachers to develop. In this regard, Ni Shuilleabhain (2016) stated that along the cycles of lesson study, the teachers started to predict, notice and think about the mathematical strategies of students more frequently, to clearly develop learning series for the students, and to develop content based on the content related to the prior knowledge of students.

In the light of these results, it can be suggested that such methods can be used in order to develop other pedagogical content knowledge of prospective teachers. Besides, it is believed that running practice-based courses such as teaching practice and school experience through methods such as lesson study would be appropriate in that this method involves many processes such as students making preparations, coming together with students, discussion, preparing lesson plans, implementation of the plan, and revision of the plan, and doing practice collaboratively in groups. In studies conducted in this regard, the lesson study method was evaluated as an encouraging method for developing teaching practices based on collaborative lesson planning, lesson observation and evaluation (Schols, 2018). In this context, it is believed that in courses whose structure is suitable for lesson study method such as teaching practice, the lecturers being more on the practice content, carrying out studies in groups, supporting the prospective teachers in the planning stage, doing reflections on the practices of the prospective teachers, and giving feedback on the practices (Baki & Arslan, 2015) would increase pedagogical knowledge of the prospective teachers based on their professional development, and the effectiveness and efficiency of the course.

As this study was limited to teaching practice courses, time related problems regarding practices were encountered. Therefore, in order for methods such as lesson study to be used more effectively in practice courses, the duration of practice courses can be increased, and thus time related problems can be overcome. In addition, a similar study can be conducted with the participation of teachers, and the effects of lesson study method on teacher learning can be examined through different or the same variables, and research processes can be compared. In this way, advantages and disadvantages can be revealed, and a guide can be provided for other studies.

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We hereby declare that the study has no unethical issues and that research and publication ethics have been observed carefully.

Examples of author contribution statements

M.K., Y.S., and F.H. conceived of the presented idea and developed the theory. All authors were encouraged to investigate the background of the study and the literature review of the studies. And all authors who contributed to the data collection and analysis process discussed the results and final manuscript together.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

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We hereby declare that the study has no unethical issues and that research and publication ethics have been observed carefully. Research data were collected in 2018. Therefore, there is no ethics committee approval document.

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Appendix 1.

ÖLÇME-DEĞERLENDİRME BİLGİSİ GÖZLEM FORMU

Gözlem Okulu: …… **Gözlemin başlama zamanı:……Bitiş zamanı:…….**
Gözlenen Öğretmen: …….. **Gözlem yapılan sınıf: ……**
Gözlemci:…… **Öğrenci Sayısı: ……..**
İşlenen Konu: …….. **Gözlem Tarihi:……**

ALT BİLEŞEN	No	HEDEF DAVRANIŞLAR	E	K	H	Açıklamalar ve Yorumlar
ÖLÇME-DEĞERLENDİRME BİLGİSİ	1	Öğrencilerin sahip olduğu hata ve kavram yanılgılarının farkına varmalarını sağlayacak şekilde dönüt ve düzeltmeler yaptı.				
	2	Öğrencilerin sahip olduğu hata ve kavram yanılgılarını sınıf içi diyaloglardan veya öğrencilerin yazılı dokümanlarından tespit edebildi.				
	3	Derste kullandığı sorular ve problemler öğrenci seviyesine uygundu.				
	4	Derste kullandığı sorular ve problemler hedeflenen kavramları ölçebilecek düzeydeydi.				
	5	Öğrencilerin kavramlarla ilgili ön bilgilerini ölçmeye yönelik yeterince ölçme faaliyetlerinde bulundu.				
	6	Öğrencilerin kavramları anlayabilme düzeylerini ölçmeye yönelik yeterince ölçme faaliyetlerinde bulundu.				
	7	Çağdaş yaklaşımlara uygun bir şekilde ölçme ve değerlendirme faaliyetleri gerçekleştirildi.				

PROGRAM(MÜFREDAT) BİLGİSİ GÖZLEM FORMU

No	DAVRANIŞLAR	Gözlemlenmedi	Yetersiz	Kısmen Yeterli	Yeterli
1	İlköğretim matematik programının dayandığı felsefi yaklaşıma uygun bir öğretim gerçekleştirdi.				
	İlköğretim matematik programının kazandırmayı hedeflediği temel becerilere uygun etkinlikler kullandı.				
2	İlköğretim matematik programının dayandığı felsefi yaklaşıma uygun ölçme ve değerlendirme faaliyetlerinde bulundu.				
3	Zamanı etkili kullandı.				

4	Ders planında hedeflediği öğretim faaliyetlerini etkili bir şekilde gerçekleştirdi.				
5	İlköğretim matematik programının hedeflediği kazanımların dışına çıkmadı.				
6	İlköğretim matematik programının hedeflediği kazanımlara uygun bir içerik kullandı.				
7	Öğrencilerin seviyesine uygun bir öğretim gerçekleştirdi.				
8	İlköğretim matematik programının dayandığı felsefi yaklaşıma uygun bir sınıf iklimi oluşturarak, öğretmen ve öğrenci rollerinin gerçekleşmesini sağladı.				