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Analysis of the Changes in Prospective Secondary Mathematics Teachers' Knowledge of Lesson Plan

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Abstract

The purpose of this study is to investigate how prospective mathematics teachers' develop their knowledge of mathematics lesson plan in a Teaching methods course. We conducted this qualitative study with eight prospective secondary mathematics teachers studying at at a state university in Turkey. We have collected during the course of "Teaching methods in mathematics education". We have asked questions about planning mathematics lessons to 60 prospective teachers at the beginning of the course. We have individually interviewed with eight prospective teachers. The prospective teachers prepared lesson plans in pairs based on the acquisition in the curriculum that was provided by the instructor of the course. After the Teaching methods course, we again interviewed these prospective teachers with their peers whom they prepared their lesson plans with. In beginning of the course, some of the prospective mathematics teachers confused mathematics lessons plan with mathematics curriculum. We have explored two categories at the beginning of the course: knowledge of components in lesson plans and knowledge of students' motivation and understandings. The knowledge of teachers' self-assessment is the other category, which evolved from the data at the end of the course. We have found that prospective secondary mathematics teachers' knowledge of mathematics lesson plans change from structural level to instructional level. In the beginning of the course, the prospective teachers mentioned sections of a lesson plan, elements of teaching process, and classroom context. After the course, they gave detailed information about how to organize an instructional process considering students' motivation and understandings. The prospective teachers also put the acquisitions in center of the lesson plan. They had never referred mathematical content before they took the course. However they realized the importance of their own mathematical content knowledge while designing a plan.

Keywords: pedagogical content knowledge, prospective mathematics teachers, mathematics education, secondary level, lesson plan

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Ortaöğretim Matematik Öğretmen Adaylarının Ders Planı Bilgilerindeki Değişimin Analizi

Öz

Bu araştırmada, ortaöğretim matematik öğretmen adaylarının "Özel öğretim yöntemleri" dersinde matematik ders planı bilgilerini nasıl geliştirdiklerini incelemek amaçlanmıştır. Bu nitel araştırma Türkiye'deki bir devlet üniversitesinin beş yıllık matematik öğretmenliği programına devam etmekte olan sekiz öğretmen adayı ile gerçekleştirilmiştir. Araştırmanın verileri katılımcıların eğitimlerinin sekizinci döneminde aldıkları "Özel öğretim yöntemleri" dersinde toplanmıştır. Dersin başlangıcında toplam 60 öğretmen adayına matematik dersini planlama ile ilgili sorular yöneltilmiştir. Araştırmacılar katılımcıları belirlemek için öğretmen adaylarının cevaplarını analiz etmişlerdir. Belirlenen sekiz öğretmen adayıyla bireysel görüşmeler yapılmıştır. Bu ders boyunca öğretmen adayları ikişerli gruplar halinde, dersin yürütücüsünün belirlediği ve öğretim programında yer alan kazanımlar doğrultusunda ders planları hazırlamışlardır. Öğretim yöntemleri dersinin sonunda ders planlarını ikişerli hazırlayan öğretmen adayları ile görüşmeler yapılmıştır. Elde edilen bulgular ışığında dersin başında, bazı öğretmen adaylarının matematik ders planı ile öğretim programı arasındaki farkları ayırt edemedikleri görülmüştür. Dersin başında öğretmen adaylarının ders planı bileşenleri bilgisi ile öğrencilerin anlamaları ve motivasyonları bilgisine sahip oldukları belirlenmiştir. Dersin bitiminde ise öğretmenin kendini değerlendirme bilgisi yeni bir kategori olarak ortaya çıkmıştır. Öğretmen adaylarının ders planı bilgilerinin yapısal düzeyden öğretimsel düzeye dönüştüğü görülmüştür. Özel öğretim yöntemleri dersinin başında öğretmen adaylarının bir ders planın bölümleri, öğretim sürecinin elemanları ve sınıf ortamından bahsettikleri belirlenmiştir. Dersin sonunda ise öğrencilerin anlamaları ve motivasyonlarını göz önünde bulundurarak öğretimsel süreci nasıl organize edeceklerine dair detaylı açıklamalarda bulunmuşlardır. Öğretmen adayları ayrıca kazanımları, ders planının merkezine yerleştirmişlerdir. Öğretim yöntemleri dersini almadan önce matematiksel içerikten bahsetmemişlerdir. Ancak bu dersle birlikte ders planı tasarlarken, kendi matematiksel içerik bilgilerinin önemini fark etmişlerdir.

Anahtar Sözcükler: pedagojik alan bilgisi, ortaöğretim öğretmen adayları, matematik eğitimi, ortaöğretim seviyesi, ders planı

Introduction

Prospective mathematics teachers often form their ideas on teaching mathematics based on their school experiences in the past, both at K-12 and undergraduate level (Barkatsas & Malone, 2005). Their experiences in Mathematics Teacher Education Programme enable them to obtain new perspectives for both mathematical content and teaching mathematics (Prescott, Bausch, & Bruder, 2013). The content knowledge on its own is not adequate for teaching mathematics in an effective manner, it is also important to examine the way mathematics are taught (Ball, Hill, & Bass, 2005; Shulman, 1986).

The studies focusing on teachers' knowledge are mostly based on the works of Shulman (1986, 1987). Shulman's (1987) theory for knowledge of teaching consists of subject matter knowledge, general pedagogical knowledge, and pedagogical content knowledge, which he defines as "a special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (p. 8). Most scholars and policy makers agree on Shulman's pedagogical content knowledge in that it has an important contribution to teaching and learning mathematics (Hill, Ball, & Schilling, 2008). How to teach mathematical content and understand students' way of thinking have been an issue for pedagogical content knowledge (An, Kulm, & Wu, 2004). Many researchers have been inspired by Shulman's (1986, 1987) pedagogical content knowledge conceptions in mathematics education (Baumert et al., 2010; Hill et al., 2008; Tatto et al., 2008). For example, Baumert et al. (2010), within the scope of COACTIV (Professional Competence of Teachers, Cognitively Activating Instruction and the Development of Students' Mathematical Literacy) have examined pedagogical content knowledge into three subcategories, including; (i) knowledge of mathematical tasks, (ii) knowledge of students' thinking and assessment, and (iii) knowledge of multiple representations and explanations of mathematical problems. The International Association for the Evaluation of Educational Achievement (IEA) has questioned the differences among mathematics teacher education programmes. They have also investigated the effectiveness of these programmes. This international comparative study is called as "Teacher Education and Development Study – Learning to Teach Mathematics (TEDS-M)", in the literature (Tatto et al., 2008). TEDS-M has explained knowledge for teaching mathematics through two conceptions, which are (i) mathematics content knowledge, and (ii) mathematics pedagogical content knowledge. Researchers from University of Michigan have also produced another conceptual framework. As described by Hill et al. (2008); mathematical knowledge for teaching comprises of subject matter knowledge, and pedagogical content knowledge. The subject matter knowledge consists of common content knowledge, specialized content knowledge, and knowledge at the mathematical horizon. The subcategories of pedagogical content knowledge include knowledge of content and students, knowledge of content and teaching, and knowledge of curriculum. In our study, while analyzing the first experiences of the prospective mathematics teachers on preparing a lesson plan, we have taken the related literature into account.

Understanding and having knowledge on (i) mathematics, (ii) students and, (iii) pedagogical strategies may influence the effectiveness of the teaching (NCTM, 2000). Preparing a mathematical lesson plan is necessary for an effective teaching. The knowledge required for designing a proper mathematics lesson is one of the components of pedagogical content knowledge (Prescott et al., 2013). The main reason why a lesson plan is prepared is to ensure the efficiency of the lesson and to make the lesson effective in the given time (Gall & Acheson, 2011). Preparing a lesson plan also has an influence on students' getting meaningful learning opportunities. Lesson plans help us document our ideas on teaching and share and/or use them after adjusting them to students and environment for the upcoming years. In short, lesson planning forms the instruction, which teachers design for implementation (Ozogul & Sullivan, 2009). In the classroom, teachers might face with a variety of challenges. Lesson planning has the potential to help the implementation of instruction despite these challenging situations (Akyuz, Dixon, & Stephan, 2011). It is known that lesson planning could not demonstrate all aspects of pedagogical content knowledge (Chick & Pierce, 2008). This kind of knowledge has a critical role, especially for the prospective mathematics teachers who are at the beginning of their professional career. However, the literature has paid only little attention to knowledge of lesson planning. It is of importance for both prospective teachers and their educators to realize what prospective teachers gain from the courses related to the mathematics teaching and learning. We believe that the educators of prospective teachers must shed light on constructing knowledge of lesson planning. We have focused on prospective mathematics teachers' knowledge of mathematics lesson plans in order to reveal the development of their pedagogical content knowledge in a "Teaching methods in mathematics education" course. Such a course allows prospective teachers to construct their own pedagogical content knowledge and also enables teacher educators to reflect on their lesson planning process (Rusznyak & Walton, 2011). Lastly, we have formulated our research question as: In what ways the prospective secondary mathematics teachers develop their knowledge on preparing a lesson plan in a "Teaching methods in mathematics education" course?

Method

Participants

We conducted this qualitative study with eight prospective secondary mathematics teachers studying at a five-year teacher education program at the Secondary Science and Mathematics Education department of a state university in Turkey. The prospective secondary mathematics teachers have completed most of the mathematics content courses such as algebra and geometry. Besides, they have also taken most of the pedagogy courses such as developmental psychology and classroom management. After completing these courses, the prospective teachers have taken technologies and material design, and mathematics teaching courses that include modeling, problem solving, abstraction, generalization, mathematical understanding, nature of mathematics and preparing activities required for teaching mathematics which combines knowledge from mathematics content with pedagogy

courses. While coding the raw data, we have assigned each participant a number from 1 to 8. We have coded each prospective teacher as PT_x. Here, X refers to the number we have assigned to each prospective teacher.

Data Collecting Process

We have collected data from the prospective secondary mathematics teachers during the course of "Teaching methods in mathematics education", which was taken during their 8th semester. Firstly, we have asked 60 prospective mathematics teachers to put forward their ideas on planning mathematics lessons at the beginning of the course. Table 1 displays the questions in the survey:

Table 1

The Questions that We Asked at the Beginning of the Course

1. What comes to your mind when you think about a lesson plan?
2. Have you ever examined a lesson plan before? If you have, could you write about your observations regarding the lesson plan?
3. What are the things that a lesson plan must contain, in your opinion?
4. Is it necessary and/or important for you to prepare a lesson plan?
5. How do you think a lesson plan should be prepared?

We analyzed the answers of 60 prospective mathematics teachers in order to select the participants. The reason why eight participants were selected was because they provided us with rich data by writing their ideas in a detailed way. Then, we have individually interviewed these prospective teachers and asked them to clarify their answers written in the survey. The video typed interviews, which were conducted before the Teaching methods course; have approximately taken 15 minutes for each participant.

The instructor of "Teaching methods in mathematics education course" is a professor in mathematics, who has been teaching this course for 10 years. The course, which lasted for 14-weeks, was carried out in three stages. The first stage of the course took two weeks. The instructor of the Teaching methods made an introduction to the Turkish secondary mathematics curriculum, the skills the curriculum aims to gain, and how to read and interpret the acquisitions, which are the national standards, in the Turkish curriculum (MoNE, 2013). Then in the second stage, which took two weeks of the course, the instructor informed the prospective teachers about the lesson plan, which included the aim, structure and content of the lesson plan. In the last stage that covers the remaining weeks of the 14-week course, the prospective teachers prepared lesson plans in pairs according to an acquisition selected from the curriculum, and presented their lesson plan in the classroom. The prospective teachers prepared their lesson plans in pairs based on the acquisition in the curriculum that was provided by their instructor. While the prospective teachers presented their lesson plans in groups, other prospective teachers monitored and criticized their contents and structures of the lesson plans.

After the Teaching methods course, we interviewed the participants with their peers whom they prepared their lesson plans with. Table 2 indicates the questions we have asked in the interview. The last videotaped interviews, which were conducted after the Teaching method, have approximately taken 30 minutes for each.

Table 2

The Questions that We Asked at the End of the Course

1. Can you discuss the experiences you had during the process of preparing a lesson plan?
2. After the lesson designing experience you have had, what do you think should be included in a lesson plan? What should a lesson plan cover?
3. After the lesson designing experience you have had, how do you think a lesson should be designed? What should you take into consideration while designing a lesson plan?
4. What do you think of the necessity and significance of designing a lesson plan?

Data Analysis

The qualitative content data analysis, designed by Auerbach and Silverstein (2003), was adopted while analyzing the data collected throughout the research. Firstly, we have transcribed and read the row data. Considering the pedagogical content knowledge literature, we have highlighted what we have found as relevant. The related data were separated into meaningful units in the first step of coding, as described by Patton (2002). The data were coded and categorized according to these units; moreover the categories were analyzed and interpreted.

Findings

We have explored two categories for prospective teachers' knowledge of mathematics lesson plans at the beginning of the course. These categories are (i) knowledge of components in lesson plans and (ii) knowledge of students' motivation and understandings. At the end of the course, we determined another category, which is named as "knowledge of teacher's self-assessment" and is different from the two other categories (see Table 3). We will provide further details for these categories in the subsections.

Table 3

Knowledge of Prospective Secondary Mathematics Teachers on Lesson Plans

Categories	**Sub-categories at the beginning of the course**	**Sub-categories at the end of the course**
Knowledge of the components in lesson plans	Structure of the lesson plan sections Structure of teaching process Structure of classroom context	Structure of the lesson plan sections Structure of teaching process Structure of the classroom context Considering curriculum
Knowledge of students' motivation and understandings	Motivating students Realizing students' prior knowledge	Motivating students Realizing students' prior knowledge Being aware of students' individual differences Evaluating students' understandings in the process of teaching
Knowledge of teacher's self-assessment		Examining different resources Reviewing teachers' own mathematical content knowledge Using the lesson plan as a guidance

Prospective Mathematics Teachers' Knowledge of Lesson Plans at the Beginning of the Course

At the beginning of the Teaching methods course, some of the prospective mathematics teachers confused mathematics lessons plan with mathematics curriculum. They thought that lesson plan and the curriculum could be viewed as the same with minor differences. Also, they declared that a lesson plan was a more detailed version of a curriculum. Here are some of prospective teachers' explanations:

> *PT_3: "I think that teachers should plan how to organize acquisitions for a whole session. Lesson plans are elaborative forms of the curriculum. Teachers have to plan both lessons and the whole session. They should firstly make the plan in their minds."*

> *PT_4**:** "Lesson plan could be designed for a period or for a whole session. For this reason, teachers should efficiently use the time."*

These prospective teachers thought that lesson plan could be used not only for one lesson but for the whole year. Through these statements, they referred to planning all of the lessons before the academic year begins. As seen from the explanation of prospective teacher PT_3, a lesson plan itself is a kind of a curriculum.

Knowledge of components in lesson plans

The prospective teachers specified the elements a lesson plan should contain. They mentioned sections, teaching process etc. while preparing a lesson plan. We coded this category as the knowledge of components in lesson plans.

The prospective teachers explained what sorts of sections a lesson plan should include. We coded this as *structure of the lesson plan sections.* The explanations of prospective teachers are as follows:

> *PT_1: "It is a written outline that comprises of what I will do in the classroom, the acquisition I will consider, what I will expect from students, what I will do if an extraordinary thing happens, and the materials I will bring to the classroom. In this way, students do not get confused."*

> *PT_2: "A plan should be prepared in a detailed manner for each lesson. It should include the acquisition and the subject, which I will provide the students with. Also, it should contain what I will ask and pay attention as well as the sources I will bring to the classroom."*

> *PT_3: "A lesson plan does not need to be in a written form. The teacher must already have something in mind about how he/she is going to do the things in the classroom."*

The prospective teachers stated that a lesson plan should not only include the subject matter knowledge but also the things to do in the classroom. They also mentioned that a lesson plan should contain what a teacher expects from the students. A lesson plan could be called as a "to do list" by the prospective teachers.

One of the other sub-categories, which we explored, is *the structure of teaching process*. The prospective teachers mentioned that timing as well as using materials, activities, and various techniques should be included within the instruction in a classroom. Some of the prospective teachers' explanations of their ideas are as follows:

> *PT_5: "We should determine the time usage according to the subjects and the acquisitions."*

> *PT_7: "We have to determine the techniques and methods related to the subject. If we are going to use videos, computer software or activities in the classroom, we should adjust the time usage accordingly."*

> *PT_8: "We have to plan what we will do in 45 minutes. We will decide whether we will use materials, videos or not."*

The prospective teachers mainly considered the time usage as a factor for structuring the teaching process. It is possible to assert that they perceived time limitation as one of the most important components of preparing a lesson plan. They mentioned other components after time usage component.

The prospective teachers stated that the status of students and teacher, and the environment of the classroom should be taken into consideration while preparing a lesson plan. We coded this sub-category as *the structure of classroom context.* Some of the quotations are stated below:

> *PT_1: "I have to consider the status of students, physical environment, and myself. Then I should prepare the lesson plan according to these statuses."*
>
> *PT_4: "Physical and school environment should be considered while preparing a lesson plan."*
>
> *PT_6: "The features of the classroom context should also be taken into account. If there are roundtables in the classroom, then you could use group work. But if there is a traditional seating in the classroom, then you implement other ways."*

The prospective teachers recommended considering where the school is located while preparing a lesson plan. One of the points that they remarked is desks in a classroom. They suggested implementing a method according to the physical environment of the classroom.

The knowledge of students' motivation and understandings

The prospective teachers discussed how they motivate the students in the classroom. They stated that they would pay attention to students' prior knowledge while preparing lesson plans. We named this coded category as the knowledge of students' motivation and understandings.

One of the sub-categories that we explored is *motivating students.* The prospective teachers mentioned the significance of motivating students in the classroom. Some of the quotations of the prospective teachers are as follows:

> *PT_2: "Teacher must begin with an introduction that is attention-grabbing to the lesson. Considering how the concept is used in our everyday lives, demonstrating books or displaying interesting videos related to the subject could be part of drawing attention to the lesson at the beginning."*
>
> *PT_3: "I have to motivate the students and grab their attention as mentioned in the 5E model of instruction. This must be a part of all lessons. Making the lesson amusing is very important for me; a teacher should not be boring during the lesson."*

The prospective teachers believe a teacher could use interesting activities at the beginning of a lesson. They also added that displaying videos or real life examples could motivate students at the beginning of the lesson. They mentioned that motivating activities should be included in all of the sections of a lesson plan.

Being aware of students' previous knowledge is another sub-category that we coded. The prospective teachers took students' prior content knowledge into

consideration while preparing lesson plans. Here are some of the prospective teachers' explanations for this sub-category:

> *PT_2: "You have to write to which level of the students you are going to implement the lesson plan to. Also we have to write down reminder notes such as "Pay attention to this point in that classroom" based on our thoughts on students' previous cognitive levels."*
>
> *PT_3: "I have to enable students to remember their previous knowledge. We have to detect and know their competence in the previous subjects."*
>
> *PT_7: "I organize the lesson plan according to the level of the students in the classroom. After that, I try to choose the best techniques and methods for these students."*

As indicated in the abovementioned statements, prospective teachers stated that teachers must pay attention to the previous cognitive level of their students. They also had plans to determine the techniques and methods according to their students' previous content knowledge. It can be inferred that they would try to map their students' previous knowledge before preparing a lesson plan.

Prospective Mathematics Teachers' Knowledge of Lesson Plans at the End of the Course

At the end of the course, none of the prospective teachers confused a lesson plan with a curriculum. Of course, it is an expected result after having such a course, in which the prospective teachers were introduced how to prepare a lesson plan. But now, we have the knowledge of how the prospective teachers improve their pedagogical content knowledge on preparing a lesson plan.

Knowledge of the components in lesson plans

The prospective teachers discussed *the structure of the lesson plan sections* according to the acquisition. They argued the central role the acquisition plays in a lesson plan. Some of the prospective teachers explained their ideas by saying

> *PT_3: "It seems to me that a lesson plan should involve everything related to the subject before taking the Teaching methods course. I also thought that it must contain all skills of Bloom's Taxonomy, but it is not like that. We have to organize the lesson in accordance with the acquisition."*
>
> *PT_8: "Firstly what we have to consider is the acquisition itself. We determine the aim of the lesson according to the acquisition. Then, we decide the rest of the sections, in the plan in line with this aim."*

The prospective teachers stated that a lesson plan should be prepared in accordance with the acquisition. Before the Teaching methods course, they thought that a lesson plan was similar to a "to do list". As they have obtained an experience

with preparing a lesson plan, they have started viewing acquisition as the key component.

The prospective teachers explained *the structure of teaching process* in the same way, in which they described it at the beginning of the Teaching method course. However, after taking the Teaching methods course, they considered the acquisition firstly while organizing the teaching process. Some of the explanations of the prospective teachers are as follows:

> *PT_1: "You have to specify which techniques you will implement and which of them are suitable for the acquisition."*
>
> *PT_3: "Modeling examples or just only one photograph could be used while introducing a new concept."*
>
> *PT_6: "While designing the lesson plan, we used computer software. But you know, there will not be computers in the classroom context. So we arrange an alternative plan for the activities."*

Before the Teaching methods course, the prospective teachers had given attention to time usage for structuring the teaching process. As seen from their abovementioned statements, they mentioned the structure of the teaching process along with the acquisition. They also added some other elements such as using real life and modeling examples, photographs; as well as applying alternative activities.

The prospective teachers explained *the structure of the classroom context* in a similar way before and after taking the Teaching methods course. They evaluated the teaching practices in the classroom environment. Their statements are as follows:

> *PT_2: "Classroom structure is important. For example you decide to use technology but if the classroom environment is not suitable for using technology, it is just nonsense. You have to figure out another way."*
>
> *PT_4: "I have to keep in mind the social environment of the classroom while preparing a lesson plan."*
>
> *PT_8: "I have to look at the physical conditions of the classroom. According to them, we decide whether to use computers, or. If there is no computer, maybe we could do activities that only require paper and pencil."*

The prospective teachers highlighted the classroom structure while choosing the Teaching methods. They also stated that social situations must be considered while organizing the lesson plan. They specifically stressed on taking technological opportunities in the classroom into consideration.

After taking the Teaching methods course, the prospective teachers stated that the mathematics curriculum must be considered while organizing the lesson plan. We coded this as *considering the curriculum,* which refers to the new sub-category of

structuring the lesson plan. Some of the prospective teachers' explanations are as follows:

> *PT_3: "We have to look at the mathematics curriculum; the content of the subject is a very important matter."*
>
> *PT_5: "Also we have to examine the time allocated for the acquisition. We have to consider this while preparing the lesson plan."*
>
> *PT_6: "What is the acquisition and what the acquisition involves are significant. So, we have to carefully examine the curriculum."*

The prospective teachers stated that what curriculum allowed for the acquisition, such as time usage, is important. They also took into account of subject matter, which is mentioned in the curriculum, while organizing the lesson plans. It can be concluded that after taking the Teaching methods course, the prospective teachers' knowledge of lesson plan also includes the curriculum.

The knowledge of students' motivation and understandings

The second category, which is the knowledge of students' motivation and understandings was elaborated and expanded further than the first category, which is the knowledge of components in lesson plans at the end of the course. The prospective teachers stated that being aware of students' understandings and the individual differences could have an influence on the process of preparing a lesson plan. They also mentioned evaluating students' understandings in the process of teaching in this category.

The sub-category of motivating students did not display any major changes after completing the Teaching methods course. The prospective teachers added that maintaining students' motivation plays a crucial role in preparing a lesson plan. Some of the prospective teachers' explanations are indicated below:

> *PT_3: "We have to motivate the students so that they can pay more attention and be interested in the lesson."*
>
> *PT_8: "We could give some reminders for the subject in order to draw students' attentions. If we want students to learn then we have to make them wonder. Wondering could be triggered through a material, a video or an event from the history."*

The prospective teachers extensively focused on drawing students' attentions at the beginning of the lesson. They thought that the more attention students pay to the lesson, the more motivated they are for the lesson. They also stated that making students wonder is significant to keep students motivated.

One of the other sub-categories, which has displayed minor changes, is *being aware of students' previous knowledge* at the end of the Teaching methods course.

The prospective teachers mentioned cognitive levels of students. Some of their explanations are as follows:

> *PT_8: "We should determine learning methods and techniques according to the level of students."*
>
> *Researcher: "How could you determine them?"*
>
> *PT_7: "We could choose the methods and techniques based on the readiness level of students. We should consider how students comprehend that subject."*

This sub-category remained the same in terms of its content after the Teaching methods course, as seen from the quotations of the prospective teachers. They emphasized to choose techniques and methods according to the readiness level of their students. They also stated that they would pay attention to the students' cognitive levels.

After completing the Teaching methods course, the prospective teachers stated that there could be differences in students' learning and understanding. We coded this as *being aware of individual differences*, which is the new sub-category. Some of the prospective teachers' explanations are indicated below:

> *PT_1: "If students like to solve puzzles, they may be interested in puzzle activities that we have prepared. However, you have to think alternative activities for the others, who do not like solving puzzles."*
>
> *PT_6: "You have to take students with high abilities and students with low abilities into account at the same time while designing activities in the lesson plan."*
>
> *PT_8: "For the related acquisition, we could investigate where students make mistakes or have difficulties. We could consider the Theory of Multiple Intelligences. For the students with visual-spatial abilities, we could use materials or videos. Also, whenever we use group work in a classroom, we can ask students, who have verbal-linguistic abilities, to prepare an activity."*

The prospective teachers stated that there could be different activities for different students. They offered to elaborate the activities according to individual differences of students. They also suggested investigating the difficulties the students experience regarding the concepts through the literature and thus raising awareness for these difficulties.

After taking the Teaching methods course, the prospective teachers stressed on monitoring students' learning during the act of teaching. This new sub-category that we coded is *evaluating students' understandings in the process of teaching*. One of the prospective teachers explained his/her ideas through the following statement:

PT_8: "We should plan to ask high level questions to the students between the activities that we implement in the classroom. These questions should assess if the students understood the first activity, or not, before proceeding with the second activity. In fact, we receive feedbacks about the learning process."

As seen from the quotation, PT_8 believe that asking questions about the activities implemented by the teacher serves as an evaluation. This evaluation could be for both assessing students' learning and feedback of the implementation. It can be said that the prospective teachers enhanced their knowledge of preparing a lesson plan at the end of the course.

Knowledge of teacher's self-assessment

The prospective teachers explained what a teacher must know for preparing a lesson plan. Also they mentioned how a lesson plan must be used by a teacher. We coded this category as the knowledge of teachers' self-assessment, which evolved from the data at the end of the Teaching method course.

Examining different resources is one of the sub-categories that we explored from the data. The prospective teachers denoted that using libraries, looking for advanced level books etc. are essential for preparing a lesson plan. Some of the prospective teachers' quotations are noted below:

PT_2: "One of our instructors told us: "Wherever you are appointed, go to the library of the university in the city." I agree with him, as teachers, we should follow the academic studies."

PT_5: "How and what we will teach students in the lessons have roots in the field of academics. We could forget some of them, this could happen. But we could use books or internet based resources to remember and revise our knowledge."

The prospective teachers stated that they would go to the library in order to follow the new studies in mathematics education literature. They also recommended using books and internet for maintaining their knowledge active. It can be inferred that the prospective teachers intend to enhance their background for both subject matter knowledge and pedagogical knowledge.

The prospective teachers declared the importance of mathematical content knowledge while preparing a lesson plan. We coded this sub-category as *reviewing teachers' own mathematical content knowledge*. Some excerpts from the prospective teachers' statements are as follows:

PT_4: "Before this course, I thought that every definition in the books was right. I have never criticized them. I always believed that they all were correct, but this is not the case. While preparing the lesson plan, we made this mistake more than once. From now on, I think we will criticize the mathematical knowledge in every sense."

> *PT_5: "We prepare an activity in our lesson plan. However, we have seen that we couldn't make the definition of limit from the right. The instructor of the course showed us how to re-organize our activity. I believe that teachers have to be certain of their mathematical content knowledge before preparing a lesson plan."*

The prospective teachers realized the importance subject matter knowledge possesses for preparing the lesson plan. They also pointed out the mistakes they made about the concepts while preparing a lesson plan. It is possible to say that for the prospective teachers, having the right mathematical concepts is the main component of preparing a comprehensive lesson plan.

One of the sub-categories for the knowledge of teachers' self-assessment is *using the lesson plan as a guidance*. The prospective teachers asserted that the lesson plan serves as a guidance in the process of instruction. Here are some of the prospective teachers' explanations:

> *PT_1: "I think that we prepare the lesson plan for ourselves. It facilitates the teachers' work. It determines your path and is a kind of a guidance for the lessons. It also helps with students' comprehensions. You make yourself confident. Everyone wins. For example if there is something to be said that is very important and you forgot it, you can remember by looking at the plan. They could monitor the time schedule. In fact, it could serve as a development schema of the teachers."*

> *PT_2: "The lesson plan is helpful for the teachers. If you make the plan for each lesson, it will be fruitful for you and your students."*

The prospective teachers thought that a lesson plan is not only for students' understanding of the subject but also for teachers. They declared that the lesson plans could make the lessons easier to organize for teachers. They believe that preparing lesson plans could help teachers to monitor themselves during the lessons.

Discussion, Results and Suggestions

Lesson planning has the potential to reveal prospective teachers' knowledge of content, teaching and students' understandings (Chick & Pierce, 2008). From this point of view, we tried to explore the developmental process of prospective secondary mathematics teachers' knowledge of lesson planning during the "Teaching methods in mathematics education" course. For this purpose, we interviewed eight prospective teachers. As stated in the literature, we have seen that the participants improved their pedagogical content knowledge about lesson plan (Prescott et al., 2013). This could be interpreted as a natural result of having such a Teaching methods course as we mentioned before. The findings indicate that prospective secondary mathematics teachers' knowledge of mathematics lesson plans change from structural level to instructional level via teaching methods course. At the beginning of the course, the prospective teachers mostly discussed structural issues such as sections of a lesson plan, elements of teaching process, and classroom

context. After the course, they were able to provide elaborative information about how to organize an instructional process. They also put the acquisitions in center of the lesson plan. It is possible to say that the prospective teachers improved not only their knowledge of content and teaching, but also their knowledge of curriculum (Hill et al., 2008; Tatto et al., 2008). The prospective teachers obtained further knowledge of content and students (Hill et al., 2008) after the course emphasized the significance of considering students' motivation and understandings while preparing a lesson plan. For example they highlighted the importance of being aware of individual differences and evaluating students' understandings in the classroom. Having this knowledge could prepare the prospective teachers for unexpected situations (Shalaway, 1997) in their early career.

Prospective secondary mathematics teachers had never mentioned mathematical content before they took the course; however, they had recognized the role of their own mathematical content knowledge, and the effect it has on designing a plan, which may result from the instructor's point of view in the course. The instructor emphasized the importance of mathematical content in both being a rigorous mathematics teacher and preparing a lesson plan according to the acquisition in curriculum during the course. Accurate mathematical knowledge itself is not enough for an efficient lesson plan; however, it still plays a key role in structuring a lesson plan (Ball et al., 2005; Ozogul & Sullivan, 2009).

The prospective teachers also started to review a lesson plan as a guidance for their teaching experiences, which may be due to the fact that they considered themselves as more of a teacher at the end of the course. We believe that it could be useful to provide prospective teachers with feedback so as to support the development of their knowledge of lesson plans as we did at the end of the course. As the prospective teachers presented their lesson plan, they received constructive feedbacks not only from their instructor but also the other prospective teachers. The Teaching methods course enabled the prospective teachers to effectively discuss and reflect on all lesson plans they presented. They gained insight into preparing a lesson plan both through their own experiences and also the experiences of others. The context itself served as a teaching tool and a way to develop their pedagogical content knowledge, as stated in the literature (Chick & Pierce, 2008; Prescott et al., 2013). The role of such a context in constructing pedagogical content knowledge of prospective teachers could be studied in future researches. Further researches that are designed to investigate how prospective mathematics teachers use lesson plans in their teaching experience, could also provide significant implications for both prospective teachers and teacher educators.

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