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Getting Ready for the Profession: Prospective Teachers' Noticing Related to Teacher Actions

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Abstract: The aim of this study was to investigate what the prospective elementary mathematics teachers noticed and how their noticing changed in an environment in which they discuss on video cases. To achieve this aim, we asked senior elementary mathematics prospective teachers to watch and discuss videos depicting real elementary mathematics classrooms. In this qualitative study, the main data sources were the participants' reflection papers and interviews with the focus participants. The online discussions among the focus participants were also analyzed. For the analysis, the Learning to Notice framework (van Es & Sherin, 2002) was used. The findings suggested that prospective teachers noticed several issues related to teacher actions that reflect specific domains of teacher knowledge, and their noticing increased over time. In conclusion, it is suggested that the use of case-based pedagogy in teacher education is an effective way to help future teachers get ready for the profession.

Introduction

Teacher education programs are the fundamental periods for future teachers to begin to think like a teacher, and they are the first opportunities for them to learn how to teach. These programs should model the complexities and challenges of teaching in order to help prospective mathematics teachers develop the necessary professional knowledge (NCTM, 1991). Although initial teacher education helps prospective teachers with gaining theoretical and some practical knowledge, it does not adequately prepare them for the complexity of professional work (Greene & Campbell, 1993; Veenman, 1984). When they enter the profession, novice teachers have to rapidly implement the knowledge they have acquired, develop appropriate skills and attitudes. Novice teachers experience difficulties in the initial learning by doing period (Flores, 2006; Hebert & Worthy, 2001), and the responsibility load limits the opportunities for learning to teach (Huling-Austin, 1992). Thus, it is important for prospective teachers to receive sufficient education and training to minimize the problems they will face and maximize their opportunities for learning to teach. In keeping with these ideas, in this study, we created an environment for prospective teachers to prepare them for the real classroom and to examine what prospective teachers noticed and how their noticing changed in relation to elementary mathematics teaching as they watched and discussed video cases of real mathematics classrooms in an online discussion forum.

Case-Based Pedagogy

The *case idea* (Sykes & Bird, 1992) as a pedagogical approach (called case-based pedagogy) can be employed in teacher education programs to improve prospective teachers' noticing skills to prepare them for real classrooms. Shulman (1992) defines the case methods of teaching as "...the methods of pedagogy employed in conjunction with teaching cases" (p. 19). The literature suggests that case-based pedagogy is an effective method to prepare teachers for the complexities of teaching (Cherubini, 2009; Harrington & Garrison, 1992; Mayo, 2004) as it provides teachers with opportunities to reason about teaching (Harrington, 1999).

Case-based pedagogy might also be a tool for teacher development as it "...embraces ideas that are grounded in critical curriculum inquiry and the importance of teachers' knowledge" (Arellano et al., 2001, p. 506). Borko et al. (2000) suggest the use of cases to improve teachers' pedagogical knowledge. Similarly, Hammerness, Darling-Hammond, and Shulman (2002) underlined that the use of cases in teacher education can provide prospective teachers with opportunities to develop their professional knowledge.

In order to facilitate future teachers' preparation for actual classroom teaching, in this study, case-based pedagogy was employed. More specifically, case-based pedagogy was used to examine what prospective teachers notice related to teacher actions for effective teaching, and how their noticing changes.

Learning to Notice Framework

The *Learning to Notice* framework was developed to support teachers in learning to notice (van Es & Sherin, 2002). Van Es and Sherin (2008) state that it is possible to examine the development of *teachers' professional vision for reform pedagogy* through the use of this framework (p. 245). Through this framework it is possible to perceive the changes in teachers' thinking over a period of time. Studies employing this framework suggest that it is possible to improve prospective teachers' noticing skills (Alsawaie & Alghazo, 2010; Star & Strickland, 2008).

Van Es and Sherin (2008) underline that if prospective teachers are given opportunities to develop norms to notice important features in a classroom environment and are able to interpret classroom interactions, they might learn to analyze teaching. Thus, it is important to create environments to develop prospective teachers' noticing skills since "in the context of reform, noticing is a skill that teachers may need to develop further" (van Es & Sherin, 2008, p. 245). Additionally, Star and Strickland (2008) comment that it is important to develop teacher candidates' observation skills in order to help them think about teaching and learning process more deeply. They suggest that it might be possible to increase the effectiveness of field observations through developing prospective teachers' noticing skills.

In the *Learning to Notice* framework, there are three key aspects of noticing; 1) identifying what is important or noteworthy about a classroom situation, 2) making connections between the specifics of classroom interactions and the broader principles of teaching and learning they represent, and 3) using what one knows about the context to determine the reason for the classroom interactions (van Es & Sherin, 2002, p. 573). In the present study, the *Learning to Notice* framework was used to examine future teachers' ability to notice important aspects of teaching.

Significance of the Study

This study created a professional development environment for prospective teachers in which they could develop noticing abilities with respect to the teacher actions through a case-based pedagogy. Via reflective dialogue on cases, it is believed that prospective teachers may more easily pass through the transition period from being student to becoming a teacher, and they can start thinking like a teacher (Jay, 2004).

When it comes to the reform-based visions of teacher education, it is necessary to provide prospective teachers with opportunities to become familiar with the responsibilities demanded of them in terms of effective teaching. This study created a learning environment in which prospective teachers had opportunities to discuss teacher actions gained from watching videos of real classroom practice and learn from each others' points of view.

This study also made use of video cases as a professional development tool. Researchers state that video analysis is a way to learn classroom practices for teachers (Bayat, 2010; Borko, Koellner, Jacobs, & Seago, 2011; Cherrington & Loveridge, 2014; Santagata & Angelici, 2010; Santagata & Guarino, 2011; van Es, Tunney, Goldsmith, & Seago, 2014). In that point, Star and Strickland (2008) state that "there is little research that confirms whether pre-service teachers attend to the aspects of the video(s) that teacher educators anticipate or desire" (p. 107). Since more research on the use of videos in teacher learning is needed (Marsh & Mitchell, 2014; Seidel, Stürmer, Blomberg, Kobarg, & Schwindt, 2011), it is believed that this study may contribute to the literature in relation to what teachers gain from the use of video-based cases in teacher education.

Purpose and Research Questions

The purpose of this study was to examine what prospective elementary mathematics teachers noticed in case study videos related to mathematics teaching that they watched and their discussions in an online forum. Specifically, our research questions were 1) What do prospective elementary mathematics teachers demonstrate that they noticed when watching video cases of elementary mathematics instruction during their engagement in online discussions? 2) To what extent did elementary prospective mathematics teachers' noticing change during their video case-based teacher education?

Methods

The nature and purpose of the present study requires understanding of prospective teachers' experiences in an environment in which they discuss on video cases depicting real practices in elementary mathematics classrooms. In other words, it was vital to fully understand their perspectives and interpret the changes they went through, to obtain a large and in-depth picture of the experiences that the prospective teachers underwent. For this, a qualitative research approach was needed. More specifically, we conducted a phenomenological study since we tried to describe "...the meaning for several individuals of their lived experiences of a concept or a phenomenon" (Creswell, 2007, p.57). Mainly, our focus was to describe what prospective teachers had in common as they engaged in a video-case discussion.

In this study, we examined what prospective teachers noticed, and used different sources of information to collect data in order to provide in-depth picture of the experience. The main data collection instruments were the participants' reflection papers and transcripts

of interviews with the 15 selected focus group participants. We also used the data from the online discussions to strengthen our findings.

Context

The participants in this study were senior prospective teachers in the Elementary Mathematics Education [EME] program at a large public university in Ankara, Turkey. The EME program aims to educate future mathematics teachers who are capable of teaching the subject on the basis of student understanding rather than a rote learning approach. The prospective teachers graduating from this program will teach mathematics in primary and middle schools. They were purposively selected as participants since they were close to become teachers. These prospective teachers have completed most of their course load including mathematics, pedagogy, and education courses. During the study, they were in their seventh semester in their final year, and they were taking Mathematics Teaching Methods and School Experience II courses. In the Teaching Method Course, they were learning about issues related to effective and reform-minded teaching such as how to teach mathematics for student understanding, the knowledge a teacher should have, and what kind of misconceptions students might have about mathematical concepts. They were receiving instruction to improve their knowledge on issues such as facilitating student understanding, and how to conduct student-centered lessons and to make use of multiple representations. While taking the course of Mathematics Teaching Methods, the participants also complete their last field experience in the School Experience II course. The online video-case discussions were held during the School Experience II course. In this course, prospective teachers were expected to undertake school observations in terms of organization, management, daily activities, group activities, teacher and student responsibilities, courses, school problems, and materials.

Selection of Participants

The data was collected for an entire semester from the senior elementary mathematics prospective teachers. During the semester, there were two sections taking the School Experience II course, and each section was divided into two groups forming 4 different discussion groups in total. The main reason for forming four different groups was to allow richer discussions since too many or too few participants might not be effective. The first group contained 5 females and 5 males, the second group consisted of 6 females and 4 males, the third group comprised 10 females and 3 males, and finally the fourth group contained 9 females and 3 males. For the online discussions, we worked with 45 prospective teachers (30 females and 15 males), and asked them to watch and discuss six videos of real mathematics classrooms.

In this study, 15 focus participants were purposively selected from each of the 4 groups; taking the participants' gender, discussion groups, and grade point averages (GPA) into consideration. From each of the four discussion groups, 3 or 4 prospective teachers were selected as focus participants. There were 4 males and 11 females in the focus group. Participants' ages ranged from 21 to 23 and their GPA's ranged from 2.09 to 3.38 out of 4. Some of the participants had some private teaching experience. It should also be noted that the majority of the focus participants intended to be mathematics teachers when they graduate.

It should also be noted that, while the data of reflection papers and the online discussions were gathered from whole 45 participants, in this study, we only analyzed the data from the 15 focus participants' interviews, reflection papers, and online discussions.

Video-Case Study

During one semester, the participants watched 6 videos which, except for the 5th grade and one of the 6th grade videos, had been filmed by the first researcher in real classrooms. The teachers in the videos were teaching different topics in mathematics. The videos were targeted to share teachers' real implementation processes. To decide which videos to select from those recorded, the first researcher viewed all the videos, and prepared checklists of the critical points in the videos with respect to the teaching and learning activities consistent with effective and reform-minded teaching. That is, the main issues listed in the checklist included; conducting student-centered lessons; facilitating student understanding; guiding and motivating students; helping students discover mathematical concepts; developing activities and applying them in classroom, encouraging students to question, think, and discuss; and letting students build their own knowledge (TTKB, 2006). In addition to the checklists, expert opinion was taken from a mathematics educator. With the use of the checklist and the critical points listed by the mathematics educator, the videos most suitable for discussion were shared with the prospective teachers.

The videos recorded a selection of male and female in-service and prospective teachers teaching different levels (Appendix 1). In the first video, a female prospective teacher was teaching the properties and surface area of a cube to 5th graders. In relation to this video, the participants were asked to discuss online whether the teacher was successful at facilitating student understanding. In the second video, a female teacher with 3 years experience was asking students to solve the stair-case problem related to pattern finding, and the participants were asked to discuss the aim of the lesson and the teacher's instructional activities to achieve those aims, and the students' mathematical thinking. In the third video, a male prospective teacher was teaching ratios and proportion to 6th graders. For this video the focus of the discussions was on the quality of instruction and whether the activities were in keeping with the aim of the lesson. In the fourth video, an in-service male teacher with 15 years experience was teaching measurement of liquids to 6th graders. In this video, participants were encouraged to discuss the aim of the lesson and what activities teacher devised to achieve the aims, and whether those aims were attained. The fifth video showed a female teacher with 20 years experience teaching the multiplication of decimals to 6th graders. After discussing the aim of the lesson and what students learned, the participants were asked to discuss how to make it more effective. In the last video, a female teacher with 26 years experience was teaching the concept of interest to 7th graders, and the participants were asked to discuss which aspects of the lesson were effective or not.

There were different discussion prompts for each of the 6 videos since the dynamics of each video varied (Appendix 1). For example, the first video was suitable for the reflection on the teacher's facilitation of student understanding and building a transition between two different concepts. The second video was more appropriate as the stimulus for a discussion on how to improve the lesson to enhance student learning while the third video was suited to a reflection on the selection of the activities. The fourth video was more fitting for the discussion of whether the aims of the lesson were attained since the teacher in the video appeared to be conducting a teacher-centered lesson although he was thinking the opposite. The fifth and the last video were appropriate for the participants to reflect on whether those lessons were consistent with effective teaching. The discussion prompts were gradually

introduced to the participants for each video each week. The participants were informed about the topic and focus of each video immediately before watching them in the class with other students. The videos were also available to be rewatched during the discussions.

Process

Each week the prospective teachers watched a video in the classroom and they wrote reflection papers for each video immediately after they watched the video. The participants were given a sheet on which they were asked to answer the question “What did you see/notice in the video and what aspects did you think stood out?” The participants were given 15 minutes to reflect on the video they had watched. Then, they discussed each video on the online discussion forum over the following week. The reflection papers aimed to catch the initial and individual noticing of the participants before discussions, and also to determine the possible progression in their noticing skills. These papers were read and utilized by the first researcher before the discussions to effectively direct the flow of the discussions.

For the online discussions, the participants were distributed into 4 groups to discuss the cases on an online forum called the METU-Online Forum, and respond to the questions raised by the first researcher as the moderator. The moderator tried to create a rich learning community for the participants, and to provide opportunities for them to share different perspectives. She tried to create a learning environment that would not discourage the prospective teachers, and in which they were in charge of their work (Fernandez, 2005).

In order to prepare the discussion questions, a mathematics educator and a mathematics teacher were asked to watch the videos before starting the discussions. The lists acquired from these experts were helpful in asking more effective questions during the discussions. Additionally, reading and utilizing the prospective teachers’ reflections on videos before each online discussion session was helpful in more effectively directing the flow of the discussions. Per each video, on average, three main questions were raised. The major questions raised by the moderator were mainly concerned with the aim of the lesson, teacher activities in the videos, student understanding, and teacher responsibilities for effective teaching (Appendix 1). In addition to asking questions specific to each video, participants were also guided directly to the issue of effective teaching and reform-minded curriculum, and to related textbooks. During the online discussions, participants were also free to raise their own topics, and were encouraged to ask each other questions.

The other main data collection tool was the face-to-face interview with each of the 15 prospective teachers which allowed deeper and more detailed information gained from the participants concerning the video case-based discussions. The interviews with the focus participants were held individually, and were carried out at the beginning, in the middle, and at the end of the study. The aim of the first interview was to obtain information about what the participants noticed in the first video in terms of teacher actions for effective teaching. The focus participants were asked to respond to questions about whether and how their noticing changed after the discussions, their ideas concerning the teacher’s actions in the video after reflection and discussion, and their post discussion evaluation of the lesson shown in the video. With the second interview, our aim was to understand the changes in their noticing skills after watching three videos and discussing them in the forum. The participants were asked questions such as how their noticing shifted after watching three videos and entering into the discussions, in which aspects was the video consistent with effective teaching, what did they gain from the experience in terms of their future as teachers. Our target in the last interview was to understand how the participants analyzed the six videos, the kind of changes they went through during the experience, and what they learned from the

whole experience. More specifically, we asked participants what they noticed most during the experience, whether their noticing shifted and if so, how did it change, what they could say about teacher actions reflecting domains of teacher knowledge, how consistent the videos were in relation to effective teaching, and how the experience influenced their observations in real classrooms during the school teaching practice. The interview questions were open-ended. For the validity, two mathematics educators reviewed the interview questions. Each interview was conducted by the first researcher and lasted about 45 minutes long.

Data Analysis

To analyze the data, we employed a constant comparative method developed by Glaser and Strauss (1967). Accordingly, the first researcher and a mathematics educator compared different occasions in the same or another set of data, and this comparison led to tentative categories. We also compared the categorizations, and determined the similarities and differences. Then, we grouped the data into similar dimensions, labeled them and they became the categories for the analysis (see Appendix2). With respect to the unit basis selected in the data analysis, the prospective teachers' responses to the interview questions and the ideas included in the interviews, in the reflection papers, and in the online discussions were examined; and one or two sentences or an entire paragraph or more was coded (De Wever, Schellens, Valcke, & Van Keer, 2006; Merriam, 1998). Merriam (1998) states that a unit of data might be any meaningful piece of data which gives the smallest piece of information, and it can either be a sentence or pages-long-field notes.

We coded the interview transcripts, the reflection papers, and the online discussions of the focus participants with the help of the analytic framework *Learning to Notice* (van Es & Sherin, 2008, 2010) in order to examine what the participants noticed over time. In this framework, there are five dimensions in which to analyze the data; Actor, Topic, Stance, Specificity, and Video-focus. In our analyses, we focused on what participants identified as important, and we limited the coding categories to the *Actor* dimension in order not to lose the main focus of the study. This dimension refers to the person the participants comment on (teacher, student, curriculum developers, self, other). We again limited our focus to the *teacher* as the *Actor*.

To label the new themes and categories and finalize the codes, the first researcher met with a mathematics educator and discussed the codes emanating from the data. The codes were both derived from the data and from the theory where the open coding process was resulted in themes related to Lee Shulman (1987)'s knowledge categories. The main themes were established, and the main and sub-issues were put under the main themes in a matrix. During this process, a table was created, the codes were allocated into the different categories, and with the help of a mathematics educator the codes were finalized (see Appendix 3).

To ensure the reliability during the coding procedure, the codes were discussed with a mathematics educator who had many years teaching experience at the university. The second coder was a doctoral candidate in mathematics education. To increase the percentage of the agreement which was initially about 70%, we discussed our coding in a two-way conference, finally arriving at a total consensus. In order to maintain the trustworthiness, multiple sources of evidence were used (data triangulation); data was collected over an extended period of time; different evaluators were used (investigator triangulation); direct quotations (verbatim) were used in order to decrease the amount of inferences; and feedback was received from different educators (Johnson, 1997).

Findings

Noticed Topics about Teacher Actions

On completion of the data analysis, we came up with 3 main issues with a number of sub-issues related to teacher actions that reflect specific domains of teacher knowledge, namely, Pedagogical Content Knowledge (PCK), General Pedagogical Knowledge (GPK), and Curriculum Knowledge (CK). These knowledge categories are defined by Lee Shulman (1987). Shulman states that teachers require a good knowledge of the subject; content and general pedagogy; the curriculum; learners and their characteristics; educational contexts; and educational ends, purposes, values, and their philosophical and historical bases (see Shulman, 1987, p. 8). Accordingly, pedagogical content knowledge, which is related to how to teach subject matter content, includes the representations of ideas and the ability to choose the representations are most useful for student understanding, understanding students' difficulties and their typical misconceptions, and knowing which topics students would find interesting. General pedagogical knowledge mainly includes classroom management and the organizational techniques and strategies. Finally, curriculum knowledge consists of the arrangement of the topics in a curriculum, and how to use the curriculum resources in order to organize instruction (Shulman, 1987).

Similarly, in our categorization, pedagogical content knowledge was regarded as the issues related to student understanding such as their thinking, anticipating their difficulties, and being able to produce strategies in classrooms in order to help students better understand the content. General pedagogical knowledge was taken as covering classroom management techniques, and knowledge of learners and approaches to learners. Finally, curriculum knowledge was considered to be understanding the reform-minded elementary mathematics curriculum, being able to reflect on lesson plans and use curriculum resources such as textbooks and manipulative.

It should be noted that in this paper, only the major sub-issues are presented, and the other minor sub-issues noticed by less than half of the participants were eliminated. The noticed issues in the first, second, and third interviews and reflection papers are given in Appendix 2. For each sub-issue, frequencies are provided for both interviews and reflection papers. For example, in the phrase "noticed (9;3)" in Appendix 2, the first intervention title indicates that 9 participants noticed the related sub-issue in the first interview and 3 participants noticed it in the first reflection papers. The definitions of each sub-issue are given in Appendix 3.

Noticed Issues related to Teacher Actions Reflecting Pedagogical Content Knowledge (PCK)

This was one of the issues most discussed during all interviews and reflection papers. More specifically, in the first interview, participants mostly mentioned the sub-issues *student understanding* and *representations* related to PCK. In the second interview, in addition to the issues noticed in the first interview, participants also noticed *real life*, and *activities* sub-issues. As in the first and second interviews –in the third interview all the participants talked about PCK, and the most noticed sub-issues were the same as in the second interview with the addition of *understanding*, and *inquiry* sub-issues.

For example, one of the common issues related to PCK was *representations*; that is the use of multiple instructional methods and multiple representations, selecting the most appropriate method for student understanding, and using different instructional methods and

conducting effective and student-centered lessons. The *representation* sub-issue was noticed by 8 participants in the first interview, and this increased to all 15 participants in the third interview. One participant (P5) explained in the third interview (I3) that there are multiple ways of representations in effective teaching, and it is a responsibility of teachers to know and use them:

There is not only the use of counters in effective teaching; there is the number line, different materials, different activities that are used to explain a subject. There are many of activities. We should know and learn all of them so that the students can learn in the way they can easily understand. If this is our target, we have to do this... Not all students learn in the same way... (P5-I3)

Parallel to the first interview, in the first reflection paper (R1), Participant 6 commented on the same issue concerning the effectiveness of using multiple representations on student understanding:

The fact that the students were shown the open shape of the cube using materials and verbal description this indicates that different instructional methods were employed in the lesson. This makes student learning easier for those who learn in different ways (P6-R1)

Another noticed sub-issue related to PCK was *activities*; creating activities, familiarizing students with the activities, selecting appropriate activities and examples, preventing students from perceiving activities as games, and applying activities appropriately. This sub-issue was noticed by 7 participants in the first interview, 12 participants in the second, and 13 participants in the third interview. One of the participants reflected in the first interview that:

The role of the teacher, of course, is to plan the activity appropriately. There should be no unnecessary elements in the activity. For example, I found an unnecessary element; after the teacher put the shapes on the board, the students only found the areas of the single squares. However, they could have found the whole area, and then reach a generalization from that point. The students did not understand that the generalization was coming. In my opinion, the teacher could have made her direction more clear. (P15-I1)

To conclude, the participants noticed several teacher actions reflecting teachers' pedagogical content knowledge in all the interviews and reflection papers. Among these issues, participants mostly mentioned using multiple representations; making activities; having students justify their answers; and ensuring student understanding. These sub-issues were noticed more after the first interview as the participants had the opportunity for the further discussions.

Noticed Issues related to Teacher Actions Reflecting General Pedagogical Knowledge (GPK)

Another main issue the participants discussed most during all three interviews and the reflection papers was General Pedagogical Knowledge (GPK). More specifically, in the first interview, participants mostly mentioned the sub-issues of *reasoning, management, facilitation, student centeredness, and pressure*. In the second interview, the participants again mentioned all the sub issues but this time instead of *pressure* they preferred to talk about *approach*. In the third interview, the most noticed sub-issues were *facilitation, reasoning, student centeredness, management, and approach* with the addition of the *communication* sub-issue.

The frequencies show a change in the participants' noticing from the first to the last interview. The sub-issues *facilitation, reasoning, communication, approach, and shaping*

students were noticed more from the first to the last interviews while *management* and *pressure* were noticed less.

In relation to the noticed sub-issues related to GPK, several participants reflected on *management* issue in the interviews and in the reflections. More specifically, participants talked about issues such as; managing the class and time, setting up the rules, and establishing order. Participant 4 reflected on this issue in the first interview criticizing the teacher for not being able to manage the class:

The first thing I noticed was that there were too many students and the classroom was too small. Because of this, it was hard for the teacher to approach the students. There was too much noise because of the crowded conditions. I observed that the teacher had difficulty with ensuring silence. For example, since the teacher couldn't maintain silence when she got an answer to her question from a student, other students didn't hear what that student was saying. Except for the noise, there was chaos after each question posed, and the teacher did nothing to prevent this. (P4-I1)

Similarly, in the second interview, although the frequency was decreased, the majority of the participants noticed and reflected that it was among the responsibilities of teachers to manage the class and time, set up the rules, and secure order. For example, Participant 15 criticized the teacher thus:

To be honest, I didn't like it [the lesson], because I didn't like her attitude during the activity... I mean, she couldn't manage the students well. (P15-I2)

In the online discussions, participants also reflected on this issue. To give an example, during the online discussions (OD) after watching the first video, one participant focused on classroom management as below:

I think that the teacher tried to encourage the students to discover a topic through materials, but she didn't succeed. Because one of the most important things to consider while letting students discover a topic is to be able to manage the classroom, and this teacher struggled a lot with that. She couldn't make students listen to each other while one of them gave an answer, and there was constant murmuring in the classroom. Additionally, one of the requirements of a successful discovery method instruction is that the teacher periodically sums up the lesson and draws a conclusion. That way, any misunderstandings can be resolved. However, the teacher in the video only summed up at the end of the lesson, and unfortunately couldn't do it since she couldn't manage the time. (P4-OD)

Another most popular issue noticed in interviews and reflection papers was *reasoning*. The participants reflected that teachers should motivate students to think and reason, should not encourage them to memorize, give the underlying meaning of concepts, let students build their own knowledge, encourage them reach generalizations, and ensure long-lasting comprehension. The number of the participants' noticing this sub-issue increased from the first to the last interviews and similarly in the reflections. For instance, in the first reflection paper, Participant 12 referred to the role of reasoning in student learning with understanding:

The fact that the teacher asked students to explain their answers while they were sharing the properties prevented them from memorizing and let them learn with understanding (P12-R1)

Parallel to the interview and reflections, in the online discussions, participants reflected on this issue. For instance, during the discussions on the first video watched, participants focused on the fact that the teacher in the video didn't encourage the students to

think and reason, but let them memorize. Participant 6 reflected that:

The students knew almost all of the properties of a cube. They were even able to talk about the parallelism of opposite sides, which shows that they knew it already. I mean I don't think they discovered it [in the lesson]. However, in my opinion while stating the properties of a cube, the first thing they should say was that it was three-dimensional. They were not aware why an object was 3D. Even though the teacher elicited real life examples, she didn't connect the cube to the main subject which was the 3D shape. (P6-OD)

As seen from the comment above, Participant 6 noticed that the issue was missing in the lesson in the video thus she felt that there was no reasoning in the lesson. Similarly, another participant (Participant1) criticized the teacher for making the students memorize, and this participant provided the following suggestions to improve the lesson:

In my opinion, the students were used to memorizing. I mean without discovering or reasoning. Giving them prisms to hold and encouraging them to use their previous knowledge, students could be motivated to list its properties without being afraid of making mistakes. (P1-OD)

Another issue noticed related to GPK was *communication* referring to the teacher's interaction with and between students and the setting up proper relationships was noticed with an increased frequency from the first to the last interview. For example, Participant 12 mentioned in the third interview that she noticed first the relationship between the teacher and the students:

The first thing that drew our attention in the reflections was the teachers' attitudes toward their students rather than the lesson. For example, there were teachers who were distant from their students or were not able to clearly answer students' questions. This is the most important thing, I think... I already commented on this for the last video. The teacher should communicate appropriately with their students. She should know what they want to explain. This was the first thing that came to my mind. (P12-I3)

Similarly, in the second reflection paper, Participant 4 reflected on this issue as in below:

There was no time lost at that time, but still she [the teacher] extended the duration of some parts unnecessarily. She could have used the time more effectively. (P4-R2)

To sum up, the most noticed sub-issues with an increase throughout the interviews were *facilitation*, *reasoning*, *communication*, *approach*, and *shaping students*. Another finding is that the percentages of noticing of the issues *management*, and *pressure* decreased through the interviews.

Noticed Issues related to Teacher Actions Reflecting Curriculum Knowledge (CK)

Curriculum Knowledge (CK) was another main issue the participants discussed most. More specifically, the most noticed sub-issue in the first interview was *materials*. In the second interview and reflections, the most noticed sub-issue was *introduction* with almost half of the participants also talking about *materials* and *student levels*. In the third interview, participants again noticed and mentioned the sub-issue *materials* and *student levels*, but they also preferred to talk about *reform-minded curriculum*, *being prepared*, and *introduction*.

In the frequencies (see Appendix 2), it is possible to see a change in participants' noticing from the first to the last interview. In all sub-issues related to CK, the number of the participants noticed each sub-issues increased from the beginning to the end of the experience.

For the noticed sub-issues related to CK, the majority of the participants mentioned the issue *materials* in all the interviews. In other words, most of the participants were aware that one of the responsibilities of teachers was to prepare and use correct materials in an accurate way without creating misconceptions, and prevent misconceptions through the use of materials. For instance, Participant 3 commented:

There is a lot of learning by seeing and doing in effective teaching. For this, the teacher prepared cubes, and she distributed them to the groups and wanted the students to learn by seeing and discovering... Later when she wanted the students to see the net of a cube, she asked them to open each of the cubes. (P3-I1)

Parallel to the first interview, in the online discussions, the participants reflected on the use of materials. For example, in relation to the first video, Participant 5 criticized the teacher for not managing materials appropriately:

... about the materials, it was nice that the teacher asked students to open up the cubes. But, as far as I observed, the cubes were not the same (the lengths of their sides were different). I think that it would have been better if the teacher had used cubes of the same size, because then the students could see the connection between the shapes as they opened the cubes and as they came up with different nets. (P5-OD)

For another sub-issue related to CK, the issue *introduction* referring to the effective introduction to the lesson, stating the aim of the lesson, and providing students with the basics, was mentioned by almost two third of the participants in the second interview where it was noticed by almost all of the participants in the second reflections. When compared to the first interview and reflections, it was seen that this sub-issue highly increased from the first to the second interviews. The increase in the participants noticing this issue was quite high from the first to the last interview. As an example, here is a comment from Participant14 reflected from the second interview concerning the teacher's roles:

He started the lesson by explaining the aim of the lesson, and what the students would do. Isn't it already one of the roles of a teacher? We should announce what we're going to do. (P14-I2)

Another sub-issue; *reform-minded curriculum* was noticed by almost all of the participants in the third interview. The participants talked about understanding the reform-minded curriculum and being able to adopt it. In comparison with the content of the first and second interviews, this was the most popular issue in the third interview as shown in the comment by Participant4 emphasizing the importance of understanding and implementing the reform-minded curriculum and blaming teachers for a lack of professional development. Here, it is seen that Participant4 was noticing what the teachers were doing wrong:

I would test the teachers after the seminars and workshops. I am very strict about that issue, because the reform-minded curriculum has been

introduced and you have to implement it. You should already know it. I don't even mention it. There is also the implementation aspect; the teachers don't even understand it. Teachers are disasters. Besides, the teachers I talked to during my internship were private high school teachers, not teachers teaching in a village school in the eastern part of Turkey. Maybe those village teachers are more capable of understanding the reform-minded curriculum. It is more related to personal development. You can't learn anything if you believe that you know everything. This is so important. I mostly notice this in the school where I am doing my internship... (P4-I3)

Similarly, in the third reflection papers, Participant15 blamed the teacher in the video for not being able to implement the reform-minded curriculum:

As in the previous week, we again face a teacher in this classroom who wants to give the impression that she is implementing the reform-minded curriculum using materials, but actually, she can't give up the traditional ways of teaching. This is a common problem of the teachers who have been teaching for a long time. (P15-R3)

In relation to the teachers' curriculum knowledge in the three interviews and reflections, the most interesting increase was seen in the issue *reform-minded curriculum*. While this issue was noticed by only one third of the participants during the first and second interviews, it was noticed by almost all participants in the last interview. The other issues showing increase throughout the interviews were *materials*, *introduction*, *being prepared for the lesson*, and *student levels*.

Discussion and Conclusion

The aim of this study was to examine what the prospective elementary mathematics teachers noticed through online video-case discussions and how their noticing changed over time. The findings revealed that the participants commented on several issues related to teacher actions that reflect specific domains of teacher knowledge in the three interviews and in the reflections as well as the online discussions. More specifically, pedagogical content knowledge, general pedagogical knowledge, and curriculum knowledge were the noticed main issues.

Our results also indicated that noticing some of the teacher actions related to teacher knowledge showed an increase through the three interviews. The issues showing an increase from the first to the last interviews were *facilitation*, *approach*, and *shaping students* under GPK; and *representation*, *activities*, *understanding*, and *inquiry* under PCK. The issues *real life* under PCK and *student levels* under CK showed an increase from the first to the second interview, and then they stabilized. Another point to underline is that the frequencies of noticing of *management* and *pressure* issues under GPK decreased throughout the interviews. There were also issues which either decreased or increased nonlinearly.

Discussion of the Findings

The findings of the online video-case discussions indicated that prospective teachers noticed some issues more at the end of the study that were emphasizing responsibilities of the teachers they have to carry out to teach effectively. Specifically, prospective teachers started to notice some teacher actions less such as managing the class, setting up the rules, time management and securing the order, and not putting too much pressure on students; and started to notice some actions more such as understanding effective teaching and reform-minded curriculum, facilitating and ensuring student understanding, connecting mathematics to real life, motivating students to think and reason, conducting student-centered lessons, using multiple instructional methods, preventing misconceptions, being able to understand student questions and their ideas, and asking students to explain and defend their answers (see Appendix 2). Our results are consistent with several studies in the literature that through the use of cases, it is possible to assist teachers to notice more about classroom interactions, and develop their ability to interpret and analyze several features of effective teaching by interacting with each other (Baran, 2007; Calandra, Brantley-Dias, & Dias, 2006; Fadde, Aud, & Gilbert, 2009; Koc, 2011; Lloyd, 1999; Rosaen, Lundeberg, Cooper, Fritzen, & Terpstra, 2008; Sowder, 2007; Tripp & Rich, 2012; van Es & Sherin, 2002, 2008; Walen & Williams, 2000; Zhang, Lundeberg, Koehler, & Eberhardt, 2011). In the present study, the participants analyzed classroom situations from different perspectives as in the study by Yadav et al. (2007), and interpreted them in terms of teacher actions reflecting teacher knowledge. In other words, through peer interaction and discourse, they started to develop professional knowledge (Blomberg, Sturmer, & Seidel, 2011; Manouchehri, 2002).

Consistent with the literature, in the present study, the prospective teachers had the opportunity to discuss and enhance their knowledge about effective teaching (Tripp & Rich, 2012; Walen & Williams, 2000; Zhang, Lundeberg, Koehler, & Eberhardt, 2011). Throughout the online video-case discussions, the prospective teachers reflected on the responsibilities of teachers, and discussed the effective and non-effective parts of the teaching process in the videos. As the participants in the study became more competent, they offered suggestions as to how the videoed teachers could improve the quality of the lessons. One of the participants (P4) even condemned judge in-service teachers for not adopting the reform-minded curriculum, and suggested ways to force them to do so.

Considering the increase in prospective teachers' noticing, different factors influencing such an improvement might be taken into account. The prospective teachers started to see new points of view and gained new perspectives on effective teaching as they participated in video case-based discussions and interacted with each other. They had the opportunity to see different classroom instructions and to discuss them. Through collaborative learning and interaction during the online discussions with the facilitation of a moderator, they were able to become accustomed to the learning environment. The prospective teachers started to motivate each other, focused more on the shared target, and improved their awareness on the issues related to effective teaching.

The findings also revealed that some of the teacher actions related to teacher knowledge showed an increase from the first to the second interview, and then they stabilized, or some of them either decreased or increased nonlinearly. At this point, the issues such as moderation and video selection come to the fore. The content of the videos watched as well as the discussion prompts on the videos might have an influence on what the participants notice and how their noticing changes.

It should also be noted that the increase in participants' noticing related to teacher actions reflecting teacher knowledge was not parallel in all the interviews and reflection papers. This finding is attributed to the fact that the reflection papers were written

individually before the group discussions, and the space and time provided was limited. Additionally, the reflection papers were written immediately after watching a video and were related to that particular video. On the contrary, although the interviews were also individual, they were held after the group discussions, and the second and the third interviews were conducted after watching three and six videos respectively. All these factors are believed to have an influence on the self reported participant' noticing in the reflection papers. The same factors also explain why the length of the quotations selected from the reflections was short in comparison to the interviews.

One last point to underline is that while it might be suggested that prospective teachers connect videos to their own experiences, it should also be considered that the courses the prospective teachers engaged in during this study and participants' observations during their school experience might also have an influence on what they obtained from the whole experience. In our case, the fact that the prospective teachers were taking Teaching Methods and Guidance Courses and were doing their internships possibly had an influence on what they noticed and what they obtained from the video-case based instruction. The online video-case based discussions eventually became a place to discuss what they had learned during the courses they received as well as what they had experienced during their internships. An alternative explanation might be that the private teaching experience of some of the prospective teachers also had an influence on the video-case experience. We observed that the prospective teachers who taught in test preparation centers or gave private lessons shared their experiences through connecting them to the videos.

Implications of the Findings

As there were not many opportunities for prospective teachers to understand effective teaching, and it was the time in which they undertook their internships in real classrooms; in the last year of their training, the prospective teachers started to see themselves as teachers. In addition to the internship experience, as they watched the mathematics teaching videos from real classrooms over a semester, the prospective teachers had a chance to improve their noticing skills related to teacher actions reflecting domains of teacher knowledge. They were able to connect what they had learned theoretically to what they experienced both during the internship and in the videos. Thus, it might be suggested that their awareness of teacher knowledge for effective teaching improved. As a result, experiences such as video-case discussions with a clear frame should be provided for prospective teachers throughout teacher education programs (Barnett, 2006). As Star and Strickland (2008) comment, in order to help prospective teachers understand teaching process and increase the effectiveness of field observations, prospective teachers' noticing skills should be improved.

The increase in prospective teachers' noticing demonstrates that while prospective teachers had ideas about knowledge for effective teaching at the beginning of the study, they started to notice and felt the need to discuss more on teacher actions as the discussions took place over time. Especially, the fact that they started to focus more on issues such as facilitating and ensuring student understanding rather than focusing on managing the class points that it is important to consider how teachers can learn to focus more on issues related to effective teaching. From this, we can deduce that prospective teachers want and need to focus more on issues related to teacher knowledge for effective teaching during their teacher education. Then, environments to develop prospective teachers' noticing skills should be created (van Es & Sherin, 2008). Providing future teachers with opportunities to

collaboratively analyze teaching in terms of teacher knowledge for effective teaching might help them get ready for the teaching profession.

To conclude, it is expected that a teacher education program gives teachers opportunities to notice, interpret, and use those interpretations for pedagogical decisions (van Es & Sherin, 2008), therefore, teacher educators should employ case-based pedagogy in their programs with a clear target and frame in mind. If video-case discussions are conducted from the first to the last year of teacher education programs, prospective teachers' awareness of teacher responsibilities can be maximized. In order to enrich the effectiveness of the courses such as Teaching Methods Courses and internship experiences, we believe that the employment of video-case discussions would be very beneficial. When prospective teachers watch different kinds of videos from different grade levels, individually reflect on those real classroom videos and then discuss and analyze them through on target questions, and create a knowledge base from those cases, it is believed that they can notice and learn several important points on effective teaching (Jay, 2004).

Limitations and Recommendations

In addition to its contributions, this study has also some limitations. First, in this study the online video-case discussions were conducted with a whole class of senior prospective teachers (45 participants), but the data that was analyzed was gathered from only 15 participants. Since the interaction among 45 participants during the discussions was rich, and there were about 5,000 messages sent to and from the participants, it was not feasible to analyze the whole interaction among all participants during the online video-case discussions. Thus, we chose to focus on the interviews of the focus participants, and to their reflection papers and online discussions. Although we do not consider that analyzing only the data from the focus participants negatively affected the findings of the study, we feel that similar studies might be conducted with different groups in different contexts, and with the analysis of the whole discussion group in a smaller context.

Another limitation is that, during the analysis period, except from the teacher actions, other issues related to effective teaching were ignored as they were outside of the scope of this study. For the analysis of data, the dimensions of *Actor*, *Topic*, *Stance*, *Specificity*, and *Video-Focus* (van Es and Sherin, 2002) might be used to obtain richer information on how teachers' noticing changes over time. Thus, it is recommended that researchers conduct studies to examine other issues related to teaching. Furthermore, the influence of the video-case discussions on teachers' practices can be examined to understand how cases guide the teachers' instructional practices and how they change their instruction according to effective teaching (Masingila & Doerr, 2002; Tripp & Rich, 2012; van Es and Sherin, 2010).

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Appendix 1: Videos and facilitator prompts

Teacher name	Status	Level	Content	Facilitator Prompts
Aydan	Prospective	5th grade	Geometry (Properties and surface area of a cube)	<ol style="list-style-type: none"> 1. First of all, let's discuss the teacher and student roles in this video. What do you think? Describe the classroom environment and culture and give examples. 2. In your opinion, did the students understand the 2D and 3D concepts? Do you think the transition between the dimensions was successful? Discuss with examples from the video. 3. Now, put yourself into the students' shoes who were trying to draw a cube on their notebooks. What were you thinking at that moment? What did you know?
Gizem	In-service with 3 years experience	6th grade	Patterns	<ol style="list-style-type: none"> 1. In your opinion, what was the aim of this lesson? What kind of instructional moves were made to reach the aims? Discuss with concrete examples from the video. 2. Now, imagine yourself as the students in the video, and try to understand what they were thinking. What were the following students thinking: the students who were making estimations for the given problem (min 02:27), the student who was drawing the blocks one under the other (min 11:47), the students who asked whether it could be 55x10 (min 12:59) and/or the group who told it was 15 for each 5 (min 14:13)? What do you understand from a comparison of these students in terms of their mathematical thinking? 3. Let's make a last evaluation for this lesson. What do you think the students learned/ were not able to learn in this lesson? How the activity might be improved to enhance student understanding? What other subjects it might be connected to or how it might be extended? Discuss what might be the next step in this lesson.
Mehmet	Prospective	6th grade	Ratios and Proportion	<ol style="list-style-type: none"> 1. What was the aim of this lesson? Discuss about the instruction in this lesson and whether the activities were appropriate to the aim. Provide examples from the video. 2. Now, think about the following part of the lesson in the video, and what the teacher might have been done. In your opinion, what might be the things to do in the following lesson? Then, I will share what the teacher did in the next part of the video so that we can talk about it together. 3. Attached are the raw video and the second part. Let's see whether your predictions were consistent with the second part of the video. Let's evaluate this video together, what do you think? Please discuss using specific examples from the video, and raise questions as many as possible.

Metin	In-service with 15 years experience	6th grade	Measurement (Liquids)	<p>1. What do you think the aim of this lesson was? What kinds of activities were undertaken to achieve the aims? To what extent the aims were attained. Discuss with examples from the video.</p> <p>2. Please look at the teacher and student roles mentioned in the vision and the approach of the reform-minded elementary mathematics curriculum. Which roles can you see in this video? Which roles are absent? Evaluate this video from this aspect as well.</p> <p>3. How would you assess this lesson? What might be the objectives of the following lesson?</p>
Nergis	In-service with 20 years experience	6th grade	Multiplication with decimals	<p>1. What was the aim of this lesson? What did the students learn/ could not learn in this lesson?</p> <p>2. Let's take this lesson and adopt it entirely to effective teaching. What we should do? What we should change? How should we teach this lesson? Please explain with specific examples.</p>
Gulsen	In-service with 26 years experience	7th grade	Interest	<p>1. Do you think this video was consistent with effective teaching? Which aspects were consistent and which aspects were not? Please discuss with examples from the video.</p> <p>2. If you were the teacher in this video, how would you teach this lesson? Let's share different methods and ideas in detail. Discuss how it is given in the teacher's book, and what is needed to make the students more active? What might be done to improve this lesson? Provide specific examples.</p> <p>3. We talked about how the teacher gave instruction. Well, what do you think about the level of the teacher's subject matter and pedagogical knowledge? To what extent was she successful in transferring her knowledge to real life teaching?</p>

Appendix 2: Noticed issues in the first, second, and third interviews and reflections*

ISSUES RELATED TO TEACHER KNOWLEDGE		1st	2nd	3rd
<i>Main-Issues</i>	<i>Sub-issues</i>	Interview and Reflection	Interview and Reflection	Interview and Reflection
Pedagogical Content Knowledge (PCK) (6 sub-issues)	REAL LIFE	Noticed (5;6)	Noticed (9;9)	Noticed (9;0)
	REPRESENTATIONS	Noticed (8;5)	Noticed (12;8)	Noticed (15;7)
	ACTIVITIES	Noticed (7;2)	Noticed (12;7)	Noticed (13;1)
	UNDERSTANDING	Noticed (1;2)	Noticed (3;1)	Noticed (8;8)
	INQUIRY	Noticed (5;8)	Noticed (7;6)	Noticed (9;6)
	STUDENT UNDERSTANDING	Noticed (10;8)	Noticed (10;3)	Noticed (12;4)
General Pedagogical Knowledge (GPK) (9 sub-issues)	FACILITATION	Noticed (9; 3)	Noticed (10;2)	Noticed (14;3)
	INSTRUCTIONS	Noticed (2;3)	Noticed (10;4)	Noticed (9;4)
	REASONING	Noticed (11;6)	Noticed (11;7)	Noticed (14;13)
	STUDENT CENTEREDNESS	Noticed (9;4)	Noticed (13;5)	Noticed (12;8)
	COMMUNICATION	Noticed (7;0)	Noticed (7;0)	Noticed (10;2)
	MANAGEMENT	Noticed (14;10)	Noticed (12;7)	Noticed (9;6)
	APPROACH	Noticed (4;0)	Noticed (8;0)	Noticed (10;7)
	PRESSURE	Noticed (9;2)	Noticed (5;0)	Noticed (1;3)
	SHAPING STUDENTS	Noticed (2;0)	Noticed (3;0)	Noticed (7;0)
Curriculum Knowledge (CK) (5 sub-issues)	MATERIALS	Noticed (11;10)	Noticed (7;2)	Noticed (12;6)
	INTRODUCTION	Noticed (3;1)	Noticed (9;13)	Noticed (7;2)
	REFORM-MINDED CURRICULUM	Noticed (5;2)	Noticed (5;0)	Noticed (14;3)
	BEING PREPARED	Noticed (3;3)	Noticed (3;0)	Noticed (8;0)
	STUDENT LEVELS	Noticed (4;1)	Noticed (7;1)	Noticed (7;2)

*The number of the participants noticing the sub-issues in the interviews and reflection papers respectively

Appendix 3: Final issues related to teacher actions that reflect domains of teacher knowledge

Main-Issues	Sub-Issues
Pedagogical Content Knowledge (PCK)	<i>Real-life</i> Connecting mathematics to real life, teaching concrete mathematics
	<i>Representations</i> Using multiple instructional methods, using multiple representations, selecting the most appropriate method for student understanding, using instructional methods in line with effective teaching, conducting lessons in line with the reform-minded curriculum
	<i>Activities</i> Performing activities, familiarizing students with the activities, selecting appropriate activities and examples, preventing students from perceiving activities as games, applying activities appropriately
	<i>Understanding</i> Being able to understand student questions and what they say, being able to answer student questions and providing feedback, giving concrete answers
	<i>Inquiry</i> Asking questions, encouraging students to inquire, asking for reasons and having students explain and justify their answers, not giving the rules
	<i>Student understanding</i> Ensuring student understanding, conducting student-centered lessons even if it takes more class time
General Pedagogical Knowledge (GPK)	<i>Facilitation</i> Facilitating student understanding, assisting students, helping students discover, providing hints when necessary
	<i>Instructions</i> Using clear and proper instructions and statements
	<i>Reasoning</i> Motivating students to think and reason, not letting them memorize, giving the underlying meaning of concepts, letting students build their own knowledge, making students to reach generalizations, ensuring long-lasting comprehension
	<i>Student-centeredness</i> Activating students, conducting student-centered lessons, giving students opportunities, not directing students too much, not being the center of the answer/approval process
	<i>Communication</i> Communicating with students, setting up proper relationships and establishing the interaction between the students
	<i>Management</i> Managing the classroom, setting up the rules, managing time and securing the order
	<i>Approach</i> Having positive approach towards students, not controlling too much, giving flexibility, not being too harsh, not behaving rude, not humiliating, and being decent
	<i>Pressure</i> Not putting too much pressure on students, approaching the students who make mistakes positively, and providing them opportunities
	<i>Shaping students</i> Shaping students, teaching them their roles, and distributing student roles appropriately
Curriculum Knowledge (CK)	<i>Materials</i> Preparing and using correct materials in an accurate way without creating misconceptions, preventing misconceptions through the use of materials
	<i>Introduction</i> Effective introduction to the lesson, stating the aim of the lesson, and providing students with the basics
	<i>Reform-minded curriculum</i> Understanding the reform-minded curriculum and being able to adopt it
	<i>Being prepared</i> Being prepared for the lesson
	<i>Student levels</i> Suitability of the lessons to the levels of the students