



HAL
open science

How does online professional development nurture teachers' noticing skills of students' thinking?: The case of data analysis

Emine Çatman-Aksoy, Ayşe Nur Ucuzoğlu, Mine Işıksal Bostan, Sibel Kazak, Seçil Yemen Karpuzcu, Reyhan Tekin Sitrava

► To cite this version:

Emine Çatman-Aksoy, Ayşe Nur Ucuzoğlu, Mine Işıksal Bostan, Sibel Kazak, Seçil Yemen Karpuzcu, et al.. How does online professional development nurture teachers' noticing skills of students' thinking?: The case of data analysis. Twelfth Congress of the European Society for Research in Mathematics Education (CERME12), Feb 2022, Bozen-Bolzano, Italy. hal-03751818v2

HAL Id: hal-03751818

<https://hal.science/hal-03751818v2>

Submitted on 19 Nov 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

How Does Online Professional Development Nurture Teachers' Noticing Skills of Students' Thinking?: The Case of Data Analysis

Emine Çatman Aksoy¹, Ayşe Nur Ucuzoğlu², Mine İşıksal Bostan³, Sibel Kazak⁴, Seçil Yemen Karpuzcu⁵, Reyhan Tekin Sitrava⁶

¹Middle East Technical University, Faculty of Education, Ankara, Turkey; ecatman@metu.edu.tr

²Pamukkale University, Faculty of Education, Denizli, Turkey; aucuzoglu19@posta.pau.edu.tr

³Middle East Technical University, Faculty of Education, Ankara, Turkey; misiksal@metu.edu.tr

⁴Pamukkale University, Faculty of Education, Denizli, Turkey; skazak@pau.edu.tr

⁵Dumlupınar University, Faculty of Education, Kütahya, Turkey; secil.karpuzcu@dpu.edu.tr

⁶Kırıkkale University, Faculty of Education, Kırıkkale, Turkey; reyhantekin@kku.edu.tr

This paper presenting one aspect of a design-based research project examines the development of a teacher's noticing skills in the context of data analysis and interpretation during her involvement in an online professional development program (OPD). For this purpose, the noticing skills of the teacher for the strategies used in the given students' responses were identified according to the modified version of the Jacobs et al.'s (2010) framework. By examining the teachers' discussions in the OPD, how the teacher's noticing expertise evolved throughout this process was investigated. Findings show that the teacher had difficulties in each interrelated skill of noticing at first. However, enhancement in her noticing of students' thinking in the context of data analysis was observed throughout her participation in the OPD.

Keywords: Collaboration, data analysis and interpretation, online professional development, teacher noticing

Teacher noticing, which is a key part of teaching expertise (van Es, & Sherin, 2021) and has been a prominent construct in the mathematics education literature for the last 20 years, is generally defined as all the processes that teachers engage to deal with the ongoing information in the classroom (Sherin, Jacobs, & Philipp, 2011). Teacher noticing is essential for efficient instructional practice (Blömeke et al., 2015) and has a direct influence on students' learning (van Es & Sherin, 2021). Although different conceptualizations exist about teacher noticing, researchers generally regard it as including two main processes: paying attention to and making sense of the notable situations in the classroom (Sherin et al., 2011). Jacobs and her colleagues (2010) add one more process to the above description, which is decision-making. Furthermore, they focus particularly on noticing students' mathematical thinking, which is an essential practice to promote students' learning (National Council of Teachers of Mathematics [NCTM], 2014).

Despite the value of teacher noticing, the relevant studies suggest that noticing is not an innate ability and the teaching experience alone does not provide sufficient improvement (Jacobs et al., 2010). Therefore, researchers attempted to develop teachers' noticing skills through variety of ways. For instance, Fernandez, Llinares, and Rojas (2020) showed evidence of enhancement in prospective teachers' noticing skills through sharing narratives about their own practices in an online forum and

collaborating with their partners and tutor. Moreover, Fernandez et al. (2020) and several other researchers (e.g. Klein, Fukawa-Connelly, & Silverman, 2017) agree that online systems “slow down the process of learning” (Clay, Silverman, & Fischer, 2012, p. 762) by giving teachers extra time to reflect on the situations, which allows them from different contexts to collaborate around instructional situations. The necessity for such environments has been felt even more during the COVID-19 pandemic. Taking into account the advantages of online environments for teachers’ professional development and its particular need during the pandemic, in this paper, we report one aspect of a larger research project which aims to support middle school mathematics teachers’ noticing skills of students’ mathematical thinking through their involvement in an Online Professional Development (OPD) program.

Although we focus on various mathematical contents in the project, the specific domain of students’ mathematical thinking considered in this paper is about analyzing and interpreting data which is the core process of the statistical reasoning (Jones et al., 2004). More specifically, this process includes “recognizing patterns and trends in the data and making inferences and predictions from data.” (Jones et al. 2004, p.103). In this research paper, our aim is to examine to what extent a middle school mathematics teacher attends to and interpret students’ inferences from a given data and how the teacher base their decisions on students’ understandings. Moreover, we are interested in how the teacher’s participation in the OPD could support the development of her noticing skills. In other words, the following research question guided the research study: How do a middle school mathematics teacher’s noticing of students’ thinking in the context of analyzing and interpreting data develop throughout her involvement in an online professional development program?

Alternative to the studies that use online systems for developing teachers’ noticing skills (Fernandez, Linares, & Valls, 2012; Fernandez et al., 2020), synchronous modes of communication were also used in the present study. Furthermore, in this research, we work with in-service teachers who have less than 15 years of experience. By this way, we have a chance to investigate novice teachers’ development of noticing skills regarding students’ understanding through collaboration with other colleagues from different schools across Turkey. Lastly, we particularly focus on the content of data analysis and interpretation, which gets relatively less attention in the available literature. Hence, this study may provide valuable information to the teacher noticing literature about the nature and development of middle school mathematics teachers’ noticing skills in the context of data analysis.

METHOD

This study is part of a large research project, which adopt design-based research as its methodology (Bakker, 2018). However, in the current study, we limited ourselves to a teacher, Aslı, as our case and examined how her noticing skills developed during her participation in the OPD.

Participants

The teacher Aslı was selected among the project participants who are 35 middle school mathematics teachers whose professional experience did not exceed 15 years and working in public schools in different cities of Turkey. We selected Aslı, who has 8 years of teaching experience, for this study because she was one of the very active teachers in the OPD. She tried to enhance collaborative

discussion environment by challenging the other teachers through her questions and making comments to their opinions.

Data collection

The data of the study was collected through the basketball problem, shown in Figure 1 below. This item was adapted by Gökce (2019) from the work of McGatha, Cobb and McClain (2002). In the problem, the scores of two basketball players were given during the last 10 games and the students were asked to decide which player the coach should choose. To decide, students should analyze the given data by using appropriate measures of central tendency and variability, and interpret the results in the given context. Research suggests two strategies that students generally use while answering such comparison questions. Therefore, student responses including those strategies are provided under the problem to examine how teachers notice them. As shown in Figure 1, Student 1 (S1) chose Barış by focusing on the mean score of each player. Her reasoning was partially correct since she ignored the variability of the given data. On the other hand, Student 2 (S2) also chose Barış by only focusing on the scores above a certain value, 15. Since he ignored the data less than 15, reasoning of S2 was not correct.

The coach will select one player from the school's basketball team to play in the all-star tournament. Below is a listing of points scored by the two candidates, which the coach thinks choosing, for the last ten games of the season.

Players	Points Scored in Games									
Arda	8	14	11	13	15	12	10	10	9	13
Barış	4	15	8	17	18	9	19	6	18	5

Which player would you recommend the coach to choose? Explain why.

Your students, Student 1 and Student 2, responded as follows:

Student 1 (S1)'s response:

He should choose Barış because while Arda's average is 11.5, Barış's average is 11.9.

Student 2 (S2)'s response:

He should choose Barış because he scored 15 or more in half of the games that he played.

Figure 1. The basketball problem

To determine the teachers' noticing skills before the discussions held in the OPD, teachers were asked to answer three questions suggested by Jacobs et al. (2010) based on the given cases. Subsequently, the basketball problem was discussed in the OPD with all teachers and research team during 3 weeks period. To summarize the discussion in the OPD, a synchronous session was conducted by the facilitator, a member of the design team and researcher who has many research studies on statistical thinking. In that session, teachers were expected to ask any questions they have in their mind regarding the problem and state their opinions regarding the online asynchronous discussion held among the teachers. Moreover, the facilitator mentioned some big ideas, such as the importance of the context in interpreting the given data, that did not get enough attention in the discussion. Lastly, semi-structured interviews were conducted to get in-depth information regarding the change in teacher's noticing skills after asynchronous and synchronous discussions. Teacher Aslı's written answers about two students' strategies, participating teachers' comments in the asynchronous discussion held in the OPD and summary session, and Aslı's interview transcripts were constituted the data for this study.

Data Analysis

For the analysis of the data, the theoretical framework by Jacobs et al. (2010) was modified by taking into consideration the data collected and the Teacher Recognition Skills framework developed by Kilic and Dogan (2021). Accordingly, while teachers' attending skills was examined at four levels, the skills of interpreting students' understanding and deciding how to respond were examined at five levels. In particular, teachers' attending skills, the ability of teachers to identify the mathematical details in students' strategies, were categorized as No Attempt, Lack, Limited and Robust Evidence as different from Jacobs et al.'s (2010) framework. For interpreting skill, identification of students' understanding based on their strategies, one more category, Substantial Evidence was added to the categories of attention. In relation to the last skill, the teachers' ability to base their decisions on students' understandings, were not evaluated as lack, limited and robust. Instead, categories named as No Attempt, Ignorance, Questioning, Challenging and lastly Responding to child and Incorporating were used based on the data. Based on this framework, we firstly determined the noticing skills of teacher Asli. Then, by examining the teachers' discussions in the OPD and the interview of Asli, we tried to find evidence in the development of her noticing skills and how those developments occurred.

Findings

In this paper we aimed to examine the development of a teacher's noticing skills during her involvement in the OPD program. Below, teacher's responses and the changes in her ideas during and after the discussions in the OPD will be provided for each noticing skill, respectively.

The teacher's evolving expertise in attending and interpreting skill

The below response presents teacher's attention to the given students' strategies before the discussion in the OPD:

Aslı: For S1, mean is the best way while comparing two groups. For S2, if the range is too much among the given data, it is correct to use median and the data which are above the median. We can say that statistical reasoning of S2 was correct if we just evaluated the player Barış. However, if the range is not too much while comparing two groups, as in the two groups in this question, comparison using mean will be a better approach just like S1 did. (Pre-test)

In this response, teacher attended that S1 used mean while comparing two groups, but she could not notice that S1 did not consider the variability while interpreting the given data. In other words, since she could not attend all the details in S1's strategy, she evaluated her reasoning inaccurately. The teacher managed to attend S2's reasoning as not correct; however, she focused on a concept, median, which was not used by the student. For these reasons, the level of teacher attention to the given student strategies was coded as lack.

Aslı began the discussion in the OPD with the same arguments in the pre-test . Following her comments in system, the below discussion held among some teachers.

T1: ...I believe that S2 chose Barış by considering the mode of the given data. Even though the answer of S2 is correct, I do not think that his reasoning is true.
Aslı: If S2 used the mode of the given data, should not he consider 18 [the mode of the data for Barış]? If S2 were to use mode, did not he say that 18 repeated much in the

given situation; thus, I choose Barış? I thought that since the sixth data is 15 when all of them are ordered, S2 focused on the median of the given data.

T1: I stated that S2 used the mode by grouping all the data, which are above 15. I do not think that we can take 15 as median since there are 10 games in total.

T3: Differently from above discussion, I think that neither S1 nor S2 reasoned correctly about this question. S1's reasoning is missing since she does not know that it is not enough to just look at one central tendency when the averages are so close to each other. In here, she should look at the ranges of the given data additionally. I could not understand which statistical concept S2 used with his statement of '15 and more points'. I do not think that he used the mode or median as mentioned in above comments.

Since teachers could not agree on evaluating S2's strategy, facilitator posed some questions to let teachers think and interpret the meaning of mode and median for the given data sets. After a long discussion in the system, teachers agreed that S2 did not use the concepts of mode or median, but simpler reasoning. In other words, they agreed that he only concentrated on the highest points in the given data. The following comment of Aslı in the discussion indicated that teacher's expertise in attending S2's strategy improved after this fruitful discussion.

Aslı: I believe that to organize data by grouping (She means to group the data with respect to highest and lowest scores) is correct to understand the nature/tendency of the data. However, it is missing. This is also valid for S2. While thinking the scores which are above 15, the data which are below 15 were lost. (Discussion)

When the data was analyzed in terms of interpreting skills, again her response indicated the lack of evidence in interpreting the students' mathematical understanding. The following response was received before the discussion in the OPD when Aslı was asked to interpret the students' mathematical understanding by considering the given students' strategies:

Aslı: For S1, the mean; that is, all values in the data group, is important because it is affected by the change of each data. For S2, on the other hand, if the difference among the data is high, to look at the median and the data above the median is a more accurate way to interpret the data. Because of the skewed distribution of the data, looking at the median is the most useful method for S2. (Pre-test)

Although teacher thought that S1 considered the importance of all data, S1's solution is not enough to make this claim. For S2's strategy, the teacher again focused on the concept of median as she attended in the first question. She argued that S2 knew to use the median when the data set is skewed; which indeed cannot be concluded from the student's strategy. Furthermore, the teacher did not mention variability or representativeness while interpreting the students' mathematical understanding.

When teachers were asked to interpret students' mathematical understanding in the given student responses in the OPD, Aslı's comment was as follows:

Aslı: S1 used only the mean when comparing the data groups, but did not include the concept of range, she should interpret these two concepts together. In S2's interpretation, grouping (She means to group the data with respect to highest and lowest scores) can be used to organize the data, but it is insufficient on its own for data analysis. It is seen that S2 has no knowledge of the concepts of mean, median, and range when looking at the solution. I think that the starting points of both students' reasoning are correct, but they are insufficient. To interpret the data with a single concept will not be sufficient in data analysis. (Discussion)

Most of the other teachers agreed with Aslı's comment in the following parts of the discussion. It was observed that Aslı mentioned the concepts of mean and range, which are necessary to interpret the mathematical understanding of the S1's strategy. For S2, teacher gave up her idea of median. Since teachers did not focus on the meaning that S1 attributed to the mean, facilitator let teachers discuss this through her questions. After this discussion, she interpreted S1's strategy by referring to the concept of representativeness during the interview while she did not mention it in her first comment in the OPD. Lastly, Aslı's following expression regarding her own development gave us one more evidence that discussions nurtured her interpreting skills of students' understanding. "The discussions in the OPD enabled us to brainstorm. It made me realize some new ideas. In particular, I became aware of the concept of range for this question".

The teacher's expertise in deciding skill

Before the discussion in the OPD, Aslı responded her next instructional moves as in the following:

Aslı: To show that both students' reasoning can differ with respect to the different situations, I give two data sets whose ranges are high and low and I ask which student is more successful. For example,
Case 1: Ayşe's savings during five months: 10, 50, 90, 90, 100 (Mean=68)
Case 2: Ali's savings during five months: 70, 80, 85, 85, 100 (Mean=84)
If we look at the mean, we interpret correctly and say that Ali is more successful. I can relate this question with the given problem situation by stating that it is not correct to say that Ayşe is more successful since she has 3 data which are above 90. (Pre-test)

During the interview, Aslı stated that she would use the above example for S2. Since Aslı believed that the use of mean is better for this problem, she asked such a question to S2 so that student can realize that he should use mean while answering this question. In other words, her aim of asking this question is to lead S2 to the teacher's correct answer. In addition, Aslı added some questions to understand both students' strategies better such as "Why did you use 15 in your answer?" or "Why did you use the mean?". For these reasons, the level of her expertise in deciding how to respond based on the given students' strategies were determined as questioning.

On the other hand, Aslı began the asynchronous discussion held in the OPD with the argument below:

Aslı: S1 should feel the need to look at the range while interpreting the data. So, for this purpose, I would ask which players she would choose if the mean of them were equal. Similarly, I would ask S2 which players he would choose if the number of data, which are above 15, were equal. My aim in this part is S1 and S2 should notice that their reasoning is missing and only one method is not enough while analyzing data. (Discussion)

Different from her first comment in the pre-test, Aslı asked some probing questions for S1 to let her notice that she should consider the variability of the given data. In the same way, the questions for S2 were to guide him to consider the data which are below 15. In other words, the teacher started challenging students, a higher level in the framework, to make them realize that their reasoning is underdeveloped. Although Aslı did not provide any explanation regarding how to guide S2 to the use of average in her first comment in the OPD, she offered some ways for this aim after the facilitator's question. During the discussion in the OPD, most of the teachers agreed with the Aslı's first comment. On the other hand, during the interview, when she was asked about her next problems to the students

after the basketball problem, she stated that “I again present a problem that students can provide different comments...Indeed, I would change the context. However, the characteristics of the data would be the same so that to calculate just the mean would not be sufficient.” With this description, we can say that the teacher thought providing new contexts for students. However, her aim seems to make students practice the ideas discussed in the given problem, not to emphasize the importance of the context, which was discussed by the teachers and facilitator during the synchronous session.

Discussion

The case of Asli was presented to illustrate that the OPD can help teachers in their development of noticing skills. At the beginning, the teacher had difficulties in each interrelated skill of noticing. However, the findings showed enhancement in her noticing of students’ thinking in the context of data analysis throughout her participation in the OPD. During the discussion, teachers had a chance of observing different ideas, posing questions, and making suggestions to each other. Also, the facilitator let teachers focus on the important concepts through her prompts. All these interactions might direct the teacher’s focus on students’ mathematical thinking deeply as consistent with the study of Fernandez et al. (2020). In other words, it can be inferred that the collaboration among the teachers and the facilitator throughout the discussion might allow the teacher to attend the details of the given strategies and interpret students’ understanding by covering all the essential concepts such as variability and representativeness. Moreover, the teachers were provided with two students’ strategies and the solution of S2 was particularly challenging and unfamiliar for the teachers. This could have led the discussion environment to be more productive, which in turn might have increased the collaboration among teachers.

Another factor contributing to the development in the teacher’s noticing skills could be the asynchronous nature of the OPD. Clay et al. (2012) argues this mode of communication slows down the process of learning, which could enable teachers spent more time to consider and revise their ideas (Fernandez et al., 2012; Klein et al., 2017). Indeed, this was shown by Asli’s one of the statements during the interview: “Discussions in the OPD provided us to think more on the students’ answers.” Thus, asynchronous modes of communication provided via the OPD might play an effective role in developing the teacher’s attention to the given task; leading fruitful communication among teachers which in turn enhance her noticing skills.

Although there was clear improvement in attending and interpreting skills of the teacher, deciding how to respond based on students’ understandings was more difficult for her. Preceding the discussion, the teacher’s questions were like directing students to the correct answer which was also observed by Klein et al. (2017). Even though the teacher suggested asking probing questions to challenge students throughout the discussion, she had difficulty in extending students’ understanding to a further point after the discussions. Although some new ideas were presented by the facilitator during the synchronous session such as the use of graphical representations of the data presented in the basketball problem and the importance of context for interpreting data, these ideas were not reflected in the teacher’s responses during the interview. Therefore, in future research, we suggest carrying such specific ideas into the OPD to enable teachers create more productive discussion

environment for the deciding skill. Lastly, it would be good to examine how the teachers' evolving expertise is reflected into her instructional practices in further research studies.

Acknowledgement

This research has been supported by the Scientific and Technological Research Council (TUBITAK), Turkey.

References

- Bakker, A. (2018). *Design research in education*. New York, NY: Routledge.
- Blömeke, S., Gustafsson, J., & Shavelson, R. (2015). Beyond dichotomies: Competence viewed as a continuum. *Zeitschrift für Psychologie*, 223(1), 3–13.
- Clay, E., Silverman, J., & Fisher, D. (2012). Unpacking online asynchronous collaboration in mathematics teacher education. *ZDM-Mathematics Education*, 44, 761–773.
- Fernandez, C., Llinares, S, Rojas, Y. (2020). Prospective mathematics teachers' development of noticing in an online teacher education program. *ZDM-Mathematics Education*, 52, 959-972.
- Fernández, C., Llinares, S., & Valls, J. (2012). Learning to notice students' mathematical thinking through on-line discussions. *ZDM-Mathematics Education*, 44(6), 747–759.
- Gökce, R. (2019). *Examining Middle School Mathematics Teachers' Content and Pedagogical Content Knowledge of Statistical Reasoning*. Unpublished Doctoral Thesis, Pamukkale University, Denizli.
- Jacobs, V. R., Lamb, L. L. C., & Philipp, R. A. (2010). Professional Noticing of Children's Mathematical Thinking. *Journal for Research in Mathematics Education*, 41(2), 169–202.
- Kilic, H., & Dogan, O. (2021). Preservice Mathematics Teachers' Noticing in Action and in Reflection. *International Journal of Science and Mathematics Education*. <https://doi.org/10.1007/s10763-020-10141-2>
- Klein, V., Fukawa-Connelly, T., & Silverman, J. (2017). Improving feedback through online professional development. *The Mathematics Teacher*, 110 (5), 352-358. <https://doi.org/10.5951/mathteacher.110.5.0352>
- McGatha, M., Cobb, P., & McClain, K. (2002). An analysis of students' initial statistical understanding: Developing a conjectured learning trajectory. *Journal of Mathematical Behavior*, 21, 339-355.
- National Council of Teachers of Mathematics (2014). *Principles to Actions: Ensuring Mathematical Success for All*. NCTM: Reston, Virginia.
- Sherin, M. G., Jacobs, V. R., Philipp, R. A., & Sherin, M. G. (2011). *Mathematics teacher noticing: Seeing through teachers' eyes*. New York, NY: Routledge.
- Van Es, E. A., & Sherin, M. G. (2021). Expanding on prior conceptualizations of teacher noticing. *ZDM-Mathematics Education*, 53, 17–27. <https://doi.org/10.1007/s11858-020-01211-4>