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Noticing skills of prospective and novice mathematics teachers with different teacher perspectives

Kübra Yıldırım and Gülseren Karagöz Akar

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A multi-case qualitative research study was conducted to examine the noticing skills of prospective and novice teachers who hold different teacher perspectives. Two participants' two- real classroom teachings both as a prospective teacher in 2016 and as a novice teacher in 2018 were analysed using teacher perspectives and learning to notice frameworks. Also, the lesson plans, pre-interviews, and post-interviews of the teachings were examined. Results of the analysis showed that one of the participants had the characteristics of the Progressive Incorporation Perspective (PIP) and extended level of teacher noticing and the other had the characteristics of the Perception Based Perspective (PBP) and mixed level noticing, both as prospective and novice teachers. Results suggest the use of teacher perspectives to determine why teachers notice what and how they notice.

Keywords: Teacher perspectives, teacher noticing, prospective teachers, novice teachers.

Background

There is consensus in the literature that teachers' paying attention to students' comments, answers, and mental processes while planning their lessons, during and after the lessons is important (e.g., van Es & Sherin, 2002; Jacobs et al., 2010). Some researchers define teacher noticing as evaluating the classroom through the eyes of the teacher (Jacobs et al., 2010). Van Es and Sherin (2002) reported on "what teachers notice" to understand the focus of teachers and "how teachers notice" to show teachers' "analytic stance" and "depth of analysis". Four levels of teacher noticing in the hierarchy are considered as a baseline level, mixed level, focused level, and extended level (Table 3 is at the end of the paper) (van Es & Sherin, 2002). There have been considerable efforts on determining pre-service teachers' noticing skills (e.g., van Es & Sherin, 2002); comparison of in-service and pre-service teacher noticing skills (e.g., Jacobs et.al, 2010), and development of teachers' noticing skills in professional development (PD) programs (Bastian et al., 2022). All these studies point out that years of teaching experience play a key role in teacher noticing and noticing skills of teachers simultaneously get influenced by attending teacher education programs and PD programs.

Researchers also pointed to cognition and perception views on noticing (Scheiner, 2021). The cognition view embraces the idea that "what the teacher sees in the world is strongly driven by knowledge and expectations" (Sherin & Star, 2011, p. 73). Aligning with the cognitive view, researchers emphasized and suggested examining teacher noticing in concert with teacher decision-making (Dindyal et al., 2021). Notably, Schoenfeld (2011) stated "teachers' decision-making is shaped by what teachers notice" and also suggested that noticing must be situated within teacher decision-making (p. 233). In this study, based on the construct of assimilation of mathematics teachers, we acknowledge the cognitive view as we consider "what one knows affects what one perceives" (Simon, 2013, p. 574). That is, teachers "...can only notice that which they have the cognitive structures to perceive" (Simon, 2013, p. 574).

“What can be perceived, and the sense made of what is perceived are a function of assimilation. The construct suggests what one currently knows (including the ways one knows what one knows) determines one’s perception and the sense made of those perceptions” (Simon, 2013, p. 574).

Thus, we embrace the idea that teachers’ noticing, and their decision-making are based on their major assimilatory structures. The major assimilatory structures Simon (2013) points to are the teacher perspectives. Teacher perspectives allow making sense of teachers’ epistemological stance fed by their knowledge and beliefs as a coherent system (Heinz, et al., 2000; Jin & Tzur, 2011; Simon et al., 2000). Researchers stated that perspectives can be considered as paradigms in regard to the development of mathematics knowledge and the paradigm signifies the existence of internally coherent systems (Simon et al., 2000). That is, a teacher’s perspective (i.e., meaning making systems) underlies the teaching practices that indicate not only what teachers think about, know, believe, and do but also everything that contributes to their teaching (planning, assessing, interacting with students) (Simon et al., 2000). Simon (2013) argued that teachers’ major assimilatory structures are the basis for their practices. He further emphasized that “given what people can notice, what they do notice is significantly related to the goals that they set consciously or unconsciously” (p. 574). Thus, teacher perspectives can be utilized to address the reasons behind teachers’ practices (e.g., Karagoz Akar, 2016). Considering teacher noticing as part of teacher practices, in this study we argue that given that teachers hold different perspectives we can determine the reasons behind their noticing.

In the literature, researchers reported on four different perspectives in a hierarchy: the traditional perspective (TP), the perception-based perspective (PBP), the progressive incorporation perspective (PIP), and a conception-based perspective (CBP) (Simon et. al., 2000; Jin & Tzur, 2011). In this study, due to the level of participants, we specifically show some examples of PIP and PBP from the data. Contrary to CBP, and compatible with the Platonist view of knowledge, teachers who hold PBP like the traditional approach view mathematics as part of the external world independent of the knower (Jin & Tzur, 2011). Teachers holding PIP, however, act with “...an integrated stance on knowing and learning---reflecting both ‘existence outside the learner’ (hence, teacher involvement) and ‘dependent on what a learner knows’ (hence, student active problem solving)” (p.6). Thus, from their perspective mathematics learning is an active mental process. We further point to some characteristics in the methods section.

Attending to the aforementioned research with emphasis on the impact of PDs on teacher noticing, in this study we particularly hypothesized that completing a (PD) methods course on pre-service teachers’ development of teacher perspectives aligning with constructivist approaches to learning and teaching of mathematics might contribute to teachers’ noticing skills. Therefore, conducting a multi-case study with the same participants both during their pre-service training upon completion of the PD; and, in the first years of teaching, we depict with data that teachers’ assimilatory structures--- perspectives--- might allow to explain what causes them to notice. In this respect, in this study, we investigated “What are the noticing skills of prospective and novice teachers who hold different teacher perspectives?” Previous studies that investigated teacher noticing mainly and mostly reported from the data after teaching. This study builds on and also differs from previous studies by also reporting on the data depicting the noticing levels from the lesson plans and interviews of the two participants, both before and after teaching in 2016 and in 2018. With the juxtaposition of both teacher perspectives and learning to notice frameworks in the analysis, the results might shed light not only

on *what* and *how* teachers notice but also *why* they notice in classroom activities at both stages of their professional development. In this regard, results can provide valuable information about the relationship between teachers' perspectives and their noticing skills.

Method

This study is a qualitative multi-case study. Case studies give an in-depth description and detailed analysis of a bounded system (Yin, 2014). As a bounded system (Yin, 2014), in this study, two novice teachers with PBP and PIP were selected. The two participants of this study were purposefully selected from a larger research project, conducted with six prospective and novice teachers between the years 2016 and 2018. The larger study was design-based research, a Teacher Development Experiment study (TDE), which mainly focused on the professional development (PD) of teachers in a Teaching Mathematics Methods Course focusing on developing a progressive incorporation perspective. TDEs consist of both classroom teaching experiments and (multi) case studies (Simon, 2000). We chose the two participants Alin and Elisa since they had taken the PD course. Therefore, they were rich in data about teacher perspectives. Secondly, they volunteered to be a part of the study also as in-service teachers. Data were collected in two phases: I) from the practicum teachings of the participants as prospective teachers in the Spring semester of 2016 and II) from the classroom teachings in the 2018 Fall semester when the participants were novice teachers working in private schools. Aligned with case studies that require different data sources (Yin, 2014), in Phase I, data sources included all participants' two practicum teachings, both videotaped and transcribed. For Phase II, data sources included the two participants' teaching sessions, videotaped and transcribed. Also, for both phases, pre-interviews conducted with the participants on their lesson planning and post-interviews conducted after the completion of the teachings within the same week were all data sources. Further, the second researcher observed the teachings. In lieu of space, in this paper, we share frequency tables depicting the codes from the two frameworks. We specifically share pre-interview data on the planning of the lesson from 2018 to provide further evidence of the participants' noticing skills given their perspective when they were novice teachers.

We used coded analysis in examining all the data sources (Clement, 2000). The unit of analysis was chunks of data such as a sentence or a cluster of sentences; and, dialogues from the teaching sessions depicting what, how, and why the participants noticed during the teachings. For the analysis in terms of the teacher perspectives, we used the codes prepared by Bukova Guzel et al. (2019) based on the literature (e.g., Jin & Tzur, 2011) considering teacher perspectives before teaching (coded as 1), during teaching (coded as 2) and after teaching (coded as 3). Particularly, some codes were as follows: If data pointed to whether teachers expected their students to see mathematical situations in the same way they did, we coded this as PBP.1D when the data came from the lesson plan or the pre-interview and coded it as PBP.2C when the data came from during teaching. Similarly, for example, if the teachers viewed mathematics learning as "coming to see a first-hand experience of mathematical reality shared by all through discovery" and the data came from before teaching, we coded it as PBP.1C and if it came from during teaching, we coded it as PBP.2A. In addition, if teachers created the entire lessons on their own or adjusted the available curricular materials hypothetically on students' cognitive processes and students' behaviors we coded them as PIP1A1 and PIP 1A2 respectively. Also, if the teachers viewed mathematics learning as an active mental process (PIP.2A1) on the part of students and the old incorporating the new rather than being transformed as in CBP,

we coded it as PIP.2A when the data came from during teaching. For instance, Alin's statement "*Mathematical learning is like the quantitative operation that I want children to experience, how the y values change when the x values change one by one....*" indicates that she views mathematics learning as experienced by students through their mind activities, such as simultaneous comparison of variables. So, having these characteristics, for the analysis of the data, first, we read all the transcripts of the videotaped pre-interviews, teachings, and the post-interviews. For each data source, we identified the chunks of data that identified any characteristics of the teachers' perspectives. We determined the frequency of the codes by attending to each chunk of data showing the related code. Then, we analysed the other data sources in the same way and compared any conflicting data in terms of teachers' perspectives. Once we had a consensus on the perspective of the participant, we analysed all the data using the codes from the Learning to Notice framework (van Es & Sherin, 2002) in a comparable way. We created frequency tables (Table 1 and Table 2) by recording the frequency of the codes for both participants' teacher perspectives and noticing. Then, we wrote the narratives.

Results

Results of the analysis, both when Alin was a prospective teacher in 2016 and a novice teacher in 2018 depicted that Alin showed all characteristics of (PIP). The analysis of data from Alin's pre- and post-interviews for teacher noticing also showed that Alin was at Level 4, *the extended level* both when she was a prospective and a novice teacher. On the other hand, the same set of data sources showed that Elisa had a PBP perspective and was at Level 2 for teacher noticing, *the mixed level* albeit showing some *focused level* characteristics both when she was a prospective teacher in 2016 and a novice teacher in 2018. In the following, we will provide the frequency of all the codes from 2016 and 2018 in Tables 1 and 2 (at the end of the paper) and will present some pre-interview data on their lesson plans from 2018.

Alin's results

In 2018, Alin planned a lesson about exponential functions. Aiming at students' making sense of the meaning of the decay and growth factor in exponential functions, she prepared two tasks. Assessing and acknowledging what students have already known as the data below shows, she interpreted that students were ready to learn the topic (PIP.1B). She stated the following in the pre-interview:

Alin: Exponential functions are very much related to daily life. It is an important concept to learn logarithms, an important concept to learn how the features of functions changes. Kids know that each function consists of x and y as ordered pairs, each value of x and y as ordered pairs showed a point in the graph, and when we combine all of the points that are matched with these functions' domain and range, we get the graph.

Data showed that Alin *noticed* the necessity of the learning of the subject (i.e., exponential functions) for daily life, the prerequisite of the topic and the subsequent topics in the lesson planning process and highlighted the significance of these aspects (H.4A). This also suggested that Alin prepared her lesson paying attention to both the curriculum materials and also what students knew (PIP.1A). She also acknowledged and interpreted that her questioning and the group discussions could be beneficial for students' making sense of the main ideas during teaching (W.4A and H.4B). She explained her plan and the purpose of the lesson in detail to further elaborate on how students might possibly think about the decay or growth factor in exponential functions modelled in the problem situations she provided to the students. She stated,

Alin: Mathematical learning is like the quantitative operation that I want children to experience, how the y values change when the x values change one by one, and what causes this is multiplying by the same number every time.

As the data showed Alin's focus was on how students need to think so that they knew the reasoning behind growth factor. In further explanations, Alin's elaboration on possible questions and potential students' mind activities and answers showed that Alin planned her lesson based on students' thinking. She stated that she was ready to pay attention to students' misconceptions or difficulties during teaching as she prepared questions to examine different students' thoughts (PIP.1A2). She wanted students to recall the meanings of x and y in any function formula and how these variables change with respect to each other. So, she made sure that students start the experiment with recalling their prior knowledge (PIP.2E) to re-activate their already known knowledge (PIP.2A). By asking questions to examine students' thinking and responding to students' answers with new questions, Alin also showed that she made connection between her teaching principles and students' learning (W.4A and H.4E).

Elisa's result

Elisa prepared a lesson plan about the Reimann sum and its relationship with integral. She explained that the main purpose of the lesson was calculating the area under the graph with Reimann sum or integral. She planned for her students' dividing the area under the graph into smaller parts for understanding Reiman sum and concept of Integral. Elisa believed that learning the intended knowledge at the end of the lesson was more important than students' thinking during the process (PBP.1A). She emphasized:

Elisa: Students can estimate the area under a graph by Riemann Sum. This is the goal. Then, at the end of the lesson, the students should have information about the area under a curve that can be found by integral.

In the interview, although she noticed some significant aspects, her main focus was on her actions rather than students' thinking. She pointed that the main purpose of using shapes already known by the students was making the mathematical relationships more apparent for them (PBP.1A). Elisa stated that learning is a gradual process, so she used steps in her lesson from basic and known to more complex (PBP.1B). Explanations of Elisa about why she started with rectangles and triangles also depicted that Elisa attended to students' prior knowledge and the requirements of the topic for dividing the area under the graph (W.2A). In addition, Elisa prepared a task for students to create a learning environment so that dividing the graph first into four and then into more pieces would allow them to learn easily and construct the knowledge permanently (PBP.1C). Moreover, Elisa pointed that she designed the learning environment for all students to provide the same experiences. She stated,

Elisa: I want to hear them to say more division. They have to say I can cut it into smaller pieces. We divided it into 4 pieces, we divided it into 10 pieces. Now, if we divide it into n pieces. The concepts will be abstract to them, but I will show them slowly. I will remind them the summation symbol.

Data suggested that she planned to listen to her students' answers or discussions during teaching to decide what they perceived and what was her next step. So, she prepared her lesson plan to direct students by questions or tasks (PBP.1D). Though, preparation of Elisa during the lesson planning process depicted that she hypothetically planned to notice students' thoughts (W.2B).

Conclusion and discussion

The purpose of this study was to examine the noticing skills of prospective and novice teachers holding different teacher perspectives. Results showed that while one of the participants, Alin, had the characteristics of PIP and showed all the codes of *the extended level* noticing both in 2016 and in 2018, the other participant, Elisa, had PBP and showed all the codes of *the mixed level* noticing both in 2016 and in 2018. In contrast to earlier studies, which showed that novice teachers might have low levels of noticing (Kagan, 1992), this study showed that depending on the perspective a teacher might hold, the level of noticing might be at higher levels even when s/he is a novice teacher. In particular, Alin and Elisa both hypothetically *planned to notice* some aspects of teaching in their lesson planning process such as attending to *students' knowledge and difficulties, the content and the sequence of the task, and the possible students' answers to teachers' prepared questions*. Though aligning with her perspective, while Alin *planned to attend to* students' current thoughts and the progression of their thinking, Elisa targeted to reach the intended goals. This was also evident in their reasoning behind their frequent questioning as Alin would question frequently to *determine how students were thinking and if they had any difficulties*, Elisa rather planned to question if *students perceived what she thought was apparent in the examples and the task sequence she prepared*. These results suggested that the differences in their noticing were due to *why* they noticed and *how* they noticed based on their rationale and focus on the teaching and learning processes. Researchers reported that participating in a PD program affects teachers' mathematical knowledge for teaching, so it affects teachers' noticing skills (e.g., Jacobs et al., 2010; van Es & Sherin, 2002). Given that both of these novice teachers attended the same PD methods course, we propose to do further research on triangulating the teacher perspectives, teacher noticing, and mathematical knowledge for teaching so that a more coherent picture of teacher practice is understood. We propose the development of at least a PIP perspective on the part of teachers during both, pre-service and in-service professional development studies.

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Table 1: Frequencies of characteristics of PIP and codes of noticing in Alin's teaching (2016 and 2018)

		TEACHER PERSPECTIVES				TEACHER NOTICING														
Alin		PBP	PIP	CBP	What Teachers Notice				How Teachers Notice											
			2016	2018	1-Baseline		2-Mixed		3-Focused		4-Extended		1-Baseline		2-Mixed		3-Focused		4-Extended	
Before	Interview	1a	1	2																
		1a1	10	9																
		1a2	2	1																
		1b	3	3																
During	Teaching	2a	3	3																
		2a1	2	3																
		2b	2	4																
		2c	1	2																
		2d	1	1																
After	Interview	3a	3	5																
		1a	1	1																
		2a	1	1																
		4a	5	4																
		4b	3	6																
		4c	7	7																
4d	3	3																		
4e	6	5																		
4f	4	4																		

Table 2: Frequencies of characteristics of PBP and codes of noticing in Elisa's teaching (2016 and 2018)

		TEACHER PERSPECTIVES				TEACHER NOTICING														
Elisa		PBP	PIP	CBP	What Teachers Notice				How Teachers Notice											
			2016	2018	1-Baseline		2-Mixed		3-Focused		4-Extended		1-Baseline		2-Mixed		3-Focused		4-Extended	
Before	Interview	1a	4	5																
		1B	4	5																
		1C	6	3																
		1D	2	5																
		1E	3	2																
		1F	3	4																
During	Teaching	2A	5	3																
		2B	2	5																
		2C	5	4																
		2D	6	5																
		2E	10	8																
After	Interview	3a	5	4																
		2a	5	3																
		2b	2	4																

Table 3: The levels and the codes of the Learning to Notice framework

	Level 1 Baseline	Level 2 Mixed	Level 3 Focused	Level 4 Extended
What Teachers Noticed (W)	1-A: Attended to whole class environment, behavior, and learning and to teacher pedagogy	2-A: Primarily attend to Teacher pedagogy Begin to attend to particular students' mathematical thinking and behaviors	3-A: Attend to particular students' mathematical thinking	4-A: Attend to the Relationship between particular students' mathematical thinking and between teaching strategies and student mathematical thinking
How Teachers Notice (H)	1-A: Form general impressions of what occurred	2-A: Form general impressions and highlight noteworthy events	3-A: Highlight noteworthy events	4-A: Highlight noteworthy events
	1-B: Provide descriptive and evaluative comments	2-B: Provide primarily evaluative with some interpretive comments	3-B: Provide interpretive comments	4-B: Provide interpretive comments
	1-C: Provide little or no evidence to support analysis	2-C: Begin to refer to specific events and interactions as evidence	3-C: Refer to specific events and interactions as evidence	4-C: Refer to specific events and interactions as evidence
			3-D: Elaborate on events and interactions	4-D: Elaborate on events and interactions
				4-E: Make connections between events and principles of teaching and learning
				4-F: On the basis of interpretations, propose alternative pedagogical solutions