İSTANBUL UNIVERSITY CERRAHPAŞA

HAYEF: Journal of Education, 20(1); 55-65

DOI: 10.5152/hayef.2022.56
Received: October 27, 2022
Accepted: December 6, 2022
Publication Date: January 30, 2023

HAYEF: Journal of Education

RESEARCH ARTICLE

Development of Noticing Using Video Analysis by Argumentative Writing

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Abstract

In context-oriented way, the preservice teachers' noticing of students' geometrical thinking is examined with the help of reports for analysis of classroom videos prepared based on argumentative writing. A video group including 10 preservice middle school mathematics teachers was formed. The process of their development was explored through three stages including training in argumentation and argumentative writing. In these reports, it was observed that the participants generally described geometrical context rather than interpreting or evaluating the actions in individual video analysis in stage 1. Then, they took training in argumentative writing, and, they prepared reports based on Toulmin's model of argumentation. Afterward, argumentative writing could encourage the development of noticing since it provided evidence by making connections between mathematical elements in students' explanations and characteristics of students' geometrical thinking. With the help of the nature of argumentative writing enhancing critical thinking, the preservice teachers could change their foci from describing the whole process to interpreting and evaluating critical instances.

Key words: Argumentative writing, noticing, Toulmin model of argumentation, video analysis

Introduction

Recently, teacher educators emphasize the importance of teachers' noticing skills since teachers can effectively monitor students' understanding and design instructions by listening actively to them and considering their thoughts and needs (Franke et al., 2009; Jacobs et al., 2010; Sherin & van Es, 2009). Noticing describes the actions of teachers or preservice teachers (PSTs) in structuring what is observed in the classrooms, and what and how students think by attending to considering complexities of teaching and learning processes based on their knowledge (Jacobs et al., 2010; Mason, 2002; van Es & Sherin, 2002). Despite its importance, PSTs could not easily learn how to determine and interpret student thinking with respect to mathematical issues (Sherin & van Es, 2009) since professional noticing of students' mathematical thinking is about making sense of student thinking with respect to mathematical and cognitive issues rather than deciding whether they are correct or not (Ulusoy & Çakıroğlu, 2021). Although professional noticing is not improved naturally, it can be learned by providing opportunities to examine student thinking through structured training, especially in teacher education programs (Stockero et al., 2017). In the way, because it can have the power to enhance and develop teaching such as making appropriate decisions about instructional actions, it has become important to investigate and insist on professional development research and teacher training (Choy, 2013; Schoenfeld, 2011; Sherin et al., 2011; Ulusoy & Çakıroğlu, 2021; van Es, 2011; Yang & Ricks, 2011). Previous research emphasize the need for studies related to the development of PSTs' noticing in teacher training programs that insist on the use of appropriate support to encourage their professional development based on student thinking (Hiebert et al., 2007; Levin et al., 2009; van Es & Sherin, 2008).

In the literature, video clips (VCs) of classrooms have been analyzed and used as tools to link theory and practice in teacher training (Kleinknecht & Groschner, 2016; McDuffie et al., 2014; Sherin et al., 2009; Sherin & van Es, 2005; Star & Strickland, 2008). Because the PSTs can pay attention to teaching by observing teachers' practices, student learning, and their connection in videos at any time and place, they can develop their noticing (Sherin & van Es, 2005; Star & Strickland, 2008). Moreover, it is stated that the PSTs can realize the important aspects of classroom environment having impact on student learning and analyze their roles and classroom situations more focused and in-depth by developing their noticing with the help of video analysis (Santagata et al., 2007; Star & Strickland, 2008; van Es & Sherin, 2002). Although video analysis helps PSTs improve their noticing, there is still need for opportunities to encourage their professional development because previous research show that PSTs are more likely to observe teaching processes watched on videos by describing disconnected chronological events and teacher roles rather than student thinking (Levin et al., 2009; Sherin & van Es, 2005) and they have difficulty noticing particular instances (Peterson & Leatham, 2009; Stockero et al. 2017; Superfine et al. 2015). In spite of the effects of using videos in teacher education programs to enhance the PSTs' professional judgment and reasoning about teaching process in the context of complex classroom atmosphere, they tend to use judgmental perspective and make evaluations without providing evidence to support their claims (Oonk et al., 2015; Seago, 2004; Wang & Hartley, 2003). Moreover, previous research show that teachers are more likely to notice classroom instances that are less related to students' thinking by focusing on pedagogical issues such as classroom management and atmosphere (Santagata et al., 2007; Sherin et al., 2011; Star & Strickland, 2008).

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Cite this article as: Uygun, T. (2023). Development of noticing using video analysis by argumentative writing. *HAYEF: Journal of Education*, 20(1), 55-65.

Based on these explanations, PSTs' professional development of noticing can be claimed through systematic training including video analysis supported by alternative approaches. In this respect, it can be claimed that the development of PSTs' noticing by making professional judgments and providing evidence for them through analyzing videos can be encouraged by using argumentative writing. Hence, an alternative effective approach including the analysis of videos produced by the researchers in particular contexts such as geometry by argumentative writing for developing noticing can be proposed.

Using argumentative writing, the PSTs can analyze the videos by criticizing teacher roles, student thinking and teaching in complex classroom atmosphere, and evaluate them by providing evidence. In argumentative writing, an idea is produced by proposing evidence and data. In other words, argumentative writing directs individuals to reason about an idea in order to support a claim with evidence by stating "the facts are on my side" (McLaughlin & Overturf, 2013, p. 189). In this respect, while the PSTs are preparing analysis reports of videos on argumentative writing, they observe the videos while being aware of the nature of argumentative writing and how to write it. In argumentations, they know that they are expected to make judgments on videos to produce claims by providing evidence from the cases and actions on videos to form data and warrant parts of the argumentation. Hence, they would observe and reason about the teaching process and classroom atmosphere represented on videos more focused, analytically, and in-depth. Moreover, individuals can learn how to criticize, make judgment, evaluate, and respond to situations by explaining their views with the help of argumentative writing (Varghese & Abraham, 1998). Especially using Toulmin's model of argumentation, as the extensively used model in argumentation studies, the individuals are expected to form arguments composed of the elements of argument structure such as claim and data to explain their judgment with details (Toulmin, 1958/2003). By using this model and forming its elements while benefiting from the teaching process watched on videos through the production of this report, they can focus on particular learning situations and criticize them based on their previous knowledge about their profession. Hence, the PSTs' selective attention and knowledge-based reasoning necessitating noticing (Sherin et al., 2011) can be encouraged via argumentative writing. Also, producing reports through argumentative writing for videos can direct them to evaluate and interpret particular learning circumstances by enhancing their development of noticing. Therefore, the structure of this model and how to write based on this model were taught to the PSTs in order to help them prepare the reports of individual video analysis for professional development of their noticing in the current study. In other words, building the current study on noticing, it was aimed to explore how argumentative writing based on Toulmin's model of argumentation could support the PSTs' noticing through video analysis. Hence, the present study was guided by the following research question: "How do the PSTs develop their noticing through repeated enactments of individual video analysis activities supported by argumentative writing based on Toulmin's model?"

Theoretical Framework

Professional Development of Noticing

Noticing focuses on the actions of "reflecting systematically, recognizing choices and alternatives, preparing and noticing possibilities, and validating with others" (Mason, 2002, p. 95). Furthermore, noticing establishes the actions of seeing, interpreting, and deciding to respond to student thinking by encouraging perception and awareness of teaching process (Jacobs et al., 2010; Mason, 2002). van Es and Sherin (2002) explain noticing based on three main issues: "(1) identifying what is important or significant in a classroom situation, (2) using knowledge of the context to decide on interactions in the classroom, and (3) connecting the specific aspects of classroom interactions with general teaching and learning principles" (p. 573). These explanations show that noticing refers to awareness about noteworthy events taking place in the classrooms, attending to them using knowledge related to teaching profession, and interpreting them based on student thinking. In line with this view, noticing necessitated for professional development affects teaching practices by seeing, making sense of, and interpreting instructional events and classroom details (Mason, 2002; Sherin et al., 2011). Because of the possibility of professional development in noticing, PSTs must be trained "to be able to see how a lesson is going and to interpret students' ideas in the midst of instruction" (Sherin, 2007, p. 383). Hence, teacher education programs should help the PSTs improve their noticing skills (Star et al., 2011; Star & Strickland 2008; van Es, 2011; van Es & Sherin, 2008). The previous research show that the PSTs and novice teachers have difficulty interpreting and determining critical aspects of classroom in detail, evaluating situations by paying attention to superficial details rather than acquiring accurate perception, observing classroom atmosphere from general and holistic perspectives, and proposing alternative strategies (Berliner, 2001; Van den Bogert et al., 2014). In this respect, it is important to provide opportunities for PSTs to develop their noticing and profession in a systematic and structured way in their preservice years.

Based on the given requirements, the usage of video has been performed in various ways such as microteaching, analyzing lessons, establishing expert teaching, video cases, and field recordings (Sherin, 2004) since they can enhance the development of noticing by interpreting critical aspects of teaching and practices (van Es & Sherin, 2002). Also, previous research have explored the development of noticing using VCs of lessons in teacher education programs (Sherin et al., 2011; Star et al., 2011; van Es 2011). It has been observed that because PSTs can identify critical instructional events that are difficult to realize and respond to in the classroom setting on the videos, they can improve their noticing skills by analyzing and discussing VCs of classroom episodes systematically and consciously (Barnhart & van Es, 2015; Brouwer & Robijns, 2015; Calandra, 2015; Fadde & Sullivan, 2013; Star et al., 2011; Star & Strickland, 2008). It has also been observed that the PSTs can extend their learning and development acquired through videos to classroom instruction in similar paths (Santagata et al., 2007; Sherin & Han, 2004; Sherin & van Es, 2009; van Es & Sherin, 2008). Use of videos in teacher education programs helps the PSTs to discuss and interpret teaching process and/or students thinking (Star & Strickland, 2008) and to analyze the PSTs' teaching and learning (Sherin & Han, 2004). In these previous research, the positive effects of use of videos by viewing and discussing the classroom episodes have been reported. The current study focused on the development of the PSTs' noticing of teacher actions and student thinking by observing the classrooms on the videos that previous studies had performed (e.g., Santagata & Angelici 2010; van Es, 2011). On the other hand, this study differentiates from them by analyzing videos by preparing analysis reports individually in a systematic and structured way under the guidance of the instructor rather than participating in discussions of groups such as video groups or video-based communities. Moreover, analysis reports were prepared based on argumentative writing in order to make the process more structured and to scaffold the process of observing and writing. In this way, the PSTs can acquire opportunities to develop their noticing when it is not possible to participate in group discussions, watch videos in the courses, or form groups or video groups because of external factors such as limited time. Hence, important contribution can be provided to the literature and a strategy for professional development to be used in courses in teacher education programs can be proposed.

Argumentative Writing

Argumentation can be defined as a tool facilitating communication and interaction by providing opportunities for forming ideas,

supporting evidence for these ideas, using and relating them, and as a strategy for enhancing reasoning and configuring the ideas (Driver et al., 2000; Duschl & Osborne, 2002; Van Eemeren & Grootendorst, 2004). In this respect, it can be explained as a process and strategy of asserting and defending an idea with the aim of convincing and persuading others about this idea by constructing, criticizing, and modifying the knowledge over time (Chin & Osborne, 2010). Although most of the studies focus on argumentations performed verbally (Driver et al., 2000; Duschl & Osborne, 2002; Van Eemeren & Grootendorst, 2004), written argumentations, as a raising issue to be examined in the literature (Marzano, 2012), can also provide many opportunities to the learners with the help of encouraging argumentation activities by writing. Writing as an epistemological and communication tool enhances the activities of understanding context by exploring claims, ideas, and evidence in the context (Halliday & Martin, 1993) since "written language, stabilized on paper, invites kinds of reflection not so natural to oral exchanges. The written statement is more easily examined, checked, contradicted, doubted, challenged, or affirmed" (Tishman & Perkins, 1997, p. 371) and "writing is important for refining and consolidating these new ideas" (Rivard & Straw, 2000, p. 588). Through argumentative writing, individuals are expected to examine evidence to establish their ideas in contexts through reasoning and representing them in a meaningful manner. In line with this view, the individuals are expected to form their written argumentations concisely and formally by reasoning about and using related evidence based on structural aspect of argumentation (Thomas & Bostic, 2015). Hence, Toulmin's model of argumentation provides a beneficial way to form written argumentations by describing, criticizing, and verifying raised ideas in order to correspond to these expectations (Stapleton & Wu, 2015).

Toulmin (2003) proposes a framework including the elements of claim, data, warrant, backing, qualifier, and rebuttal. Of these elements, claim and data represent the core of the argumentations and take place in all arguments. First, the claim represents conclusion expression referring to the ideas asserted as true. This element is the most easily identified element when compared with the others because it may be a solution, an idea to be reasoned, or conclusion of the discussion. Secondly, the element of data represents the facts or evidence to be used to support the claim and validate its truth. Thirdly, the warrant expresses the connections between the claim and data by reasoning about the data leading to claim and making implications based on the data. Fourthly, the backing increases the validity of the argument by establishing the reasons for accepting the truth of the argument. Fifthly, the qualifiers refer to the strength of the claim. Lastly, the rebuttals are the statements used to refute the argument or the exceptional cases.

The previous research about argumentative writing in the literature has focused on the examination of students' development of argumentative writing (Nussbaum & Kardash, 2005; Nussbaum & Schraw, 2007; Qin & Karabacak, 2010), conceptual understanding, problem-solving, knowledge construction, scientific thinking, criticizing, and justification skills (Grimberg & Hand, 2009; Thomas & Bostic, 2015; Yaman, 2018; Yore & Treagust, 2006). Moreover, there have been research examining the role of argumentation to improve classroom practices as professional development and necessary pedagogical knowledge and skills to use argumentation in classrooms (McNeill & Knight, 2013). Different from these research, argumentative writing as a way for argumentation is used as a tool to develop noticing skills in the current study. Because of the argumentations' structural nature and by directing the individuals to focus on evidence to support claims by reasoning and critically analyzing the contexts, the individuals can develop their noticing. With the help of argumentative writing, the PSTs can produce ideas about teaching process in the VCs based on their knowledge about their profession and justify their ideas by providing cases and interactions taking place in the VCs as evidence for the ideas to encourage its truth.

Methods

In order to explore what/how the PSTs noticed students' thinking in VCs of classroom episodes as they analyzed these VCs, written reports were prepared based on Toulmin's model. The present study was performed as an exploratory study by focusing on two PSTs in order to have an in-depth understanding of this issue. The change in the PSTs' professional noticing skills considering what/how teachers think and criticize about attending, interpreting and responding to students' mathematical thinking was examined by analyzing the written argumentations prepared by them through three stages represented in Table 1. Hence, this qualitative research was performed based on document analysis as one of the data collection techniques of qualitative research. In document analysis, the written reports including information about the events and phenomena are the unit of analysis (Yıldırım & Şimşek, 2005).

Participants

For the current study, a video group was formed. This group included voluntarily participated 10 junior students enrolled in the elementary mathematics education program. They were the candidates of middle school mathematics teachers preparing to teach mathematics to fifth, sixth, seventh, and eighth grades in Turkey. The video group members were composed of six female and four male preservice mathematics teachers (PMTs). These PSTs were selected purposively since they might focus on detailed information about different types of knowledge such as pedagogical and pedagogical content knowledge because of the nature of the undergraduate courses. In other words, the criterion for being selected was to have taken courses such as "Special Teaching Methods," "Classroom Management," and "Instructional Strategies" since it was necessary to be familiar with mathematical and pedagogical competencies in order to be able to analyze classroom episodes. A female PMT, Susan, and a male PMT, Mark, among group members were selected based on criterion sampling strategy as a type of purposive sampling technique. Moreover, Susan and Mark were selected among the participants since they were the most willing PSTs to watch and analyze VCs in the video group. Their reports were represented in the section "Findings" of this study in order to represent the change in the PSTs' noticing levels clearly and in detail in this study.

Data Collection and Data Analysis

In order to produce VCs to be used in the study, some criteria were considered. First, the length of these videos is an important issue affecting video analysis (Seago, 2004). Secondly, in the literature, video analysis was performed on videos lasting less than 10 minutes in previous

Table 1.
The Process of the Application of the Strategy Through Three Stages

Stage	Week	Actions
1	First and second	Watching and analyzing video clips and preparing reports
2	Third and fourth	Argumentative writing training Preparing video analysis report by argumentative writing
3	Fifth	Preparing video analysis report by argumentative writing and providing feedback for this report through interview
	Sixth	Preparing video analysis report by argumentative writing and providing feedback for this report through interview

research (e.g., Colestock & Sherin, 2009; van Es et al., 2017). Thirdly, the PSTs as inexperienced teachers could have difficulty focusing on students' mathematical thinking because of non-mathematical or non-pedagogical issues such as noise (Sperfine et al., 2017). Hence, VCs used in the current study lasted approximately 10 minutes. These parts were organized by throwing the duration in which students did not talk, empty scenes, noisy parts, etc. Moreover, the VCs were the recordings that the mathematical content taught in the videos were geometry in order to help the PSTs as inexperienced teachers focus on students' thinking in detail effectively. In other words, in order to enhance the PSTs' professional development of noticing and change their levels of noticing, the VCs were narrowed into geometrical concepts and students' geometrical thinking.

In the current study, whole data collection process including training about argumentative writing that lasted 6 weeks through three stages was represented in Table 1. Initially, the researcher identified and produced 4 VCs based on the criteria of including geometry lessons representing various teaching strategies and displaying that students engaged in the classroom contexts. These VCs lasting approximately 10 minutes and representing teaching processes in real classrooms were collected from middle schools. The PMTs watched the VCs assigned to them via dropbox. They watched the VCs and analyzed them by forming individual video analysis reports until the date of meeting with the researcher for the interviews which they conducted individually on their personal laptops. Then, they prepared a report each week. They wrote about what they noticed about students' geometrical understanding and thinking and how they interpreted their understanding and thinking. After they had completed preparing their reports, they sent these reports to the researcher via e-mail so the researcher read and analyzed the report. Then, each PMT met with the researcher for the interviews. Through the interviews, the researcher asked the questions such as "What was the goal of the lesson? What were the teacher's and students' responses to the classroom events? Which issues did you pay attention to?" in stage 1. In addition to these questions, the question of "How did the strategy based on Toulmin's model applied in this process affect your noticing?" was also asked in the interviews made for the reports prepared after taking argumentative writing training in stages 2 and 3. Moreover, they discussed and identified which sentences of the report referred to which elements of Toulmin's model through the interviews made for the reports by argumentative writing. In all of the interviews, the participants were able to watch the VCs again if they wanted to show and remember. Moreover, they talked about the report and the researcher provided feedback for that report in the first, second, third, fourth, fifth, and sixth weeks. Each meeting lasted approximately 45 minutes.

In the first week, VCs of classroom episodes were sent to 10 PMTs and their reports were formed by analyzing these videos. After the interviews for the first week had been completed, video group members and the researcher came together. The researcher explained "what argumentation is," its structure, and Toulmin's model of argumentation over 2 weeks lasting for 3 hours each week. In this model, six elements of Toulmin's model of argumentation represented in Table 2 were explained. These elements were talked about since mostly these elements were used in argumentative texts. Other elements of Toulmin's model including warrant, backing, and qualifier were rarely observed and they do not tend to take place in argumentative texts as it was stated in previous research (Nussbaum & Kardash, 2005; Qin & Karabacak, 2010). In order to teach how to prepare and organize paragraphs through argumentative writing, Reid's (1988) organizational plan B was also explained. In this organizational plan, useful way could be proposed by guiding the PMTs to organize paragraphs on the reports, their ideas, and observations. According to this plan, the arguments are established in the introductory paragraph and the support is provided in the body paragraph(s). Then, the counterarguments are refuted in the body paragraph(s) if they exist. Lastly, the arguments can be restated by explaining general comments with final words. Afterward, the PMTs examined and discussed the written argumentation examples formed in different fields about various topics using the elements of argumentation model. Hence, they acquired knowledge and experience about what argumentation and Toulmin's model are and how to form a report through argumentative writing.

After this training process had been completed, they formed their reports for remaining three VCs using argumentative writing through following stages. They observed one VC each week in the following processes of the study. Through the study, 30 reports by argumentative writing and 10 reports without argumentative writing were prepared for individual video analysis by all members of the video group.

For data analysis, reports prepared through the stages were examined through qualitative methods (Strauss & Corbin, 1998). Initially, reports prepared in the study were ordered chronologically. Then, specific filed notes were taken related to the PMTs' noticing of students' geometrical thinking and understanding. With this motivation, the data set was separated into idea units referring to explanations or statements about geometrical contexts with the aim of coding reports. By using qualitative data analysis, the idea units in the reports were determined. In order to provide trustworthiness, investigator triangulation was performed. An academician taking Ph.D. degree in mathematics education helped the researcher analyze the reports. They analyzed the reports individually and prepared their idea units. Afterward, they compared their lists. Inter-rater reliability was identified as 95%. The inconsistencies were discussed in order to reach consensus. Through analysis, it was focused on how the PMTs noticed students' geometrical thinking on the reports. In other words, in order to clearly examine and represent the change in the PMTs' noticing levels by answering the research question in detail, the PMTs' reports and developmental process were focused on. Hence, the codes were formed considering the framework organized based on van Es' (2011) "framework for learning to notice" (p. 139) and the nature of argumentation is illustrated in Table 3. By this framework, the PMTs' change in noticing levels was analyzed and reported based on the levels observed in the current study (ranging from explanations of classroom events chronologically from general perspective at level 1 to interpretations

Table 2.
Six Elements of Toulmin's Model of Argumentation (Qin & Karabacak, 2010, p. 449)

Elements	Definitions
Claim	An assertion in response to a contentious topic or problem.
Data	Evidence to support a claim.
Counterargument claim	The possible opposing views that can challenge the validity of a writers' claim; these opposing views can also be supported by data (Nemeth & Kornos, 2001)
Counterargument data	Evidence to support counterargument claim.
Rebuttal claim	Statements in which the writer responds to a counter-argument by pointing out the weakness in the claims, data, or warrant.
Rebuttal data	Evidence to support rebuttal claim.

Table 3.
Framework for Noticing

	What Teachers Notice	How Teachers Notice
Level 1 (baseline)	Content, general characteristics of classroom and teacher (physical properties), teacher behaviors, manipulatives	Describing what is observed. Explaining ideas about the video clips (using direct quotations or examples from the video clips)
Level 2 (mixed)	Pedagogical and pedagogical content knowledge of teachers, classroom management, assessment, motivating students, responding students' thinking, controller of application of classroom norms and providing active engagement and participation of students, characteristics of teacher (being flexible, self-confident, warm, etc.)	Evaluating specific instances by interpreting Criticizing the noteworthy events by using some elements of Toulmin's model Making comparison with experiences/thoughts Approving/criticizing instances Providing suggestions for whole class Providing evidence/justifications at middle level
Level 3 (Focused)	Individual students' mathematical thinking and actions, particular students' characteristics and needs	Making inferences Providing suggestions for particular instances/students Comparing particular events Justification of implications by providing robust evidence Criticizing the noteworthy events by using elements of Toulmin's model

of events in connection with instructional events and student thinking by critical thinking at level 3).

Results

With the aim of examining the role of argumentative writing on the participants' development of noticing, they initially wrote their reports for the VCs without argumentative writing. Then, they formed their reports based on argumentative writing in the following weeks after taking training about argumentation. Moreover, feedbacks about their reports were provided by the researcher through the interviews. In this section, their development process observed through the analysis was explained in detail using examples acquired through data collection to further illustrate this process. Through the stages, all of the PMTs' noticing levels were identified as level 1 in stage 1 and level 2 in stage 2. Then, eight PMTs were classified as level 3 and two PMTs were done as level 2 in stage 3.

Stage 1

In stage 1, in the reports of individual video analysis before argumentative writing training, the noticing levels of all of the participants were identified as level 1. In the first stage of writing report process, Susan focused on general characteristics of the classroom based on their impressions. She explained what she saw and observed in the video. The report of this week can be exemplified by the analysis made for the VC1 as follows:

> *In the classroom, there was a student whose name was Lisa who was asking them "Who are you?" through the activity. In this task, other students were holding geometric solids such as rectangular prism, cube, cylinder, sphere, pyramid made by colorful cartons. The students holding these solids came to Lisa by singing and then explained the properties of these solids. They expressed their names, main elements, formula of volume. For example, student said "I am a cube. I have 6 faces, 12 edges and 8 vertices. My volume formula is multiplication of my length, width and height… Other students holding other geometric solids in the task made similar actions based on their objects. In this process, the rest of the classroom watched the performance of others… In this task, the students explaining the properties of geometric solids made these explanations by singing so the lesson was funny…*

Some parts of the report prepared by Mark as another participant can be exemplified as follows:

> *…the lesson was about geometric solids. The desks were placed around the corners of the classroom in U-shape by leaving wide area in the middle of the classroom. In the classroom, the students can be classified into two groups, listening and role playing. The role playing activity was performed in the wide area. The teacher talked about role playing at the beginning and did not talk through the lesson. The students in role playing group explained the visual properties of geometric solids such as corners, edges by singing. Also, they told the volume formulas these solids. These students represented the models of geometric solids prepared by them. Another group sat and listened to them…*

The explanations in the reports prepared at this stage by all of the participants were unspecific and formed focusing on general characteristics of the duration of the lesson as represented above. In the reports and interview processes, they summarized the classroom teaching episode represented on the VC by explaining what they saw on the video based on holistic perspective in the first stage. Other participants formed their reports and made explanations of similar views. They explained their observations based on mathematical content, manipulatives used in the lesson, classroom, behaviors of the whole class, and happenings and teacher behaviors in terms of what they noticed. As for how they noticed, they described the events in the classroom in chronological order by focusing on whole class. They did not focus on particular students or actions. They made descriptive explanations about classroom atmosphere and teaching and learning process. They did not make any relationship between the teacher's actions and student thinking. They did not provide sufficient details to develop their ideas and noticing. Moreover, in their reports, they did not criticize any event or form an argument about the happenings in the classroom. They did not produce any elements of Toulmin's model so they prepared their reports without using any evidence/justification. Hence, it can be claimed that the PMTs did not use critical thinking. With this motivation, the noticing levels of them writing these individual video analysis reports were identified as level 1. In this stage, all PMTs' noticing levels were identified as level 1.

Stage 2

After the PMTs participated in the training about argumentative writing in the second stage represented in Table 1, they prepared their reports based on argumentative writing. Therefore, their reports were formed using the elements of Toulmin's argumentation model. An example of the reports of the second stage can be exemplified by the report formed by Susan about VC2 as follows:

> *The teaching process represented on the video directed to the students to memorize the properties of geometric solids rather than to conceptualize them [Claim]… Designing lesson and activities considering van Hiele geometric thinking levels in order to teach geometric solids can be useful to help students*

comprehend geometrical context. This geometrical concept was not taught in this order so the students tended to memorize this concept [Data 1]… In the video, the students formed types of solids using sticks and nutty putty, and showed them by explaining their names, elements and volume and lateral area formulas in a non-systematic order based on their hierarchical relationship. For example, they introduced cylinder, rectangular prism, cone, sphere, triangular prism… They did not learn hierarchical relationship among them. For example, they did not say prisms were cylinder… Hence, they did not reach informal deduction level [Data 2]… Moreover, the teacher corrected the wrong expressions by saying accurate ones. By this behavior, the teacher might prevent students' inquiry and tend to encourage their memorization [Data 3]… Moreover, in the past, I learned the geometric solids without considering hierarchical relationship among them in this way. I think that it prevents my solid understanding of geometric solids, improvement of geometric thinking and teaching them effectively. I still hesitate to teach them [Data 4]…

The noticing level represented by Susan in this report was identified as level 2. In this report, Susan criticized the lesson by explaining its deficiencies. Furthermore, she used her theoretical knowledge about teaching profession acquired through the courses in teacher education programs in which she enrolled such as van Hiele geometric thinking level to evaluate the video. She explained the claim benefiting from this knowledge. Then, she provided data for this claim by a particular instance that the students did not examine the solids in a systematic and hierarchic order from the video. She also focused on student actions considering them as whole class. Furthermore, she evaluated the teacher behaviors by describing the effects on the students. She did not detail the ideas explained in the claim and data by detailing particular events experienced by specific students. Moreover, while criticizing her ideas, she benefited from her theoretical knowledge about geometrical thinking and her negative experience.

Some parts of the report prepared by Mark as another participant in the current study can be exemplified as follows:

I think the activity in which the students constructed geometric solids using sticks and nutty and putty was useful for teaching. This activity managed by a cheerful and helpful teacher enhanced student understanding [Claim]… By using sticks, the students could analyze their edges. They could also analyze the vertices and how to connect the edges [Data 1]… On the video, the students could also understand these concepts by making comparisons among the placement of edges and their edges. For example, in order to construct a triangular prism, they used sticks in different lengths. They could realize that lengths of the sticks used to construct the triangles were different from the lengths of the sticks connecting these triangles to form prism. Also, they could realize that they used 12 sticks in equal length to form a cube [Data 2]… Moreover, the teacher observed them in order to encourage them to construct the geometric solids and helped them by showing their errors if necessary. She provided this guidance by smiling in a helpful way so that she encouraged students' motivations [Data 3]…

His noticing level at this stage was classified as level 2 because he noticed particular events focusing on actions of students in whole class and teacher behaviors affecting students. In this report, Mark criticized VC2 and prepared his report by evaluating the happenings in the lesson differently from his report in stage 1. He focused on how students' understanding of mathematical content was improved and provided justifications for his ideas. Moreover, he explained reflections on teacher behaviors and characteristics of students. However, he did not notice particular students taking place in noteworthy events in detail.

Susan and Mark prepared their reports for VC2 from opposite points of view as represented above. Based on these opposite views observed in their reports, it could be stated that both of them were inconsistent in exposing detailed students' geometrical reasoning and the ways of analyzing students' understanding and responding to them. In these reports, it was observed that Susan and Mark focused on the pedagogical aspect of the lesson related to what they noticed. They talked about the activity and manipulatives used in the lesson. When their current reports of this stage were compared with their reports of the first stage, it was observed that there were differences among them. For example, different from stage 1 in which Susan and Mark described the activity and manipulatives, they criticized the usage of them focusing on how teacher used them and how they affected student thinking. Moreover, by differentiating from their reports formed in the previous stage, they made explanations focusing on student thinking based on whole class by her general impressions in the report of the second stage rather than teacher actions. Moreover, they insisted on particular instances taking place on the video. They could pay attention to crucial issues in the video but she could not express her thoughts about this issue in a general way without providing details. With the help of producing claim and data, they connected their ideas and perspectives with practice in evaluative and interpretive perspectives. In this way, they could make implications and state this with claims. Then, they provided justifications for their implications with the help of data. Their justifications were classified as medium level since they did not use all elements of Toulmin's model and they could not effectively connect data 1, data 2, and so on and extend their explanations by their observations in detail. Hence, their noticing levels were identified as level 2. All PMTs' noticing levels were level 2.

After the participants had written their reports based on argumentative writing, the researcher read the report, and then they met with the researcher individually. The PMTs and the researcher talked about the written reports in the second stage through interviews. Through the interviews, the researcher provided feedback for their reports. For example, Susan was suggested to explain by considering the answers to the questions such as "How did the teacher reveal students' thinking? How were the students' questions responded? What specific math understandings and/or complex issues were observed in the video?, Who participated in particular tasks? How did they participate in them? Did the teacher's actions taking place in the classroom encouraged students' learning? Why?" in detail and more specifically. Also, they were proposed to make expressions referring to other elements of Toulmin's model of argumentation such as counterargument claim/data or rebuttal claim/data.

Stage 3

Based on the feedback provided through the interviews made for the reports prepared based on argumentative writing in stage 2, they prepared the reports of the third stage. At this stage, it was observed that they organized their reports for the video based on more than one claim. The report of this stage prepared by Susan for VC3 can be represented as follows:

Using the materials taking place in students' real life could enhance the motivation of the students so they could understand the concept effectively and participate in the lesson actively [Claim]. In this lesson, the teacher taught the concept of perimeter of circle. Initially, he asked the students the role of perimeter measurement in real life. After the students' explanations from real life such as putting up walls around a garden had listened, he introduced circle using hula hoop and ring [Data 1].

Then, he wanted students to tell how to find perimeter of circle. A student explained the usage of rope to find the perimeter of ring accurately. Another student stated that he could not understand how to find the perimeter of circle using rope. Then, the teacher directed this question to other students. In order to help this student, other students found the perimeter of different objects in shape of circle with rope. They wrapped these circular objects with rope once and they found the length of rope used to wrap the object by ruler [Data 2]. Hence, the use of materials made this abstract mathematical concept concrete since they could examine and find perimeter using their sense [Data 3]… Through engaging in activities, the teacher should have had the students criticize and discover the concept in a way as suggested in constructivist approach [Claim]. The teacher introduced the formula of 2πr and said the value of π was approximately 3 by leading students memorize the formula [Data 1]… After the activities, the students should have discovered the formula by criticizing the ratio between perimeter of circle and its diameter under the guidance of the teacher. A student asked the reason of this ratio and how this ratio was discovered in the past [Data 2]… The student solved the problem about the concept by placing the values on the formula because she might not understand the concept of π as the ratio as explained in the mathematics curriculum… [Data 3]

In this report, it was observed that Susan focused on particular students' thinking and made implications about their thinking considering their expressions and participation. She provided data based on the particular students' explanations about their thinking about the claims. In other words, she made implications about the particular instances and expressions such as using the formula without comprehension of the concept. Also, she provided suggestions such as emphasizing π as the ratio between perimeter and diameter. Susan formed the report focusing on student thinking rather than the teacher's actions and expressions. Moreover, she prepared the report by criticizing the events focusing on the particular students' expressions by making implications about their thinking. Furthermore, she examined the instances and interpreted the events from a theoretical perspective by criticizing the teacher's action of teaching formula without emphasizing its meaning by connecting with the objective in the curriculum and the role of material as making abstract concept concrete. Hence, it could be stated that the report was interpretive and evaluative because it provided detailed data to support claim. Moreover, she provided suggestions by exemplifying particular events and student thinking. By producing claims evidenced by data, Susan provided justifications for their implications. Different from her report in stage 2, although she did not use all elements of Toulmin's model, she could represent her ideas and implications by connecting data in more organized way. Therefore, the noticing level of Susan was identified as level 3 at this stage. Other PMTs prepared their reports for VC3 in similar way by producing more than one claim and providing evidence using data in more organized way than stage 2.

Through the interview about the report of stage 3, the feedback was provided. Based on the feedback, Susan prepared the second report of stage 3. The researcher suggested to form the report by thinking about the answers to the questions of "Does the classroom culture value and encourage the students to speak? If not, how could the classroom culture and learning procedure be improved? Why?" based on more specific and detailed events observed on the video. Also, the researcher insisted on using other elements of Toulmin's model of argumentation such as counterargument claim/data or rebuttal claim/data by providing detailed information. Moreover, the researcher wanted them to organize the ideas explained in the claims by connecting them coherently. In other words, she was proposed to prepare her report for VC4 in a more clearly organized structure. In the last stage, it was observed that she formed her report using counterargument claims and rebuttal claims. Also, she prepared her report by organizing and structuring the ideas based on all of the elements of Toulmin's model of argumentation. Susan's report prepared for VC4 considering all feedbacks that she had ever taken can be represented as follows:

… using technology provided many opportunities for the teacher and the students by enhancing students' understanding and conceptualizing the context effectively [Claim]. Through the animation for reflection motion, the teacher found the images of various shapes with the help of software easily. Also, they were colorful so that they could be analyzed easily. For example, a student who could not understand reflection asked questions about orientation of figure and the placement of the vertices. The animation of motion performed by colorful figures enhanced his understanding. He said "motion of figure is so clear" [Data 1]… Moreover, a student compared the image with the shape on the coordinate system. The teacher asked questions about changing and reserved properties of the shape through motion such as "what about the orientation and distances to the reflection line?" They were observed on the computer screen. Hence, she could clearly examine the motion by criticizing and understand [Data 2]… However, if technology had been used in the lesson by integrating it with conceptual and pedagogical knowledge and aspects of teaching process, its usage might have enhanced student learning [Counterargument Claim]. In solving questions about finding the image of various shapes under two consecutive reflections, the teacher represented the images of them on the computer. This provided the use of multiple representation. The students could not understand the motion since they were surprised when they saw the last image. The motion of two consecutive reflections should have been taught by asking questions about the properties and orientation of the image through two reflections by comparing with initial shape. They could not reason about critical attributes of the motion [Counterargument Data]… The lessons including the use of technology should have been organized carefully since the actions that could not be made on paper could be performed by technology easily and effectively [Rebuttal Claim]. A student drew the image of a shape under reflection. The teacher animated the formation of image on reflection with the help of the software. The animation of motion cannot be performed on paper. Then, the teacher wanted the students to name the vertices of the image by relating to the previous shape. The teacher asked the questions about the similarities and differences among the shape and its image. The animation property of software helped the student clearly observe and analyze the motion. This understanding was encouraged by the teacher's questions. Hence, it is important to have technological, pedagogical and content knowledge and related skills… [Rebuttal Data]

In the report, it was observed that Susan formed the report focusing on the particular instances in the classroom connecting the teacher's actions to theoretical knowledge such as technological pedagogical and content knowledge, the role of questioning strategy, and the role of technology in the classroom based on interpretative and evaluative perspectives. Susan provided the claim and data of the report focusing on the details of the particular instances taking place in the classroom and student thinking observed on VC4 by connecting with the teacher's actions. In other words, Susan reported her observation and made interpretations by providing details and justifications from the video. The expressions and evidence for her analysis were organized, structured, and reported considering the elements of Toulmin's model of argumentation. Different from previous reports, Susan provided data based on particular students' thinking in connection with the teacher's

actions such as examining changed and preserved properties with the help of the teacher's questions. The process of a particular student's thinking and learning about the concept with the help of the teacher's role and questions was explained. Also, this case was associated with the technological, pedagogical, and content knowledge by rebuttal data. Moreover, suggestions about the teaching process emphasized the importance of questioning strategy in the counterargument data. Susan formed the report by analyzing and evaluating the teaching and learning process by connecting the teacher's actions with students' thinking and learning. Also, this evaluation could be performed by relating practice represented on the VC to the theoretical knowledge acquired through the courses in teacher education programs. By the way, Susan prepared her report from different points of views different from her reports from previous stages. She evaluated VC4 by criticizing the events that she approved and disapproved. She represented these issues using the elements of Toulmin's model of argumentation by organizing interpretations, implications, and suggestions providing justifications. Hence, the noticing level of Susan was identified as level 3. In the last stage, it was observed that her noticing level remained at level 3 by representing the properties of these noticing skills. Furthermore, eight PMTs prepared their reports using most of the elements of argument structure by representing the characteristics of noticing skills of level 3. Their reports prepared for VC4 exhibited features of level 3. The remaining two PMTs prepared their reports with some elements of argumentation structure by providing their explanations in an organized way so their noticing levels were identified as level 2.

Discussion

The purpose of the current study is to explore PMTs' skills in noticing students' geometrical thinking. They were expected to prepare the reports with and without argumentative writing by analyzing the VCs. Through analysis, they thought how to attend, interpret, and respond to students' geometrical thinking shown on VCs.

In stage 1, the PMTs generally focused on content, general characteristics of classroom and teacher, and teacher behaviors by describing and explaining. It can be stated that while they can attend to the mathematical content and describe teacher behaviors and classroom, they could not easily evaluate and respond to students' thinking as stated in previous research (Krupa et al., 2017; Sanchez-Matamoros et al., 2019) by criticizing, interpreting, and justifying. After the training in argumentative writing, their reports were changed because of the changes in what they noticed and how they noticed with the help of critical thinking. In other words, by critical thinking, the PMTs could focus on noteworthy events and students' thinking in detail so that they could respond to students' geometrical thinking encouraging the claim "deciding how to respond on the basis of children's understandings can occur only if teachers interpret children's understandings, and these interpretations can be made only if teachers attend to the details of children's strategies" (Jacobs et al., 2010, p. 197).

This study has proposed an instructional approach to teach argumentative writing by analyzing VCs representing real classroom episodes for professional development to be used in teacher training. It has been examined that argumentative writing could enhance professional development in addition to critical thinking, problem-solving, conceptual knowledge construction, and scientific thinking skills explored in previous research (Choi et al., 2013; McDermott & Hand, 2010; Poock et al., 2007; Schoerning et al., 2015; Yaman, 2018). In this instructional approach, the PMTs took training about argumentation, elements of argument structures, and how to form reports based on argumentative writing. They observed the VCs of classroom episodes and then they formed individual video analysis reports by this approach.

When all of the analysis reports based on Toulmin's model of argumentation were considered, it was observed that the reports included claims and data as two basic elements of argument structures as the core of the Toulmin's model. These elements took place on the reports after the first stage because the PMTs participated in argumentative writing training process and learned Toulmin's model. With the help of the nature of argumentative writing, they observed the VCs and formed their reports in interpretative and evaluative perspectives. This might result from the necessity of critical thinking to produce argument structures based on the observations of the VCs. Then, when the PMTs experienced argumentative writing, they could clearly analyze the videos in more detail. Hence, they could form their reports using the other elements of argument structures. The secondary Toulmin elements such as counterargument claims and rebuttal claims were provided to form effective argumentative papers. Also, the usage of these elements enhanced the preparation of individual video analysis reports based on more interpretative and evaluative perspectives. For example, in the fourth report including all elements of argumentative writing represented above, specific request for possible interpretations and alternative pedagogical moves was also provided in counterargument claim/data and rebuttal claim/data. Hence, interpretive comments, connections between events and principles of teaching and learning, and alternatives for teaching strategies were explained. On the other hand, the usage of these elements of argumentative writing might direct and encourage the PMTs to make these explanations. Based on this finding, it can be stated that organizing ideas on the reports by argumentative writing using the elements of argument structure enhanced the evaluation and interpretation of the instances on the VCs. Also, it could become possible to analyze the happenings on the videos in detail by evaluating them to produce claim and providing data and other elements to convince the audience of the reports. Hence, it could be stated that this might happen because argumentation necessitates questioning, critical thinking, and evaluation as suggested in previous research (Abi-El-Mona & Abd-ElKhalick, 2011; Dawson & Venville, 2010; Driver et al., 2000; Jonassen & Kim, 2010; Nussbaum, 2008). Moreover, in the reports, it was observed that the PMTs provided the data for the claims and suggestions for teaching period and made evaluation using their knowledge and perceptions acquired through teacher training. For example, Susan evaluated the order of introducing types of geometric solids and made suggestions based on van Hiele geometric thinking level. Hence, by forming the reports based on argumentative writing, Susan was provided opportunities to think critically, organize her ideas about classroom episodes on the VC, and raise self-awareness of knowledge and skills about teaching acquired through preservice years as suggested in previous research (Perpignan et al., 2007).

In the study, it was observed that the PMTs' noticing levels were improved in connection with Mason (1998) and van Es (2011) based on what to notice and how to notice. With the help of individual video analysis by argumentative writing, their noticing varied in foci and structure of attention. Through the stages of individual video analysis performed in this way, the PMTs changed their foci (Mason, 1998). In the first stage, the PMTs' noticing focused on the description of events in chronological order and developed through the stages to interpretation and evaluations of particular instances based on theoretical knowledge. They started to consider students' mathematical ideas observed in the classroom episode on the video by evaluating and interpreting them based on teachers' pedagogical knowledge. By thinking about what to write for the elements of argument structures, they began to criticize the teaching episode on the video. Moreover, with the nature of argumentative writing enhancing critical thinking, they could change their foci from describing whole process to interpret and evaluate critical instances. Furthermore, with the help of characteristic of argumentation facilitating scientific thinking (Schweizer, 2002), the PMTs could begin to use their professional knowledge

acquired through teacher education program. The PMTs formed the elements of argument structure by using the ideas acquired through evaluating the instances on the video. While forming the statements representing the elements of Toulmin's model in order to convince researcher as the audience of the reports about the idea claimed in the report, the PMTs used their knowledge about teaching profession such as van Hiele geometric thinking levels and technological pedagogical and content knowledge. Hence, they could make connection between theory and practice through individual video analysis based on argumentative writing. Moreover, through the stages they formed more organized reports by argumentative writing and used more elements of argument structures. The more experienced the PMTs acquired by argumentative writing through the stages, the more they developed their noticing levels. Hence, the way suggested in this study, such as analyzing videos by argumentative writing, seems to allow the PMTs to notice student thinking in relation to teacher pedagogical skills and professional knowledge by interpreting and evaluating analytically. In this way, in this study, an alternative approach for teacher preparation enhancing the PMTs' noticing could be provided as suggested by Mason (1998) and (Sánchez-Matamoros et al., 2015) so that they could develop their noticing in a new way by teaching them. To conclude, in the current study, the properties of PSTs at the noticing level of level 3 were explained by the actions of remembering details about students' understanding in mathematical contexts, justifying their ideas/arguments, interpreting and evaluating rather than describing, and providing suggestions for instructional actions in relation to particular students' understandings and geometrical thinking. These properties are similar to the properties of teachers or PSTs at advanced noticing level explained in the previous research (Callejo & Zapatera 2017; Jacobs et al. 2010; Krupa et al. 2017; Sánchez-Matamoros et al. 2019; Ulusoy & Çakıroğlu, 2021). Hence, it can be stated that preparing the reports for VCs by argumentative writing could enhance the PMTs' analyze students' geometrical thinking with critical thinking encouraged by argumentation. Moreover, producing VCs by narrating the context and types of thinking such as geometry topics and geometrical thinking and preparing the reports by analyzing VCs individually might encourage the PMTs' noticing as suggested in the previous study of Ulusoy & Çakıroğlu, (2021).

Conclusion and Recommedtaions

In the current study, a new way to use argumentative writing in professional development rather than knowledge construction, problem-solving, and developing linguistic skills and scientific writing abilities as in previous research was proposed. In this respect, the study provided a strategy to develop the PSTs' noticing by argumentative writing. It appears that this way performed through three stages to improve noticing can be used in teacher training programs for professional development. Moreover, further research can be made conducting this strategy to PSTs in various areas different from mathematics teacher education and other contexts different from geometry. Hence, the usage of this strategy can be extended. This strategy can also be used in inservice teacher training so further research can be performed in this way to develop their noticing. Moreover, the contribution can be provided to the literature about PSTs' professional development of noticing skills and mathematics teacher educators to encourage the PSTs' development by representing the effects of analyzing classroom VCs and preparing written reports. In other words, it can be argued that writing reports for classroom video analysis in a methodological way: individual video analysis→preparing report by argumentative writing→interview. Further research can be designed by using similar methodological ways in order to examine PSTs' noticing skills. In the current study, the PSTs' noticing was examined in the context of geometry and geometrical thinking as the previous context-oriented noticing studies analyzing PSTs' written explanations or watching the classroom VCs (e.g., Callejo and Zapatera 2017; Sánchez-Matamoros et al. 2019). The properties of the professional development of PSTs' noticing skills in the context of geometrical thinking were examined through the reports by argumentative writing prepared by analyzing VCs individually. To sum up, it can be stated that the current study provides contribution to the literature about professional noticing in three ways. First, this study differentiates from many studies in the literature by examining context-specific noticing; that is, exploring PSTs' noticing of students' geometrical thinking and producing videos related to geometrical contents. Secondly, using VCs focusing on particular issues such as student interactions, unexpected events, or inconsistent student responses produced by the researchers can enhance the professional development of noticing as suggested in previous research (Ulusoy & Çakıroğlu, 2021) and emphasized by Kang and van Es (2019) by explaining "identifying the right video is challenging because what is "right" largely depends on situations and PSTs" (p. 7). Lastly, a different methodological approach including analysis of videos produced by the researchers are performed individually by argumentative writing is proposed. In the previous research, PSTs are expected to analyze videos by writing reports or participating in group discussions. In this methodological approach, it is thought that argumentation encouraging critical thinking performed for video analysis might contribute to studies focusing on the professional development of PSTs' noticing skills in the context of students' geometrical thinking.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of the Alanya Alaaddin Keykubat University (Date: April 9, 2022, approval number: 62744148-604.01.02-E.64248).

Informed Consent: Written informed consent was obtained from the perservice mathematics teachers who participated in this study.

Peer-review: Externally peer-reviewed.

Declaration of Interests: The author have no conflicts of interest to declare.

Funding: The author declared that this study has received no financial support.

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