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Characteristic of Video Clips of Preservice Mathematics Teachers' Ability to Notice

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Abstract. *Noticing is the teacher's ability to pay attention to critical moments during learning. The noticing ability of preservice mathematics teachers can be trained by watching video recordings of teaching practices. However, there are limited video clips that can be used as teaching materials to develop the noticing abilities of preservice mathematics teachers. Therefore, this study aims to identify the characteristic of preservice mathematics teacher's ability to notice. Video clips consist of a series of significant moments to observe. This research used a survey of moments in video recordings of preservice mathematics teachers when noticing their students' thinking in the learning process. The data analysis was based on learning video clips, containing the complexity of noticing problems related to the preservice mathematics teacher's ability. The results indicated that the identified video clips, recordings of classroom interactions, featured teacher activities such as asking, guiding, responding, and assisting students. However, the preservice teachers demonstrated a low ability to notice, particularly in the interpreting and shaping aspects. These video clips, specifically those that highlight these teacher activities, can be utilized as learning tools in teacher development programs to enhance preservice teachers' noticing skills, especially in interpreting and shaping aspects.*

Keywords*: noticing, preservice mathematics teachers, video*

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Introduction

Noticing is part of the teacher's pedagogical competence to accommodate students' needs (Stockero, 2021; van Es & Sherin, 2021). Noticing is also a professional skill required by teachers and preservice teachers (Sherin, Jacobs, & Philipp, 2011; van Es & Sherin, 2021), especially preservice teachers with less teaching experience. Preservice teachers find it difficult to focus on students' thoughts and important events in learning, so they must learn what should be observed in learning activities (Fernandez, Llinares, & Valls, 2012; Amador, 2016). Preservice teachers' noticing skills remain low but can be developed (Goldsmith & Seago, 2011; Roth McDuffie, Foote, Bolson, Turner, Aguirre, Bartell, Drake, & Land, 2014). Noticing involves analyzing teachers' perceptions of what happens in the classroom and how they determine important situations that can support learning (Miller, 2011). Mason (2011) also explained that teachers must be aware of what is happening and how to manage the class.

Teachers pay attention to many things in the classroom, including classroom management, learning content, assignments, and communication between teachers and students (Star & Strickland, 2008). Teachers are encouraged to develop greater flexibility in understanding students' thinking processes during learning (van Es & Sherin, 2002; van Es & Sherin, 2021). Therefore, developing noticing abilities is necessary for teachers, especially preservice mathematics teachers.

The attention skills of preservice mathematics teachers are improved after training (Sánchez-Matamoros, Fernández, & Llinares, 2015), indicated by differences in their noticing abilities before and after the training. Previous research found that mathematics teachers' noticing abilities are better than preservice mathematics teachers (Jacobs, Lamb, & Philipp, 2010), implying that teaching experience and teacher professional development activities influence the ability to notice. Experienced teachers can better differentiate between important or unimportant information in complex situations and can understand and analyze this information to create variations in teaching (Barnhart & van Es, 2015). On the other hand, preservice teachers experience difficulties in understanding students' thinking strategies (Dini, Sevian, Caushi, & Orduña Picón, 2020; Teuscher, Leatham, & Peterson, 2017; Wallach & Even, 2005), so they have difficulty implementing learning appropriate to students' thinking processes (Gotwals & Birmingham, 2016). However, when preservice teachers receive guidance or training, they can analyze students' thinking processes like professional teachers (Barnhart & van Es, 2015; Levin, Hammer, & Coffey, 2009). Therefore, it can be concluded that preservice mathematics teachers' noticing abilities can be trained.

The ability to notice can be trained by watching learning videos (Roller, 2016; Stockero, 2021; van Es & Sherin, 2006). Video can be an ideal teaching medium to develop teacher noticing (Roose, Vantieghem, Vanderlinde, & Van Avermaet, 2019; Sherin & van Es, 2005). Video can capture the complexity of a classroom, providing information or notes for teachers to reflect on what is happening (Sherin & Han, 2004). Using videos can increase the teacher's insight into important events in learning because the teacher can review the video several times from different points of view. Such activities help preservice mathematics teachers develop noticing skills.

Previous research on the use of video to develop the attention of preservice teachers was conducted by Star and Strickland (2008), who reported that the use of video increases the attention of preservice teachers in conducting classroom observations, especially paying attention to important events during learning. Watching learning videos allows mathematics teachers to observe and evaluate their learning (Santagata, König, Scheiner, Nguyen, Adleff, Yang, & Kaiser, 2021). It can also help preservice mathematics teachers provide objective assessments based on learning activities through video clips. However, video clips to foster and develop the attention of preservice mathematics teachers are limited.

In Indonesia, one of the educational training institutions for preservice teachers is Teachers Professional Education (PPG). Preservice mathematics teachers must evaluate important aspects of learning, such as students' thinking abilities. Based on the PPG curriculum, preservice teachers have learned how to determine student ability levels, strategies, methods, and learning styles that suit student needs through Principles of Effective Assessment Teaching (PPAE) I and II courses. In these courses, lecturers usually give assignments to train preservice mathematics teachers' abilities to examine class events. However, lecturers do not have video clip examples regarding important aspects to notice for student teachers. Teacher professional development can be enhanced through video-based teacher education design (Blomberg, Sherin, Renkl, Glogger, & Seidel, 2014; Roller, 2016). Therefore, video clips can help preservice mathematics teachers practice their skills in notifying learning activities, especially students' thinking processes.

This study examines "what are the characteristics of video clips that enhance preservice teachers' noticing skills?". The video clips obtained in this research can be used as teaching media material by a preservice teacher program and teacher professional development institutions.

Method

This study is part of research on preservice teachers' ability to notice students' mathematical thinking processes through video analysis, focusing on the three main aspects of noticing: attending, interpreting, and shaping. This research aims to identify the characteristics of video clips of preservice mathematics teachers. This research is qualitative to employed a survey for events in teaching video recordings of preservice mathematics teachers on students' thinking processes during learning. The research subjects were preservice professional mathematics teachers taking the preservice PPG program. They had been trained theoretically and practically to apply learning that suits students' needs. Research subjects were chosen based on the consideration that preservice PPG teachers who had studied PPAE courses and were willing to participate in this research.

The data presented in this study were obtained from video recordings of the teaching practices of four preservice mathematics teachers (PTs 1, PTs 2, PTs 3, and PTs 4). Each was approximately one hour and thirty minutes on linear and matrix programming in one of the senior high schools in Banda Aceh. The preservice teacher who taught in the video was not trained to notice so that other PTs would have more cases to examine.

Data was collected based on important events in the video. The selection of video clips was done by watching recorded videos and selecting event clips representing specific teaching and learning (Seidel, Prenzel, Schwindt, Stürmer, Blomberg, & Kobarg, 2009). The selection of video clips was also based on Mason, Burton, and Stacey (2010) phase theory of the thinking process, which consists of three phases: the entry phase, attack phase, and review phase.

The entry phase occurs in the process of recognizing the problem and defining the problem. This phase also attempted to group and recognize problems and introduce symbols and notations in mathematics; therefore, there is a process of understanding the problem. In the attack phase, mathematical activities needed to solve problems were carried out, including mathematical techniques, principles, or concepts. The review phase aimed to reflect on the previous phases. This phase also helped to re-check whether the mathematical thinking process was correct and whether the context used to solve the problem was appropriate. These video clips help PTs train their noticing skills in learning, especially towards students' mathematical thinking processes.

The video clips selected for this study were evaluated through a Forum Group Discussion (FGD) to assess the research subjects' noticing ability. The level of noticing ability was determined based on the noticing assessment criteria proposed by van Es and Sherin (2021), including three frameworks: attending, interpreting, and shaping. The noticing assessment rubric, adapted from Jacobs et al. (2010), is presented in Table 1.

Table 1. Noticing framework

Aspect	Level	Description
Attending	Evidence (1)	The teacher in the video describes important details about the students' steps or strategies in solving the problem.
	Lack of Evidence (0)	The teacher in the video did not describe in detail how students solved the problem and ignored the steps or strategies that students used.
Interpreting	Robust Evidence (2)	The teacher in the video interprets the students' understanding completely.
	Limited Evidence (1)	The teacher in the video interprets students' understanding but incompletely.
	Lack of Evidence (0)	The teacher in the video does not interpret the students' understanding.
Shaping	Robust Evidence (2)	The teacher in the video proposes questions to deeply explore students' understanding.
	Limited Evidence (1)	The teacher in the video proposes questions to explore students' understanding but lacks depth.
	Lack of Evidence (0)	The teacher in the video does not propose follow-up questions to deeply explore students' understanding.

The video clips produced in this research can also be used as teaching material to support preservice mathematics teachers in practicing their ability to notice by explaining important events that they pay attention to in the clips.

Results and Discussion

Several training or education institutions in Indonesia, including the Teacher Professional Education (PPG) program, are dedicated to preparing preservice teachers. Noticing, a fundamental aspect of teachers' professional competence (Kaiser & König, 2019), is a skill that cannot be overstated in its importance. Efforts are urgently needed to develop the noticing skills of preservice professional teachers, particularly in mathematics. One way to train these noticing skills is watching video recordings of classroom learning, focusing on significant events that occurred during the lessons.

Watching video clips positively impacts teachers or preservice teachers, enhancing their ability to observe classroom events (van Es & Sherin, 2002). These clips can be used to identify the noticing skills of preservice mathematics teachers. Watching the learning videos enables preservice teachers to concentrate on noticing critical aspects of teaching (Sherin & Han, 2004). Teachers participating in video-noticing clubs can enhance their teaching potential through discussions of video clips based on their practices (Sherin & Han, 2004). Thus, video clips allow preservice teachers to observe classroom events or interactions that might go unnoticed during actual teaching. The video clips produced in this study highlight significant events related to students' thinking processes, making them essential for observation in learning contexts.

Results of identification of important events in PTs 1 teaching video clips

PTs 1 teaches Linear Programming in Year 11. The video recording was approximately one hour and 30 minutes. Four critical moments described important events in the learning were selected. The details of the important events are presented in Table 2.

Table 2. Results of identification of important events in PTs 1 teaching video clips

No	Video Code, Time	Important Events
1	Video 00685, minutes 20-21.	The teacher asked students questions to provoke them to solve problems and help them determine appropriate problem-solving strategies.
2	Video 00685, minutes 25-27	Some students had difficulty understanding the problem on the worksheet. The teacher explained the meaning of the problem.
3	Video 00685, minutes 36-38	The teacher stated that the students' solution strategies were correct and revealed several errors in them.
4	Video 00685, minutes 44-47	The teacher helped students understand the problems based on the strategies they used to solve the problem.

The learning model used in the video clip is Guided Discovery Learning (GDL). Overall, the learning activities in the video clip show that the teacher is engaged in guiding the students to solve the problems. The teacher responds to students' questions and tries to propose questions that trigger students to find appropriate problem-solving strategies. Therefore, this video clip can be used as teaching media to develop the attention of PTs to important aspects achieved or missed in learning.

Example 1

The following is a conversation between a model teacher and students in a video clip quoted in the 45th minute.

PTs 1	:	*Let's see how many minimum points this has. (while pointing at the student's picture)*
S3	:	*Three*
PTs 1	:	*So, what is the first vertex?*
S3	:	*Five, eh (0.5)*
PTs 1	:	*What about the second vertex?*
S3	:	*Four point… (students look confused)*
PTs 1	:	*Well, y is given, isn't it?*
S3	:	*oh (0.5)*
PTs 1	:	*What does it mean? (The teacher notices that the students are looking confused) x is given. What is y? Is it given?*
S3	:	*No*
PTs 1	:	*So?*
S3	:	*y is zero*
PTs 1	:	*Yes, that's correct*

The conversation above shows that the teacher examined the students' answers, namely the graphic sketches of two known equations. The teacher found that students made mistakes in sketching the graphs; students did not determine vertices and did not know the direction of the shading of the lines, so students had difficulty determining the solution.

The conversation from minutes 36-38 in the video clip.

S4	:	*What do you mean by this? (pointing to the equation 3x+y = 5, x=0 and y = 5)*
PTs 1	:	*Oh yes, this is correct, then try it. Look at this one (pointing to the equations 3x+y = 5, y=0 and x = 5). x= 5 is incorrect; it should be x = 5/3*
S5	:	*That means 5/3 here, doesn't it? (pointing to one of the points)*
PTs 1	:	*Yes, exactly*

The teacher noticed that students made a mistake in determining the intersection of $3x + y = 5$. Students determined the value of y by assuming x = 0, so they get y = 5. However, when students said y = 0 to determine the value of x, the answer given by the student was x = 5, where the students ignored the coefficient of x. x should be 5/3. Based on the results of identifying PTs 1 teaching practice videos, four video clips describing important events were obtained. It could be notified based on indicators of mathematical thinking processes and three main aspects of noticing, as presented in Table 3.

Table 3. Four video clips PTs 1 based on the phases of the thinking process and noticing indicators

Video Clips	Indicators of the mathematical thinking process	Indicators of *Noticing*	Noticing students' mathematical thinking processes	Level of Noticing Skills
1	Entry Phase	*Attending*	The teacher attended that the students had difficulty understanding the problem and did not know the correct inequality symbol to solve the problem.	Evidence (1)
		Interpreting	The teacher interpreted the students' thinking that the students used the inequality symbol "less than" because they were confused by the word “require” in the problem.	Limited Evidence (1)
		Shaping	The teacher did not ask the students why they used the “less than” symbol but instead proposed the correct answer and asked them to agree with the teacher's opinion.	Limited Evidence (1)
2	Entry Phase	*Attending*	The teacher attended that the students had difficulty determining variables and inequality symbols because they could not understand the problem.	Evidence (1)
		Interpreting	The teacher interpreted that students did not understand the process of completing the tables and modeling word problems into mathematical symbols, so they had difficulty in determining the value of variables and inequality symbols.	Limited Evidence (1)
		Shaping	The teacher asked questions and advised on the correct problem-solving steps.	Limited Evidence (1)
3	Review Phase	*Attending*	The teacher realized that the students made mistakes in determining the intersection point of the constraint function.	Evidence (1)
		Interpreting	The teacher interpreted that the student's error in solving the problem was due to their incomprehension in applying the substitution method.	Limited Evidence (1)
		Shaping	The teacher found the students' mistakes, but the teacher did not ask about the strategies used by the students to solve the problem.	Limited Evidence (1)
4	Review Phase	*Attending*	The teacher attended that the student had difficulty sketching a graph and made mistakes in determining the intersection point of an inequality.	Evidence (1)
		Interpreting	The teacher interpreted that students did not understand the application of the elimination method, resulting in their mistakes in finding the intersection point.	Limited Evidence (1)
		Shaping	The teacher did not ask about students' thinking in solving the problem but instead provided suggestions for the correct answer.	Limited Evidence (1)

Results of identification of important events in PTs 2 teaching video clips

Based on the results of identifying video recordings of PTs 2, four video clips were obtained and used as references to develop PTs' noticing abilities. Overall, the teaching and learning process was done following the lesson plan and student worksheets provided. PTs 2 taught linear programming in Year 11. Learning was carried out using the Problem-Based Learning (PBL) model. The video recording of this preservice mathematics teacher's lesson lasted about one hour and thirty minutes. Four critical moments describe important selected events, as presented in Table 4.

Table 4. Results of identification of important events in PTs 2 teaching video clips

No	Video Code, Time	Important Events
1	Video 00692, minutes 5	The teacher provided examples to encourage students to understand the concept of inverse function.
2	Video 00692, minutes 11-12	Some students conveyed their answers. The teacher corrected and explained that their answers were incorrect
3	Video 00692, minutes 14-15	Some students conveyed problem-solving strategies, and the teacher asked them to re-check them.
4	Video 00693, minutes 2-3	Some students asked questions, and the teacher helped them find the correct answer.

Based on the results of identifying the learning video recordings described in Table 4, the teacher attempts to recognize several events regarding students' thinking strategies and how to respond to students' thinking processes.

Example 2

The following is a conversation in a video clip selected from the teaching recording at the 11^{th} minute.

S1 : *Is this a negative result? (pointing $f(x) = 85{,}000x – 20{,}000$, for $x = 35$)*
PTs 2 : *Well, why is it negative? what is 85,000 times 35?*
S1 : *(trying to revise incorrect answers)*

Based on the results of the conversation above, it can be seen that students had problems in their thinking processes regarding mathematical multiplication operations. The problem requires determining how many flash drives can be obtained with a discount of 20,000. Based on the students' answers, they mistakenly believe that 85,000 is equivalent to 85,000 minus the discount of 20,000. This results in a negative value, which is incorrect since the number of items cannot be negative. Four video clips were obtained based on the results of identifying PTs 2 teaching practice videos, and the details are presented in Table 5.

Table 5. Four video clips PTs 2 based on the phases of the thinking process and noticing indicators

Video Clips	Indicators of the mathematical thinking process	Indicators of *Noticing*	Noticing students' mathematical thinking processes	Level of Noticing Skills
1	Review Phase	*Attending*	The teacher realized that the student made a mistake in the division operation.	Evidence (1)
		Interpreting	The teacher interpreted that the student should divide by 85,000, but the student divided by 85 and considered the three zeros meaningless.	Limited Evidence (1)
		Shaping	The teacher did not ask the students for their reasoning for dividing by 85. Instead, the teacher stated that the student's answer was incorrect and asked, "What about the zeros? If that’s the result, it means it’s divided by 85."	Limited Evidence (1)
2	Review Phase	*Attending*	The teacher attended that the student made a mistake in operating the numbers, resulting in a negative solution.	Evidence (1)

Video Clips	Indicators of the mathematical thinking process	Indicators of *Noticing*	Noticing students' mathematical thinking processes	Level of Noticing Skills
		Interpreting	The teacher interpreted that the students should have multiplied 85,000 by 35, but they multiplied 85,000 by 35, which, when subtracted by 20,000, resulted in a negative value, and the number of items cannot be negative.	Robust Evidence (2)
		Shaping	The teacher did not ask why the student multiplied by 85,000. Instead, the teacher responded to the student's answer with, "Why is it negative? I85,000 multiplied by 35, what is the result?"	Limited Evidence (1)
3	Review Phase	*Attending*	The teacher attended that the problem-solving used by the student was correct.	Evidence (1)
		Interpreting	The teacher interpreted the students' problem-solving steps as correct for determining the value of the inverse function.	Lack of Evidence (0)
		Shaping	The teacher did not ask questions concerning the procedures the students used to solve the problem. Instead, the teacher stated that the problem-solving steps the students used were correct without exploring the strategies they used.	Lack of Evidence (0)
4	Review Phase	*Attending*	The teacher realized that the students had difficulty understanding the steps to find the inverse.	Evidence (1)
		Interpreting	The teacher interpreted that the students did not understand that the inverse form is expressed in f(y) or y.	Limited Evidence (1)
		Shaping	The teacher did not ask follow-up questions to help students recall the inverse function. Instead, the teacher suggested the student's question by saying, "The inverse is expressed in 85,000x-20,000= y."	Limited Evidence (1)

Results of identification of important events in PTs 3 teaching video clips

The learning was undertaken by applying the Culturally Responsive Teaching (CRT) approach, namely applying Acehnese culture to create a franchise business. The material was operations on matrices in Year 11. The overall learning video recording lasts approximately one hour and thirty minutes. Four video clips were extracted representing important events or critical moments in the learning. Table 6 presents the results of identifying four important events for PTs 3.

Table 6. Results of identification of important events in PTs 3 teaching video clips

No	Video code, Time	Important Events
1	Video MAH01799, minutes 62-68	Teachers helped students understand problems through guidance and asking questions, triggering students' thinking processes.
2	Video MAH01799, minutes 69-72	Some students asked questions, and the teacher responded to students' questions and guided students to solve problems.
3	Video MAH01799, minutes 73-76	Some students said that the numbers were combined, and the answer was correct. The teacher re-checked the meaning of combination and told them that it was not a combination number.
4	Video MAH0677 minutes 3-6	The teacher helped students' thinking process determine the general matrix addition form.

Based on the results of identifying the four video clips, illustrated in Table 4, the video clip activity describes important events to train the noticing skills of PTs. Noticing focuses on what teachers can or cannot identify as important events that occur in the classroom (Star & Strickland, 2008). Therefore, the results of identifying video clips from learning recordings can be used as a learning medium to develop the noticing abilities of preservice mathematics teachers.

Example 3

The following is a conversation between a teacher and a student in one of the video clips, which has a duration of sixty-four minutes.

PTs 3	:	*(there have been some questions and answers between the teacher and students) what is the meaning of total in this problem?*
S1	:	*Hmm, the overall value*
PTs 3	:	*Yes, that's right. What are the total costs required for shops A and B?*
S1	:	*That means 500,000 plus 1,000,000 equals 1,500,000*
T	:	*Yes (confirming student's answer)*

Based on the events in the video clip, the students seem to have misconceptions about the meaning of "total cost". The students added all the elements in the first column of matrix A and the first column of matrix B, resulting in an incorrect total cost. The teacher explained the "total cost"; so, the students could correct their answers based on the correct addition rule of two matrices. Four video clips were obtained based on the results of identifying PTs 3 teaching practice videos, and the details are presented in Table 7.

Table 7. Four video clips PTs 3 based on the phases of the thinking process and noticing indicators

Video Clips	Indicators of Mathematical Thinking Process	Indicators of *Noticing*	Noticing students' mathematical thinking processes	Level of Noticing Skills
1	Entry Phase	*Attending*	The teacher realized that the students had mistakenly determined the total cost in matrices A and B.	Evidence (1)
		Interpreting	The teacher interpreted that the student assumed "total cost" means adding all the elements in matrices A and B.	Limited Evidence (1)
		Shaping	The teacher did not ask why the students added all the elements in both matrices to obtain the total cost. The teacher only clarified the meaning of "total cost" to avoid misconceptions in understanding the problem.	Limited Evidence (1)
2	Attack Phase	*Attending*	The teacher attended that the students' problem-solving steps were correct, but they had difficulty describing the solution.	Evidence (1)
		Interpreting	The teacher interpreted that the student did not understand how to pair the columns and rows in the matrix. The student paired the matrix pattern (1-1) with (2-2). Thus, the description given was incorrect.	Robust Evidence (2)

Video Clips	Indicators of Mathematical Thinking Process	Indicators of *Noticing*	Noticing students' mathematical thinking processes	Level of Noticing Skills
		Shaping	The teacher asked questions to help the students understand the location of the matrix.	Robust Evidence (2)
3	Entry Phase	*Attending*	The teacher attended that students have difficulty understanding the addition of two matrices.	Evidence (1)
		Interpreting	The teacher interpreted that the students did not understand the location of the matrix, so they had difficulty adding two matrices.	Limited Evidence (1)
		Shaping	The teacher noticed that students had difficulty understanding the addition of two matrices. Therefore, the teacher explained it and was passive in asking questions to students.	Limited Evidence (1)
4	Attack Phase	*Attending*	The teacher attended that students had difficulty describing the general form of the sum of two matrices.	Limited Evidence (1)
		Interpreting	The teacher interprets that students wrote the addition of two matrices from $\begin{bmatrix} a & b \\ c & d \end{bmatrix} + \begin{bmatrix} e & f \\ g & h \end{bmatrix}$ to ac + eg, because students added matrix A and matrix B of the first row.	Robust Evidence (2)
		Shaping	The teacher asked questions to help students understand the procedure for adding matrices; thus, they could write the general form of adding two matrices.	Robust Evidence (2)

Results of identification of important events in PTs 4 teaching video clips

The learning on video recordings of mathematics teacher candidate learning was conducted using a Culturally Responsive Teaching (CRT) approach to linear programming in Year 11. The lesson lasted approximately one hour and thirty minutes. The video clips selected in this study comprised four clips representing each important moment in the learning carried out, as presented in Table 8.

Table 8. Results of identification of important events in PTs 4 teaching video clips

No	Video Code, Time	Important Events
1	Video MAH0676 minutes 28-29	The teacher helped students clarify that the problem-solving process they used was correct and guided them to better understand the problem.
2	Video MAH0676 minutes 31-32	Some students asked questions, and the teacher answered and explained the problem to the students.
3	Video MAH0676 minutes 32-34	The teacher guided the students to realize their answers were incorrect.
4	Video MAH0676 minutes 42-44	Some students solved the problems, and the teacher helped answer students' questions regarding the problems.

The results of identifying the learning video recordings of the last subject were not much different from those of the previous research subjects. Activities that occur in learning include guiding students, correcting student answers, responding to and explaining questions given by students, and helping students to develop their mathematical thinking processes.

Example 4

Based on the results of identifying important events in Table 8, the following is an example of a conversation between the teacher and students at the 28th minute in the video clip.

S1	:	*What about this part? (pointing at the equation 1: 30.000x+20.000y≤1.200)*
PTs 4	:	*This is the expense, which means it is related to price, isn't it? (while checking students' answers) well 30,000 and 20,000. What is cardboard A, for example?*
S1	:	*x*
PTs 4	:	*This means that the form of the equation is 30,000x plus... (students immediately continue with the teacher's statement)*
S1	:	*30,000x plus 20,000x, Eh 20,000y (students can immediately correct errors in the answers given)*
PTs 4	:	*What does the inequality symbol mean?*
S1	:	*Less than, isn't it?*
PTs 4	:	*Yes, that's correct*
S1	:	*These are just two equations. However, why are four equations asked for in the problem? (The students looked critical when reading the questions.) (teacher explaining) equations 3 and 4 are obtained from the need for cardboard boxes purchased to pack the product*
PTs 4	:	*The third equation is obtained from the number of boxes to pack item x, so x ≥ 0 is the equation for item y*
S1	:	*oh, okay (the student continues working on the questions after hearing the teacher's explanation)*

Based on the interaction between the teacher and students, it is evident that the students understood the given problem well. However, they struggled to determine the other two equations. The problem requires finding four equations, but the students could only find two. The teacher instructed the students to pay closer attention to the problem, commenting, "If someone buys or uses cardboard, then there is cardboard purchased, even if one cardboard is for packing goods, isn't it?" Therefore, the third and fourth equations are x≥0x≥0 and y≥0y≥0, where $x \geq 0$ and $y \geq 0$ represent cardboard boxes A and B, respectively. Four video clips were obtained based on the results of identifying PTs 4 teaching practice videos (see Table 9).

Table 9. Four video clips PTs 4 based on the phases of the thinking process and noticing indicators

Video Clips	Indicators of the mathematical thinking process	Indicators of *Noticing*	Noticing students' mathematical thinking processes	Level of Noticing Skills
1	Entry Phase	*Attending*	The teacher noticed that the students could determine two of the four inequalities instructed in the problem.	Evidence (1)
		Interpreting	The teacher interpreted the reason why students could not determine the other two inequalities: Students only wrote two inequalities based on the information in the problem, and they did not think that the minimum purchase amount of cardboard boxes A and B is zero ($x \geq 0$, $y \geq 0$).	Limited Evidence (1)
		Shaping	The teacher did not ask questions, directing students to find the other two inequalities; instead, the teacher only explained how to determine them.	Limited Evidence (1)

Video Clips	Indicators of the mathematical thinking process	Indicators of *Noticing*	Noticing students' mathematical thinking processes	Level of Noticing Skills
2	Entry Phase	*Attending*	The teacher attended that the students had difficulty understanding the information in the problem.	Evidence (1)
		Interpreting	The teacher interpreted that the students did not understand how to determine the x and y variables.	Limited Evidence (1)
		Shaping	The teacher did not ask questions that helped students understand the information in the problem; instead, the teacher tended to help them determine the x and y variables.	Limited Evidence (1)
3	Review Phase	*Attending*	The teacher attended that students made mistakes in formulating the inequality requested in the problem.	Evidence (1)
		Interpreting	The teacher interpreted that students made mistakes in determining the required inequation. In the inequation for cardboard A, students formed the inequation as 30x+20y = 1,200, with 20 being the number of bottles in cardboard B.	Robust Evidence (2)
		Shaping	The teacher tended to ask questions that led to suggestions for appropriate problem-solving strategies, such as, "The number is only 1,200, isn't it?" and the students responded, "Yes."	Limited Evidence (1)
4	Attack Phase	*Attending*	The teacher attended that the students had difficulty in determining the solution region of the graph they skectched.	Evidence (1)
		Interpreting	The teacher interpreted that the student made a mistake in determining the DHP because the line shading on the graph was too short. As a result, the solution region obtained was between the lines of inequalities 1 and 2. In contrast, inequalities 3 and 4 were not shaded properly.	Limited Evidence (1)
		Shaping	The teacher did not ask about the students' problem-solving methods but rather directed them to find that the graph they had sketched was incorrect.	Limited Evidence (1)

Based on Tables 3, 5, 7, and 9, it can be concluded that the noticing ability of PTs 3 is better than that of the other PTs. PTs 3 has more teaching experience and higher education than the other PTs. While PTs 1, PTs 2, PTs 3, and PTs 4 have good attending skills, they are weak in interpreting and shaping. The preservice teachers lack skills in interpreting students' thinking processes and inquiring about the strategies used by students. Therefore, efforts are needed to improve noticing skills through noticing-based training. This finding agrees with Johar, Ramli, Sasalia, & Walker (2023), noting that preservice teachers' noticing ability remained low in interpreting and responding. They recommend training focused on developing noticing skills and suggest universities develop a curriculum to enhance preservice teachers' noticing abilities.

Watching video clips positively impacts teachers. It helps teachers or preservice teachers to improve their ability to notice events in the classroom (van Es & Sherin, 2002). Video clips can be used as discussion material to identify the noticing abilities of preservice mathematics teachers. Watching learning videos allows preservice teachers to focus on observing various important aspects of learning (Sherin & Han, 2004). Teachers who join the video noticing club can develop their teaching potential by discussing video clips based on their teaching practices (Sherin, 2004). Therefore, video clips provide preservice teachers with the opportunity to observe events or interactions in the classroom that they may not be aware of during the implementation of the lesson.

Conclusion

This research produced sixteen noticing video clips that can be used as teaching material by universities or teacher training programs to develop the professionalism of teachers and preservice teachers in teaching mathematics. The video clips in this study include teacher activities such as proposing questions to students, responding to student questions, guiding students to find the correct solutions, and helping build students' thinking processes. The video clips were selected based on problems arising in the three main aspects of noticing: attending, interpreting, and shaping. However, the preservice teachers' noticing ability in the videos was lacking in the interpreting and shaping aspects. These video clips can serve as references to develop preservice mathematics teachers' ability to notice students' thinking processes. In the next publication, the authors of this manuscript will discuss the noticing skills of preservice teachers in video clips to notice their own videos.

This study only focuses on video of preservice teachers who taught linear programming and matrix in senior high schools. These are applied mathematics and advanced mathematics topics. However, students' errors in the video clips concern basic mathematics concepts. Therefore, the future researcher may investigate the teachers' noticing skills about students thinking of basic mathematics in elementary or junior high school.

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