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EDITED BY
Christian Kosel,
Technical University of Munich, Germany

REVIEWED BY
Sara Mahler,
University of Applied Sciences and Arts Northwestern Switzerland, Switzerland
Mandy Klatt,
Leipzig University, Germany
Kris-Stephen Besa,
University of Münster, Germany

*CORRESPONDENCE
Sylvia Gabel
✉ sylvia.gabel@uni-a.de

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Guiding pre-service teachers' visual attention through instructional settings: an eye-tracking study

Sylvia Gabel[1]*, Özün Keskin[1], Ingo Kollar[2], Doris Lewalter[3] and Andreas Gegenfurtner[1]

[1]Methods in Learning Research, Faculty of Philosophy and Social Sciences, University of Augsburg, Augsburg, Germany, [2]Faculty of Philosophy and Social Sciences, Department of Educational Psychology, University of Augsburg, Augsburg, Germany, [3]TUM School of Social Sciences and Technology, Technical University of Munich, Munich, Germany

In complex classroom situations, pre-service teachers often struggle to identify relevant information. Consequently, classroom videos are widely used to support pre-service teachers' professional vision. However, pre-service teachers need instructional guidance to attend to relevant information in classroom videos. Previous studies identified a specific task instruction and prompts as promising instructions to enhance pre-service teachers' professional vision. This mixed-methods eye-tracking study aimed to compare pre-service teachers' visual attention to information relevant for classroom management in one of three instructional conditions. Participants viewed two classroom videos and clicked a button whenever they identified situations relevant to classroom management in the videos. They got either (1) a specific task instruction before video viewing ($n = 45$), (2) attention-guiding prompts during video viewing ($n = 45$), or (3) a general task instruction ($n = 45$) before video viewing as a control group. We expected a specific task instruction and prompts to better guide participants' visual attention compared to a general task instruction before video viewing because both experimental conditions contained informational cues to focus on specific dimensions of classroom management. As both a specific task and prompts were assumed to activate cognitive schemata, resulting in knowledge-based processing of visual information, we expected the specific task instruction to have a similar attention-guiding effect as prompts during video viewing. Measurements were conducted on an outcome level (mouse clicks) and on a process level (eye tracking). Findings confirmed our hypotheses on an outcome level and in part on a process level regarding participants' gaze relational index. Nevertheless, in a disruptive classroom situation, participants of the prompting condition showed better attentional performance than participants of the other conditions regarding a higher number of fixation and a shorter time to first fixation on disruptive students. Further qualitative analyses revealed that, when observing classroom videos without instructional guidance, pre-service teachers were less likely to identify disruptive situations in the video and more likely to attend to other situations of classroom management concerning the teachers' action. We discuss advantages of both attention-guiding instructions for pre-service teacher education in terms of the economy of implementation and the salience of situations.

KEYWORDS

professional vision, instructional settings, eye tracking, mixed methods, preservice teacher education, prompting, specific task instruction

1. Introduction

For the past few years, educational research increased attention on teachers' professional vision (Goodwin, 1994; Seidel and Stürmer, 2014; van Es and Sherin, 2021; König et al., 2022). Based on a definition of Seidel and Stürmer (2014), teachers notice relevant information in the classroom and reason its consequences on further actions. An important context is classroom management: effective classroom management requires professional vision to establish and maintain a beneficial learning atmosphere (Gold et al., 2017). For instance, noticing disruptive student behavior at an early stage is an important aspect of successful classroom management (Grub et al., 2020; Gold et al., 2021).

However, professional vision differs systematically between pre-and in-service teachers (Gegenfurtner et al., 2011; Wyss et al., 2021). For pre-service teachers, it is challenging to make quick decisions about what information to pay attention to and what to ignore during lessons as well as how to make sense of students' behavior, positioning, and participation (Santagata et al., 2021). As a result, we speak about visual expertise when experienced teachers are able to notice situations quickly and interpret them based on solid knowledge in order to consider their options for further action. In a following section, the characteristics of visual expertise qualities will be addressed in more detail. Consequently, it is necessary to establish learning environments for pre-service teachers to develop visual expertise. Here, video formats turn out to be effective tools (Gaudin and Chaliès, 2015). They are widely used in teacher trainings (Kersting, 2008; Zottmann et al., 2012), as they represent simultaneity and multidimensionality of the classroom (van Es and Sherin, 2002; Sherin and van Es, 2005).

However, video analysis requires high mental effort for pre-service teachers to identify relevant situations (Blomberg et al., 2013; Mayer and Fiorella, 2014; Martin et al., 2022). For this reason, it is important to provide instructional support that guides their visual attention during video viewing (Star and Strickland, 2008; Seidel et al., 2013; Gaudin and Chaliès, 2015). Two promising opportunities for instructional support are specific tasks that are provided before video viewing and attention-guiding prompts that are provided during video viewing (Demetriadis et al., 2008; Walker, 2008; Grub et al., 2022a,b; Gabel and Gegenfurtner, 2023; Martin et al., 2023). In this study, we investigated the attention-guiding effect of these instructions. To measure attentional processes, we used eye-tracking technology as an established method to analyze participants' eye movements (Wolff et al., 2016; McIntyre et al., 2017; Seidel et al., 2021; Stahnke and Blömeke, 2021; Keskin et al., in press).

2. Theory

2.1. The salience of classroom management situations

An important context where teachers require professional vision is classroom management. To provide an effective learning atmosphere, they need to monitor and coordinate all events occurring in the classroom (Kounin, 1970; Evertson and Weinstein, 2006; Bear, 2015). However, it is often difficult for pre-service teachers to distinguish relevant from irrelevant situations, as various events occur at the same time and require increased attention (van Es and Sherin, 2002; Sherin and van Es, 2005; Blomberg et al., 2013). In addition, pre-service teachers also seem to struggle noticing all critical events of all students in the classroom which leads them to reduce their attention to fewer students (Kosel et al., 2021). For this reason, the salience of the situations plays a crucial role in professional vision. Salient situations have a higher visibility. Large movements such as a student getting up from his seat, for example, can be a salient event in the classroom, whereas a student playing with his pencil might be less salient. These situations are frequently regarded as relevant since they catch more attention. However, salient situations are not always relevant situations. The question which classroom management situations are more or less salient to pre-service teachers remains open and will be investigated in this study. To guide pre-service teachers' attention toward situations that are important – but not always salient – instructional support is needed. For this reason, the first aim of this study is to compare what kind of instructional support is needed to guide their attention toward important classroom management situations. In addition, we aim to examine which classroom management situations pre-service teachers consider as more and less salient. Identifying which relevant situations they perceive as less salient, let us conclude which situations they are more likely to need instructional support for.

2.2. The cognitive theory of visual expertise

As pre-service teachers have little practical experience and little professional knowledge, their professional vision differs from experienced in-service teachers. This is why we talk about visual expertise in this section. To understand which processes pre-service teachers need to acquire, we take a closer look at the cognitive theory of visual expertise (Gegenfurtner et al., 2023). The theory shows the characteristics of experienced teachers' professional vision and is based on three assumptions: (1) Experts can process a large amount of information in their long-term working memory due to their extended capacity. (2) Second, due to their previously stored knowledge, they also process information in a knowledge-driven manner. (3) Finally, through reflective visual practices, experts actively shape visual information in their environment and develop extended cognitive schemata. Based on these three presumptions, there are cognitive processes that determine visual expertise: firstly, experts process visual information foveally (information are visually focused) and parafoveally (information from the visual field's periphery) in their visual register, highlighting a holistic perception of visual information. After selecting important and ignoring irrelevant visual information, these are aggregated in image chunks. Those image chunks are further enriched with previously stored declarative knowledge in long-term working memory, developing an integrated mental model of the perceived visual information. By interacting with the environment, expert teachers enrich this model with further visual information. Finally, experts use metacognitive strategies and knowledge in order to regulate and monitor the visual processes.

In contrast, pre-service teachers typically do not have these cognitive processes fully developed yet: they mainly process information foveally – that is, they only process information they visually focused on (Gegenfurtner et al., 2023). What happens around

their visual focus is often not perceived. Furthermore, they tend to struggle with structuring and integrating their knowledge – which is usually also restricted – to their visual information (Wolff et al., 2021). Visual expertise of teachers is an important ingredient of teacher professional vision. Like in other professions, such as medicine, sports, or transportation domains, also teachers can develop their expertise in processing domain-specific visual stimuli, which, then, gives rise to their very highly developed professional vision in classrooms. To make professional vision and its differences between pre-and in-service teachers measurable, eye-tracking technology has become an important methodological approach (Holmqvist et al., 2011).

2.3. Eye tracking as methodological approach to investigate professional vision

So-called areas of interests (AOIs) are characterized to analyze eye movements of a certain area. Various eye-tracking parameters can be conducted to measure gaze movements regarding these AOIs: (a) number of fixations and visits, (b) fixation durations, (c) time to first fixation and (d) the gaze relational index, which we will go into more detail now.

2.3.1. Fixation counts and visits

According to Holmqvist et al. (2011), fixations are time intervals where gaze activity has very little to no movement. Fixation visits demonstrate how frequently all fixations occur in a defined area of interest (Keskin et al., in press). While watching classroom videos, previous studies frequently compared professional vision of pre-and in-service teachers (Keskin et al., in press). In-service teachers fixate relevant situation more often than pre-service teachers (Wyss et al., 2021). According to the information-reduction hypothesis (Haider and Frensch, 1996), increasing experience might help to better distinguish task-relevant from task-irrelevant information (for a meta-analysis, see Gegenfurtner et al., 2011).

2.3.2. Fixation duration

This parameter defines how long a fixation continues (Holmqvist et al., 2011). Findings show that in-service teachers generally have a shorter fixation duration than pre-service teachers (Gegenfurtner et al., 2011). This confirms the assumption of a top-down perception of in-service teachers, since they observe teaching events through shorter fixations and thereby search for critical events in a more knowledge-driven manner (Wolff et al., 2021; Gegenfurtner et al., 2023). This contrasts the rather longer fixation durations of pre-service teachers, which seems to be caused by a stimulus-based bottom-up perception (Hershler and Hochstein, 2009; Gegenfurtner et al., 2023). These findings indicate a more holistic monitoring behavior of in-service teachers.

2.3.3. Time to first fixation

In addition, teachers should be able to recognize critical events as soon as possible to intervene quickly (Gold et al., 2021). Here, the time to first fixation can be a suitable parameter to measure this aspect of visual expertise. Grub et al. (2022b) examined whether expertise is associated with faster time to first fixation for critical events. However, no difference between in-and pre-service teachers has been found on this parameter so far (Grub et al., 2022b).

2.3.4. Gaze relational index

Finally, the gaze relational index (GRI) – the ratio of mean fixation duration and mean fixation number – is a novel metric to get insights into the depth of visual processing (Gegenfurtner et al., 2020). This parameter assumes that in-service teachers tend to have more and shorter fixations because they perceive visual stimuli selectively and in knowledge-driven manner (Gruber et al., 2010; Sheridan and Reingold, 2017). For this reason, a lower GRI indicates a more knowledge-driven, top-down perception (Gegenfurtner et al., 2020).

This methodological approach reveals different gaze parameters of pre-and in-service teachers. It is evident that visual expertise is characterized by shorter but more frequent fixations and revisits, which is an indication of improved monitoring behavior. In order to guide pre-service teachers' professional vision to relevant information in a video, knowledge-based processing is necessary (Sherin and van Es, 2009; Grub et al., 2022a; Gegenfurtner et al., 2023). However, since they have not automated a knowledge-based processing yet, instructional support is necessary to direct their attention. Pre-service teacher training should focus on the integration of knowledge into their professional vision, as knowledge helps to select relevant visual information and to ignore irrelevant visual information (Blomberg et al., 2013; Grub et al., 2022a). To support pre-service teachers developing this expertise, they need to shift their visual perception from a stimulus-driven process to a knowledge-driven process. To guide this knowledge-driven process, instructional settings can be provided.

2.4. Instructional settings to develop visual expertise

Instructional settings help learners structure their observations and integrate knowledge (Kali et al., 2003; Linn et al., 2003). By providing support, learners actively process information and focus on specific aspects in video viewing (Santagata and Angelici, 2010; Santagata and Guarino, 2011; Chernikova et al., 2023). However, instructional support can be provided at different times – prior or during video viewing. Therefore, the question arises when to guide pre-service teachers' professional vision?

For instance, general and specific tasks are instructional settings provided at the beginning of a task. In contrast to general task settings, specific task settings provide more detailed information about what should be focused on during task processing, for example to focus on smoothness and momentum in the teaching process. Through this type of instruction, specific knowledge schemata can be activated at the beginning of a task (Grub et al., 2022a). Two studies of Grub et al. (2022a,b) investigated the difference between a specific task instruction and a general task instruction to enhance professional vision in the context of classroom management. Professional vision was measured by the total number of correctly detected classroom events and their velocity of the recognition. Based on the assumption that specific task instructions can activate cognitive schemata, they expected the participants to show a faster and more accurate visual perception in the specific task setting (Grub et al., 2022a). As the cognitive theory of visual expertise outlines, a profound knowledge base directs visual perception in a top-down process (Gegenfurtner et al., 2023). In both studies, all participants ($n = 86$ in the first study; $n = 71$ in the second study) saw six video sequences and received a

general task instruction for the first three video sequences, and a specific task instruction for the last three video sequences. In the specific task, the participants were asked to stop the video when they identified teaching disruptions, whereas the general task only asked them to stop the video when they identify something relevant. For both studies, no significant effect between these two minimal interventions could be found enhancing professional vision. However, the second study included eye-tracking data, which showed an attention-leading effect of the specific task instruction. When provided specific task instruction, the participants showed a more global monitoring behavior – indicated by more and shorter fixations – as well as a more focused visual perception – indicated by a higher number of fixations and a higher visit count on relevant events. Furthermore, the gaze relational index was lower with a specific task instruction than with a general task instruction indicating a scanning gaze behavior with many quick fixations. Thus, their gaze behavior – following to a specific task instruction – showed characteristics of visual expertise.

Another study examined whether a brief pre-training before video analysis can activate knowledge (Martin et al., 2023). In a single-session format, one experimental condition ($n = 29$) received a text activating subject-specific knowledge and another experimental condition ($n = 29$) received a text activating pedagogical-psychological knowledge, while the control condition ($n = 27$) received a text with general information about classroom video analysis. In the subsequent video analysis, students from the experimental conditions showed better performance regarding in professional vision than students from the control condition. Professional vision was measured by the amount and quality of references to pedagogical concepts in their video analysis. This indicates a beneficial effect of knowledge activation by providing specific content-related information before video analysis (Martin et al., 2023).

Since some prior studies imply that instructional settings at the beginning of a task may have an attention-guiding effect on visual perception, another instructional method is to provide instruction during task processing. This kind of instruction is often realized with prompting. This is an already established and tested strategy to enhance learning in various learning environments (Demetriadis et al., 2008; Walker, 2008; Kramarski and Friedman, 2014). Learners may know how to perform certain skills declaratively, but they do not apply them spontaneously in specific situations. Here, prompts serve as instructional cues that support learners to perform these skills (Berthold et al., 2007; Bannert, 2009; Bannert et al., 2015). Thus, they "do not teach new information, but rather support learners in the execution of their self-regulation knowledge and skills" (Müller and Seufert, 2018; p. 3). Regarding professional vision, cognitive prompts might help focus attention on relevant aspects during classroom video viewing (Roth McDuffie et al., 2014).

As noted in the study of Grub et al. (2022b), a specific task prior to video viewing is attention-guiding. Taking this further, it is interesting to investigate how specific task instructions perform in comparison to scaffolds that are not presented before the task, but during it. In a previous study, we compared the effect of specific task instruction and prompts on pre-service teachers noticing (Gabel and Gegenfurtner, 2023). Similarly to Grub et al. (2022a,b), participants were tasked to click a button when they identified relevant situations. They received information to focus on three specific aspects of classroom management that were either shown as a specific task before video viewing ($n = 42$) or as prompts during video viewing ($n = 43$). The findings indicated that both instructions had a similar attention-guiding effect on teacher noticing (Gabel and Gegenfurtner, 2023).

These findings provided interesting insights; however, no detailed differences can be explained. For this reason, this study examined how the types of instructions differ not only on an outcome level, but also on a process level. To measure noticing on an outcome level, we determined the events participants noticed as being relevant to classroom management. To measure noticing on a process level, eye-tracking technology can enrich this research approach. If it is true that specific task instructions have a similar effect on noticing as prompts on an outcome level, then we can assume both instructions having a similar attention-guiding effect on a process level.

3. The present study

The present study had three aims and focused on pre-service teachers' professional vision in the context of classroom management. One aim was to replicate and extend previous findings:

> RQ1: Do a specific task instruction and prompts have a similar attention-guiding effect on pre-service teachers' noticing on an outcome level – both compared to a control condition with a general task instruction?

If it is true that schema activation through prompts and specific task instructions can direct visual attention to information relevant for classroom management, then we would expect pre-service teachers to identify a similar number of relevant situations in the prompting and specific task instruction conditions (Hypothesis 1a) and a higher number in both these schema-activating conditions compared to the general task instruction condition (Hypothesis 1b).

For the second research question, we wanted to investigate the effects not only on an outcome level, but also on a process level.

> RQ2: Do specific task instructions and prompts have a similar attention-guiding effect on pre-service teachers' noticing on a process level – both compared to a control condition with a general task instruction?

Collecting data through eye-tracking technology can afford a deepened understanding of the attention-guiding mechanisms of different task instructions on a process level. Therefore, we chose two different classroom management situations and tested a set of hypotheses. In the first situation, we were interested in the gaze behavior for a critical situation where several students are disrupting the teaching process. As classroom management benefits from a quick and frequent fixation on these students, we set the areas of interest to the disruptive students and selected the eye movement parameters *time to first fixation* and *number of fixations*. If it is true that schema activation through prompts and specific task instructions can direct visual attention to information relevant for classroom management, then we would expect pre-service teachers of the prompting and specific task instruction conditions to have a similar number of fixations (Hypothesis 2a) and a similar time to first fixation (Hypothesis 2b). Compared to the general task instruction condition,

we would expect both experimental conditions to have a higher number of fixations (Hypothesis 2c) and a faster time to first fixation (Hypothesis 2d).

In the second situation, we were interested in the gaze behavior during a peer learning phase where the teacher is monitoring the students' learning. Here, successful classroom management benefits from a global monitoring over the situation, which is why we set the AOIs for students, teacher, and material and chose the eye movement parameters *number and duration of fixations* and the *gaze relational index*. If it is true that schema activation through prompts and specific task instructions can direct visual attention to information relevant for classroom management, then we would expect pre-service teachers in the prompting and specific task instruction conditions to have a similar number of fixations (Hypothesis 2e), similar fixation durations (Hypothesis 2f), a similar gaze relational index (Hypothesis 2g). Compared to the general task instruction condition, we expect both experimental conditions to have a higher number of fixations (Hypothesis 2h), lower fixation durations (Hypothesis 2i), and a lower gaze relational index (Hypothesis 2j).

For the third research question of this study, Grub et al. (2022b) encouraged further studies to examine the salience of perceived situations. In the context of classroom management, we do not know yet which situations pre-service teachers are more likely to focus on. Thus, we aim to explore this qualitatively:

> RQ3: Which classroom management situations do pre-service teachers notice more likely?

Here, we aimed to identify initial trends by qualitatively examining interview data and classifying them inductively and deductively with the hope of achieving a better understanding which classroom management scenarios are more and less salient for pre-service teachers.

4. Methods

4.1. Participants

We conducted this study with a sample of $n = 135$ pre-service teachers (108 women, 27 men; $M_{age} = 20.8$ years, $SD_{age} = 2.6$) enrolled in a national teacher education program of a large German university. A majority of the pre-service teachers were in their first semester (65.7%; $M_{Semester} = 2.1$; $SD = 1.7$). Most of the participants (66.4%) had held five or less lessons as a teacher during school internships. All students participated voluntarily and were recruited in seminars or via courses to receive course credit for participation. Data collection was guaranteed to be anonymous.

4.2. Study design

This investigation followed an experimental mixed-method design. The participants were randomly assigned to one of three conditions. Experimental condition 1 provided prompts during video viewing ($n = 45$), experimental condition 2 provided specific task instruction before video viewing ($n = 45$), and condition 3 served as a control condition, providing general task instruction before video viewing ($n = 45$). We collected mouse clicks, eye-tracking parameters, questionnaire data, and interview data.

4.3. Instruments

4.3.1. Task instructions

The task for the prompting condition was: "Please click if you identify positive elements of classroom management and those that need improvements in this video." The participants saw this general instruction prior to the video and received three prompts during the video that specified important dimensions of classroom management: "Pay attention to the smoothness and momentum" (Prompt 1), "Pay attention to the handling with disruptive behavior" (Prompt 2), and "Pay attention to the omnipresence of the teacher" (Prompt 3). We decided to show event-based prompts to prime the participants' attention prior to a specific situation in the video. Each prompt lasted for 15 s and disappeared before the situation in the video occurred.

The instruction for the specific task condition was: "Please click if you identify positive elements of classroom management and those that need improvements in this video. Pay attention to the smoothness and momentum, to the handling with disruptive behavior and to the omnipresence of the teacher." The participants had 45 s to read the task instruction.

The instruction for the control condition was: "Please click if you identify positive elements of classroom management and those that need improvements in this video" without any specifications about the dimensions of classroom management. Participants had 45 s to read the task instruction.

4.3.1.1. Videos

We chose two videos from different subjects in order to minimize a subject-specific effects on pre-service teachers' professional vision. The first video was a staged video (from the video portal Toolbox Lehrerbildung) showing a mathematics lesson in 10th grade (04:30 min). The second video (from the video portal LeHet) was an authentic video showing a German as a second language lesson in 7th/8th grade (04:48 min). Both videos were comparable in length.

4.3.1.2. Questionnaire

As a control variable, we used the pedagogical-psychological knowledge test (König and Blömeke, 2010) which contains five dimensions of teaching quality (management with heterogeneity, structuring, classroom management, motivation, performance assessment) with a total of 10 closed and 8 open items.

During video viewing, we used a 7-point Likert item of Paas (1992) to measure the participants' mental effort. After each video, they rated their mental effort: "For noticing classroom management relevant situations in the video I afforded…" with the scale from "very, very low mental effort" to "very, very high mental effort."

After video viewing, the participants rated the task workload and task complexity (Kyndt et al., 2011) of their video viewing. Both scales were translated into German. There were 9 items for task workload on a 7-point Likert scale (e.g., "I found it a difficult task," $\alpha = 0.86$). Task complexity was divided into two dimensions à 2 items on a 5-point Likert scale: familiarity with the type of task (e.g., "I've undertaken

similar tasks in the past. I was familiar with the design of the task," $\alpha = 0.89$) and availability and access to information (e.g., "I had too little information, information resources and aids at my disposal while completing this task," $\alpha = 0.73$).

4.4. Procedure

In the first part of the study – one week before participants joined the laboratory part – they answered the pedagogical-psychological knowledge test (PUW) by König and Blömeke (2010). In the second part of the study, the participants' gaze was recorded by a monitor-based Tobii Pro Eye-Tracker Nano with 60 Hz sampling rate (screen resolution: 1920 × 1,080). After ensuring that the participants were seated comfortably with a distance of about 60 cm to the monitor, the recording started with a 9-point calibration. Participants watched both videos consecutively. Before watching the first video, we provided a short definition about classroom management (Classroom management encompasses all actions a teacher takes to create and maintain an effective teaching-learning environment, Wolff et al., 2021) and information about the class in the first video for all participants. Then, the participants were given the task instruction depending on their condition. To be held comparable, we kept the different instructions similar in their wording and in their length of time. Only the timing of the presentation differed between the experimental conditions: while participants in the specific task instruction condition and in the general task instruction received instruction before video viewing – the participants of the prompting condition received instruction during video viewing. We tasked them in all conditions to press a mouse button each time participants would notice an important situation to mark time stamps as an indicator to their noticing. This method has already been proven effective in prior investigations (van den Bogert et al., 2014; Stahnke and Blömeke, 2021; Grub et al., 2022a,b). For the second video, we repeated the procedure by providing information about the video and showed the same instructions as before. After each video, participants were asked about their mental effort (Paas, 1992).

Right after video viewing, we conducted retrospective interviews. The verbal data was recorded. We replayed the videos and stopped every time the participant had marked them with a time stamp. The question for the interview in every situation was: "Why did you consider this situation as relevant for classroom management?." We asked no additional questions nor added information. As a last part of the study, participants received the questionnaire asking for task complexity and task workload (Kyndt et al., 2011) and further demographic information. For each participant, the study protocol took around 35–45 min to complete.

4.5. Analyses

For the data on the outcome level, we counted the number of mouse clicks for each participant and triangulated them with interview data. This methodological approach was also used in prior investigations (Muhonen et al., 2021, 2023; Grub et al., 2022a,b). Two research assistants transcribed the recordings and coded how many clicks were related to classroom management. Other clicks were coded as irrelevant separately and did not negatively affect the total number of relevant clicks. Each statement was considered as a coding unit. In some cases, participants mentioned two or more aspects in one statement. Each aspect was coded separately. They double coded a random subset of 10% of the transcribed data. An intraclass correlation coefficient (ICC) was calculated for the number of relevant clicks [ICC = 0.844, 95% CI 0.710, to 0.919, ($p = < 0.001$)]. Due to this high level of agreement (Greguras and Robie, 1998), the remaining material was evenly split and individually coded by both coders.

Shapiro–Wilk tests indicated that some measures were non-normally distributed. To account for the non-normal distribution, we performed Kruskal-Wallis tests. We used IBM SPSS 28 as a statistical software to analyze the data quantitatively.

4.5.1. Research question 1

For hypotheses 1a and 1b, we chose six specific situations in our analysis: these were the situations that were highlighted by the specific task instruction before video viewing and by the prompts right during video viewing. For this reason, we considered two situations about smoothness and momentum, two situations about the teachers' management with disruptions, and two situations about the teachers' omnipresence. Participants received one point for each time they clicked on these situations or mentioned them in the interview. Overall, participant scores could range from 0 to 6.

4.5.2. Research question 2

With the analysis of eye-tracking data, we wanted to gain further insights to the participants' visual focus of attention on a process level. Therefore, we used the gaze recordings during the video viewing and analyzed them with Tobii Pro Lab software (v. 1.123). Due to stationary eye tracking, we set the velocity threshold filter (IVT) to 30°/s. We excluded $n = 2$ participants from the analysis due to their angular deviation being higher than 1° in terms of data quality. As suggested by Pappa et al. (2019), we hand-coded all areas of interest (AOIs) as contouring areas. In contrast to rectangular AOIS, contouring AOIs are more reliable and less prone to incorrect fixations (Pappa et al., 2019).

For reasons of work economy, we chose two situations of the video material to analyze the participants' gaze. The first situation showed disruptive student behavior. We analyzed a video sequence (20.58 s) of the first video where the class can be seen from the front view. In this moment, the teacher is explaining the next task but many of the students do not listen to him. The teacher is trying to intervene by changing his position toward two talking students in the first row and by raising his voice. For hypotheses 2a–d, we set the AOIs for the students showing disruptive behavior. We analyzed the *number of fixations* as well as the *time to first fixation* (in milliseconds) for these AOIs.

The second situation (14.75 s) occurred in the second video and showed the teachers' omnipresence in the classroom. In a peer learning phase, the teacher is walking through the classroom and stops by every partner group to make sure that the students have understood the task and that they are working on the task. For hypotheses 2e–j, the AOIs are set for the students, the teacher, and the material in the classroom. We analyzed the *number of fixations* and the *fixation duration* (in milliseconds) for each AOI group (students, teacher, material) as well as the *GRI*.

4.5.3. Research question 3

Going further, we analyzed the interview data qualitatively in terms of the question: which strategies of classroom management do participants notice? With this analysis, we want to determine which

aspects the participants perceived as relevant as a first exploratory approach to investigate the salience of classroom management situations. For this analysis, we selected $n = 45$ participants from the control condition (general task) because their instructional format did not influence them about any specific classroom management strategies. For the situations participants identified as relevant for classroom management, we elaborated seven thematical categories and developed a coding scheme both inductively (Kounin, 2006; Ophardt and Thiel, 2017) and deductively (Kuckartz, 2012). The categories are: (A) management with disruptive behavior, (B) smoothness and momentum, (C) omnipresence and overlap, (D) group mobilization, (E) variety and challenge, (F) rules and routines, and (G) other classroom management aspects (see Figure 1).

5. Results

5.1. Control variables

To avoid external group influences on the dependent variables, we asked for mental effort after each video, task complexity, task workload, and prior pedagogical-psychological knowledge. We had to remove one participant from data analysis due to technical problems in the data transmission of the questionnaire. Regarding mental effort, the participants stated to invest rather high mental effort in the video viewing ($M = 5.21$; $SD = 1.08$). The task workload was moderate for all participants ($M = 3.02$; $SD = 0.88$). Regarding task complexity, participants stated to be familiar with the task of video viewing ($M = 2.72$; $SD = 1.59$). In addition, they also stated to have moderate access to information ($M = 2.61$; $SD = 1.36$). Regarding prior pedagogical-psychological knowledge, the participants could reach a value between 0 and 1 and had a mean value of $M = 0.49$ ($SD = 0.12$). Groups did not differ significantly on these control measures (see Table 1).

5.2. Effects of different task instructions on noticing outcomes

The first aim of the study was to investigate whether different instructional settings have an influence on noticing classroom management situations on an outcome level. For this, we took the number of identified situations into account by counting and triangulating the mouse clicks with verbal reports. Across both videos, participants made on average $M_{rel} = 7.30$ ($SD = 4.61$) relevant clicks and $M_{irrel} = 8.97$ ($SD = 4.84$) irrelevant clicks. The ratio between relevant and irrelevant clicks was rather small in the general task condition (0.69) in contrast to the specific task condition (0.83) and the prompting condition (0.94).

To test our hypotheses, we concentrated on six relevant situations. Table 2 presents the mean number and standard deviation estimates of relevant clicks for each instructional condition. We expected no differences between the prompting and specific task condition (H1a), but a higher number of relevant clicks for each experimental condition in contrast to the control condition (H1b). Findings from a Kruskal-Wallis-test showed that the three conditions differed significantly from each other [χ^2 (2) = 19.771, $p < 0.001$]. As expected in hypothesis 1a, the prompting condition did not differ significantly from the condition with a specific task $U = 845.00$, $Z = -1.393$, $p = -0.166$. However, as expected in hypothesis 1b, both experimental conditions – the prompting condition ($U = 516.00$, $Z = -4.110$, $p < 0.001$; $r = 0.43$) and the specific task condition ($U = 617.50$, $Z = -3.305$, $p < 0.001$; $r = 0.35$) – differed significantly from the control condition.

5.3. Effects of different task instructions on visual attention

The second aim of the study was to investigate whether different instructional settings had an influence on noticing on a process level.

	Category	Definition	Example
A	Management with disruptive behavior	This includes all actions of the teacher – whether successful or not – that deal with disturbances, conflicts, behavior modification, or discipline in order to return or maintain teaching and learning activities. (Ophardt & Thiel, 2017)	"I think he didn't pay attention to whether the others were quiet or not, he just kept talking and maybe many people just don't understand him anymore. He had to pay a little more attention to that" (Participant anonymized, retrospective Interview, 12th Dec 22).
B	Smoothness and Momentum	All actions of the teacher – whether successful or not – to ensure a smooth lesson flow and continued engagement with the learning activities, especially in transitional phases. (Kounin, 2006)	"Now he doesn't perceive something like that [disruptive behavior] ... It's just not a smooth process if he has to write that down first when he could have done that before... That's why he doesn't perceive something like that, he has to write first and loses focus, and so the students lose focus." (Participant anonymized, retrospective Interview, 14th Dec 22).
C	Omnipresence and Overlap	All actions– whether successful or not – teachers make clear to the students that they are always aware of the situation in the classroom and will intervene if necessary as well as the teachers' focused attention on several events at the same time. (Kounin, 2006)	"So, the students feel like they're being watched, but not in a negative sense… the teacher sees what they're working on, and she's just trying to give hints and make sure it's understood. It doesn't come across as checking, it just comes across as giving advice." (Participant anonymized, retrospective Interview, 14th Dec 22).
D	Group Mobilization	All actions of the teacher – whether successful or not – to focus on the group as a whole and at the same time, to support students individually. (Kounin, 2006)	"She calls everyone up, includes everyone and thus she gets less disturbing behavior, because everyone could be called up, everyone could be taken up and everyone really participates. It's not: One student tells the story and the rest have to listen." (Participant anonymized, retrospective Interview, 21st Dec 22).
E	Variety and Challenge	All actions of the teacher – whether successful or not – to design learning activities that are experienced as varied and challenging in order to focus the students' attention. (Kounin, 2006)	"I found the idea really good that she took the students away from their normal place and created a bit of a new situation, with the semicircle to introduce a new topic. I actually found that good and also that she let the students organize themselves, so that they called each other and actually took himself really back and listened or just nodded when it was right." (Participant anonymized, retrospective Interview, 12th Dec 22).
F	Rules and Routines	All actions of the teacher – whether successful or not – to set up and maintain rules, procedures, and routines in order to establish social order in the classroom. (Ophardt & Thiel, 2017)	"I thought it was good that the teacher asked the students to stand up to greet each other, so that the students know that class is about to begin. I think that standing up is a better signal than remaining seated." (Participant anonymized, retrospective Interview, 11th Jan 23).
G	Other aspects of classroom management	All other actions of the teachers – whether successful or not –that help create a positive learning atmosphere and provide maximum learning time.	"She has communicated nonverbally and has only shown that they should please call themselves." (Participant anonymized, retrospective Interview, 8th Dec 22).

FIGURE 1
Category system for relevant classroom management situations with definitions and examples.

TABLE 1 ANOVA findings for control variables.

	N	*df*	*F*	*p*
Mental effort	134	2	0.07	0.93
Task workload	134	2	0.12	0.89
Task complexity Familarity with the task Access to information	134 134	2 2	0.03 0.07	0.97 0.94
Pedagogical-psychological knowledge	133	2	0.45	0.64

TABLE 2 Mean number of relevant clicks.

	N	*M*	*SD*
Prompting condition	45	2.31	1.28
Specific task condition	45	1.96	1.11
General task condition	45	1.18	1.13

TABLE 3 Number of fixations and time to first fixation for situation 1.

	Number of fixations			Time to first fixation	
	N	*M*	*SD*	*M*	*SD*
Prompting condition	44	2.31	1.28	324.43	58.45
Specific task condition	45	1.96	1.11	340.05	34.67
General task condition	44	1.18	1.13	338.65	35.00

Time to first fixation in milliseconds.

TABLE 4 Number of fixations, fixation duration and GRI for situation 2.

		Number of fixations		Fixation duration		GRI	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*
Prompting condition	44	3.65	1.11	115.83	30.08	33.82	12.08
Specific task condition	45	3.57	1.04	121.60	36.21	35.60	11.46
General task condition	44	3.39	1.13	129.83	38.45	41.08	14.54

Fixation duration in milliseconds.

For the first situation, we expected no differences between the prompting and the specific task instruction (H2a), but higher fixation counts of each experimental condition in contrast to the control condition (H2c). The participants of the prompting condition had on average higher fixation counts on students showing disruptive behavior than participants of the other conditions (see Table 3). The findings indicated a significant difference between these three groups (χ^2 (2) = 9.273, p = 0.010). Further tests showed a significant difference between the prompting condition and the control condition (U = 619.00, Z = −2.911, p = 0.004; r = 0.31). Therefore, hypothesis 2a could fully and hypothesis 2c partially be supported.

Moreover, we tested whether there was a difference between the mean values of the conditions regarding the time to first fixation of disruptive student behavior (see Table 3). Here, we neither expected a difference between the prompting and the specific task instruction (H2b), but a faster time to first fixation of participants of each experimental conditions in contrast to the control condition (H2d). Further non-parametric tests showed that there was – contrary to our hypothesis 2b – a significant difference between the prompting condition and the condition with specific task instruction U = 677.00, Z = −2.569, p = 0.010; r = 0.27. Yet, the specific task instruction condition did not differ significantly from the control condition (U = 823.00, Z = −1.366, p = 0.172), nor did the prompting condition differ significantly from the control condition (U = 870.00, Z = −0.818, p = 0.413). Therefore, hypothesis 2d was rejected.

In the second situation, we analyzed the parameters: fixation durations, fixation counts, and the gaze relational index (see Table 4). Here, we expected no differences between the prompting and the specific task instruction (H2e, H2f, H2g), but shorter fixation durations (H2h), higher fixation counts (H2i), and a lower gaze relational index (H2j) in both experimental conditions in contrast to the control condition. Regarding average fixation duration, there was no significant difference between conditions [F (2,132) = 2.176; p = 0.175]. There neither was a significant difference between the conditions regarding average fixation counts [F (2,132) = 0.624; p = 0.538]. While hypotheses 2e and 2f could be supported, hypotheses 2 h and 2i needed to be rejected. Putting these two parameters in relation, the gaze relational index differed significantly between conditions [F (2, 132) = 3.879; p = 0.023]. Here, the participants of the prompting condition showed a similar gaze index as the participants of the specific task condition and did not differ significantly [t (2,87) = 0.232, p = 0.476]. Moreover, the prompting condition differed significantly from the control condition [t (2,86) = 2.549, p = 0.013; r = 0.27]; the condition with specific tasks also differed significantly from the control condition [t (2,87) = 1.976, p = 0.048; r = 0.21]. Consequently, hypotheses 2 g and 2j were supported.

5.4. The salience of classroom management situations

To address the question about the salience of classroom management situations, we examined participants' verbal data more closely in terms of classroom management strategies (RQ3). This exploratory approach can provide first insights into the question which classroom management situations are more or less salient to pre-service teachers and in which situations pre-service teachers should be instructionally supported to enhance their professional vision. We examined seven classroom management categories (see Figure 1). Table 5 shows that participants most frequently identified situations of the teachers' omnipresence (Category C), followed closely by the situations of group mobilization (Category D). In contrast, situations involving disruptive behavior (Category A) and about variety and challenge (Category E) were identified less frequently.

6. Discussion

In this study, we tested three instructional formats: a specific task before video viewing and prompts during video viewing – compared to a general task instruction. We expected a specific task instruction

TABLE 5 Number of identified of classroom management situations.

Categorization of classroom management situations	Number of situations identified
Management with disruptive behavior	24
Smoothness and momentum	48
Omnipresence and overlap	64
Group mobilization	61
Variety and challenge	24
Rules and routines	53
Other aspects of classroom management	27

to have a similar attention directing effect as prompts during video viewing. To investigate the instructional effects on professional vision, we analyzed data on an outcome and a process level.

6.1. Overview of findings

On the outcome level, both experimental conditions differed significantly from the general task instruction (H1b). Strengthening previous investigations (Gabel and Gegenfurtner, 2023), the specific task condition and the prompting condition showed a similar number of identified events and did not differ significantly (H1a). These findings support the assumption that both instructional settings support schema activation and support professional vision – regardless of the time they are provided (Grub et al., 2022a,b; Martin et al., 2023).

On a process level, both experimental conditions foster visual monitoring in the second situation (H2g), where the teacher is walking around the classroom and making sure that the students work on their tasks. Here, the pre-service teachers of the experimental conditions showed a lower GRI than pre-service teachers of the control condition (H2j). Previous investigations found similar findings for the group with specific task instruction (Grub et al., 2022b). This implies a more global monitoring behavior and is an indication for visual expertise (Gegenfurtner et al., 2020). However, in a critical situation where students show disruptive behavior, we revealed different findings at the process level: the prompting condition's priming effect appears to better direct visual attention in disrupting situations. Participants in the prompting condition show a higher number of fixations and a faster time to first fixation (H2e, H2f, H2h, H2i). The prompts seem to activate information that were not previously available shortly before the event (Berthold et al., 2007; Bannert, 2009). Due to the timing of the prime stimulus, pre-service teachers can better focus their attention on the relevant situations. This suggests that, in critical situations of classroom videos, prompts that are provided shortly before this event occur are a more effective form of instruction to guide pre-service teachers' attention and facilitate top-down processing.

Investigating the identified classroom management strategies qualitatively, participants mostly perceived strategies in which the teacher shows omnipresence as well as actions for group mobilization (RQ3). Hence, pre-service teachers seemed to view the teacher's appearance in the video as a crucial component of effective classroom management – and thus, perceive as more salient. At the same time, they tend to focus less on the management with students' misbehavior. Concluding – and agreeing with the results of the outcome level – pre-service teachers might perceive especially (the handling of) critical situations as complex.

6.2. Limitations and further directions

Before turning to our conclusion, we need to point out some limitations of this study. The sample consisted of a large number of first-year students. Even after controlling for variables like prior knowledge and task difficulty, we cannot completely rule out bias in the results given that participants were mostly in an early stage of their studies. However, in prior research, Grub et al. (2022b) compared different instructional settings to pre-and in-service teachers and identified an attention-guiding effect of specific instruction on monitoring behavior – regardless of expertise level. Nevertheless, it is possible that the instruction should be adjusted depending on prior knowledge. Therefore, a replication with students from different semesters and with different levels of prior knowledge would be interesting to investigate the need of instructional adaptation. In addition, it would be interesting to conduct a study with experienced teachers and contrast in-service with pre-service teacher assessments. Another important aspect to be considered is the length of the videos: if the specific task is shown before the video, the pre-service teachers should still be able to keep the task in mind. We used two videos of medium length (both of about 04:30 min). For this reason, our results are limited to videos of a medium length: it cannot be guaranteed that the specific task instruction is as effective as the presentation of prompts for classroom videos with a longer duration. Moreover, we have selected instructional videos from two subjects – a science lesson and a language lesson. For this reason, it is difficult to generalize the findings to all subjects. Further, we linked the instructional settings to the field of classroom management. It is likely that the findings differ depending on other observation contexts, such as didactical foci. We suggest a replication study with videos in other subjects and invite future research to examine whether the instructions need to be adapted for different disciplinary fields.

6.3. Practical implications

Noticing relevant classroom management situations is an important competence for pre-service teachers (Gold et al., 2017; Grub et al., 2020; van Es and Sherin, 2021). However, without instructional guidance, pre-service teachers are struggling with noticing relevant events (Santagata et al., 2021; Grub et al., 2022b). Our findings tend to indicate that teacher educators can implement both, a specific task instruction before video viewing or prompts during video viewing in pre-service teacher education. The decision which instructional setting to choose may depend on task economy vs. identification of disruptive student behavior. On one hand, when concerned with task economy, a specific task before video viewing is arguably easier to implement and less work-intensive than implementing prompts in a video player. On the other hand, when concerned with identification of disruptive student behavior, prompts prior to student misbehavior tends to help pre-service teachers to focus on these critical classroom management events – which is particularly important because our qualitative analyses suggests that pre-service teachers mainly struggle to identify critical situations such as (teachers' management with) disruptive student behavior.

6.4. Conclusion

Classroom videos become increasingly important in pre-service teacher education (Gaudin and Chaliès, 2015). With this opportunity – to provide pre-service teachers with teaching scenarios – however, emerges a need for optimal instructional guidance (Grub et al., 2022a,b; Martin et al., 2023). Our study contributes to this research gap by testing different instructional formats. Findings indicate that instructional formats should be adapted to the intentions of video viewing. Prompts need to be implemented and to be adjusted to certain time stamps or events during the video. In contrast, a specific task instruction can be shown prior to video viewing – appearing to have a similar attention-guiding effect and is more economic for educators to promote professional vision. However, on a process level, prompts seem to better guide attention, when it comes to critical classroom situations in the video. Therefore, educators should choose an instructional format depending on the situations of video viewing: participants seem to attend to general classroom management situations on a similar level when provided a specific task instruction prior to video viewing, whereas critical situations seem to better be monitored by prompts due to their priming effect. In a subsequent qualitative analysis, we examined which classroom management situations are more or less salient for pre-service teachers in order to support their professional vision for these situations. Consistent with the previous quantitative analyses, we found that pre-service teachers notice classroom management strategies addressing teachers' management with disruptive behavior less often than other situations. This finding indicates that instructional support needs to be adapted to identify and interpret different classroom situations in terms of their salience.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

SG: Conceptualization, Formal analysis, Methodology, Writing – original draft. ÖK: Writing – review & editing. IK: Writing – review & editing. DL: Writing – review & editing. AG: Conceptualization, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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