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Pre-service and in-service teachers' professional vision depending on the video perspective—What teacher gaze and verbal reports can tell us

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Teachers are involved in complex teaching situations every day; thus, they must understand what to pay attention to in the classroom, how this information is to be interpreted, and which teaching decisions become necessary as a result. In educational research, these competencies are known as "professional vision." The purpose of this exploratory study was to examine the professional vision of pre-service teachers (PTs) and in-service teachers (ITs) by investigating whether the groups differ in what they notice and how they reason about videotaped classroom events; whether the perspective of the video viewed influences their noticing and reasoning; and to what extent their gaze behavior differs from their verbal statements. Thirty-one PTs and twenty ITs watched a video clip of authentic teaching, shot from different perspectives, and their visual focus of attention was recorded using a remote eye-tracker. Subsequently, participants reported in an interview what they had noticed. The triangulated data show that the gaze behavior of the PTs and ITs did not differ, but the content of their verbal statements did. Depending on the video perspective, participants focused on different subjects, but this difference was not reflected in the verbal data. Thus, the gaze behavior and verbal statements are not consistent. The findings indicate that considering multiple sources and types of data is beneficial to explore professional vision and that further research is needed to understand the concept in depth.

KEYWORDS

teacher education, professional vision, eye-tracking, mixed-methods approach, in-service and pre-service teachers, video perspectives

Introduction

Teaching is a complex task. Teachers have to manage teaching and learning processes while monitoring an entire school class. They must continuously assess students' learning and performance and make teaching decisions (Kohler et al., 2008). A teacher's professional competence therefore involves understanding what to pay attention to in the classroom and how to interpret that information and making rapid instructional decisions accordingly. These competencies are referred to as "professional vision" in educational research (Keller et al., 2022).

Professional vision encompasses different sub-processes. Despite some variation in definitions, it is widely agreed that professional vision involves two main processes: "noticing" and "knowledge-based reasoning" (Grub et al., 2020; Muhonen et al., 2023). "Noticing" is the ability to focus attention on classroom events that are relevant to teaching

and learning, while "knowledge-based reasoning" describes the ability to apply professional knowledge about teaching and learning to interpret these events and draw appropriate conclusions (Grub et al., 2020; Kosel et al., 2021).

Videotaped examples of teaching as stimuli and verbal data of viewers have often been used to study professional vision (Seidel and Thiel, 2017). In such procedures, the participants are asked to comment on what they have seen in a video, and their statements are evaluated qualitatively (Seidel and Stürmer, 2014; Weyers et al., 2023). Recent technical developments have enabled the collection of not only verbal data but also the gaze behavior of participants while they watch videos. Eye-tracking technology allows the investigation of the visual attention of individuals watching videotaped teaching (e.g., with remote eye-tracking) or being active in the classroom due to mobile eye-tracking. However, eye-tracking can only map teachers' professional vision in terms of noticing. Gaze data alone are therefore insufficient to describe teachers' professional vision. Additional data are needed, such as verbal data related to observing teaching, to capture teachers' knowledge-based reasoning behind their gaze behavior (Muhonen et al., 2023). This type of mixed-methods design is seen as promising for studying professional vision and gaining further insights into its nature and characteristics (Godfroid et al., 2020; Wyss et al., 2020). Corresponding studies are, however, still rare (Minarikova et al., 2021), and it remains largely unclear to what extent the gaze behavior is reflected in verbal statements.

Professional vision is seen as a competence that evolves with the development of expertise (Gegenfurtner et al., 2020). Through deliberate practice, the initially isolated and explicit knowledge base of novices is restructured and develops into more integrated and organized scripts (Stahnke and Blömeke, 2021). This knowledge likely influences experienced teachers' ability to search specifically and efficiently for relevant clues in teaching situations. It allows them to focus on the important issues in a given situation and use their knowledge to situate and interpret these situations. In contrast, novice teachers have not acquired the knowledge that enables efficient and effective cognitive processing of classroom situations (Wolff et al., 2016) and they therefore tend to focus on superficial aspects of teaching situations that have little relevance to teaching and learning processes (Meschede et al., 2017). Studies investigating professional vision have found differences between experienced and novice teachers in both verbal and visual data. The main findings are briefly outlined below.

Analyses of verbal data reveal that novice teachers describe teaching situations in rather limited and naïve terms, whereas experienced teachers are better able to draw on their conceptual knowledge to situate, describe, and interpret situations (Stürmer et al., 2013). In terms of content, novice teachers tend to focus more on the teacher's actions and activities than on the students and concentrate more on pedagogy than on the subject and subject didactics. They also tend to evaluate rather than interpret and make general assertions rather than refer to specific events (Simpson and Vondrová, 2019).

Studies using eye-tracking technology are concerned with investigating teachers' visual focus of attention. Accordingly, visual data are of interest. Human eye movements are generally controlled by two processes. Bottom-up attention is driven by salient features of the target (e.g., a colorful garment or the restless behavior of a student); top-down attention is driven by task-related plans, current goals, and intentions derived from professional knowledge (Goldberg et al., 2021; Kosel et al., 2021). For novice teachers, bottom-up processes are more likely to be active. They are not yet able to effectively process all incoming information and to decide which visual cues are most important and are thus more likely to be distracted by salient features. Their gaze behavior may therefore differ from that of experienced teachers (Goldberg et al., 2021). Results from eye-tracking studies could indeed reveal that experienced teachers fixated more areas of classroom events, revisited them more often, and fixated more areas with relevant information (i.e., areas where activities relevant to learning were visible). Novice teachers, in contrast, tended to skip areas in their field of view and more often failed to identify relevant classroom events in standardized video sequences (Keller et al., 2022).

As visual perception is important in professional vision, the camera perspective could have an influence when working with classroom videos, as confirmed by individual studies. Paulicke et al. (2019), for instance, showed that the camera angle influenced observer ratings. The raters assessed the teaching quality of videos recorded with pupil cameras (video recordings with particularly wide-angle cameras and audio recordings of groups of pupils) as, on average, lower than those recorded with teacher and overview cameras. In a study by Cortina et al. (2018), pre-service teachers recorded their teaching with mobile eye-tracking devices. Their analysis of verbal data from the video-stimulated recalls revealed that the participants' comments focused more often on the learners than on the teacher, compared to findings from comparable studies in which participants annotated their own videos, recorded from the observer's perspective. However, to the best of our knowledge, no studies have explicitly investigated different camera perspectives in the context of professional vision.

The results available to date show differences in the professional vision of novice and experienced teachers in both noticing and reasoning about teaching. However, as few studies have explicitly conducted expert–novice comparisons, the evidence base is limited (König et al., 2022). Moreover, little research has investigated the effect of the camera perspective (Gold and Windscheid, 2020). This exploratory project aims to contribute to the identified research gap by investigating the professional vision of pre-service (PTs) and in-service teachers (ITs). Two methods of data collection were used for this purpose. While watching video clips of teaching, the participants' gaze behavior was recorded using remote eye-tracking; afterward, the participants were interviewed about their observations of the previously watched video clip. Accordingly, the potential of mixed methods to study professional vision was also exploited in the study. Due to the exploratory nature of the study, no hypotheses were formulated. The following research questions (RQs) were addressed:

RQ1: Do PTs and ITs differ in the aspects of the classroom they observe and describe?
RQ2: Does the video perspective influence what participants observe and describe about the classroom?
RQ3: To what extent do gaze behavior and verbal reports differ?

Methods

Study design and procedure

To answer the RQs, a mixed-methods design was chosen, following Wyss et al. (2020). The data were collected between November and December 2021 by three trained project members. First, PTs and ITs watched a 90-s video clip of authentic teaching. The clip was selected by two project members. They independently searched three classroom videos on three subjects, which had been recorded in a previous project, for short sequences showing as many relevant aspects of teaching and learning as possible. The individually selected sequences were compared, and a collective selection was made. The sequence shows a German lesson in which the teacher interrupts the class during a student-centered work phase because she notices that the assignment is not clear to the learners. The video clip thus contains aspects of assignment, individual learning support, omnipresence, attention control, and exhortation.

The clip was recorded from three perspectives. Two recordings show the observer's perspective and were taken with static cameras, one at the back of the room and one at the front (alongside the blackboard). The third recording shows the perspective of the teacher wearing eye-tracking glasses (Tobii Pro Glasses 2) during the lesson. The PTs and ITs were randomly assigned to one of the three perspectives. For data collection, the PTs and ITs each watched one of the clips on a laptop [HP ZBook 15 G4, display: 39.62 cm (15.6 inches), resolution: 1920 × 1080], and their gaze behavior was recorded with a remote eye-tracker (Tobii Pro Nano, 60 HZ, nine-point calibration). Immediately after the participants had watched the video clip, an oral follow-up interview of about 20 min followed (cf. Wyss et al., 2020). First, the participants were asked to report on what they had noticed in the video that they had just watched. The corresponding initial question was "What did you notice?" The participants had complete freedom to respond, and their statements were used for the analyses reported in this study. The interviews were audio-recorded and transcribed at an intermediate level of annotation.

Sample

The sample consisted of 31 PTs and 20 ITs from five lower secondary schools hosting teacher trainees from the FHNW School of Education who voluntarily participated. The PTs and ITs were randomly assigned to one of three video perspectives resulting in six test groups. Due to technical problems with the calibration and recording of the remote eye-tracker, data from 12 participants could not be used. Unfortunately, the technical problems (mainly problems with the calibration of the eye-tracking device) occurred disproportionately across the groups. In one test group, data from only three participants could be used. To have six groups of equal size, we chose the smallest group size as a reference and randomly selected three individuals from all other groups. Thus, the final sample consisted of 18 individuals, nine PTs and nine ITs (see Figure 1). Five PTs were women; four were men. They were studying in their third semester at the FHNW School of Education and were, on average, 26.11 years old (SD = 7.99). Three ITs were women; six were men. They were, on average, 47.56 years old (SD = 9.61). Three ITs had 6–20 years of teaching experience, three 21–25 years, one 26–30 years, and two 31–35 years.

Data analyses

Video codings

As the video recordings have a dynamic image, an automated evaluation of remote eye-tracking data using Tobii's analysis software was not reasonably possible. As with previous studies (e.g., McIntyre and Foulsham, 2018; Telgmann and Müller, 2023), data were therefore analyzed manually by consensus between two trained project members. While the videos were played at slow speed (0.12), the coders assigned each fixation to one predefined area of interest (AOI). The three AOIs, "teacher," "student," and "learning material," were defined based on Cortina et al. (2018). The code "other" was used for all fixations outside the three AOIs (e.g., fixation on the window). If a fixation could not be clearly assigned to one of the AOIs or "other" (e.g., fixation on student and learning material at the same time), the coders inferred from the gaze progression what the person was looking at. If this was not possible, the code "undefined" was assigned. Accordingly, five codes were applied: "teacher," "student," "learning material," "other," and "undefined." Due to the perspective of the eye-tracking video, the teacher is not visible in this video. However, the teacher's arms and hands often appear in the video. If these were fixated by the participants, the code "teacher" was assigned to this video too.

The number of each code was counted for every participant. The proportion of each code in relation to the total number of codes per participant was then determined. These values, i.e., the relative numbers (percentages), are used in the analyses.

Interview codings

The verbal statements were analyzed using qualitative content analysis (Kuckartz, 2012) in MAXQDA using individual themes as the unit for analysis, with the smallest unit being a sentence part. Statements with multiple meanings were assigned different codes. The same code was used several times by being assigned to all corresponding statements. Coding was done by consensus (Hopf and Schmidt, 1993). The same text was coded by two project members, and the coding decisions were discussed afterward. This led to a specification of the category system and ensured the quality of the coding process (Kuckartz and Rädiker, 2022). Due to the small number of cases, all data were coded as described. Following Muhonen et al. (2023), the coding system consists of two main categories "description" and "explanation." The four codes for the category "description" were adopted (like the video codings) from Cortina et al. (2018): "teacher," "student," "learning material," and "no focus." Statements describing activities and behavior of actors in the classroom (e.g., the students are working; there was a lively exchange) were coded "teacher" or "student." The code "learning material" was only assigned if the material was described that the class used in the video clip. Other aspects that were mentioned but

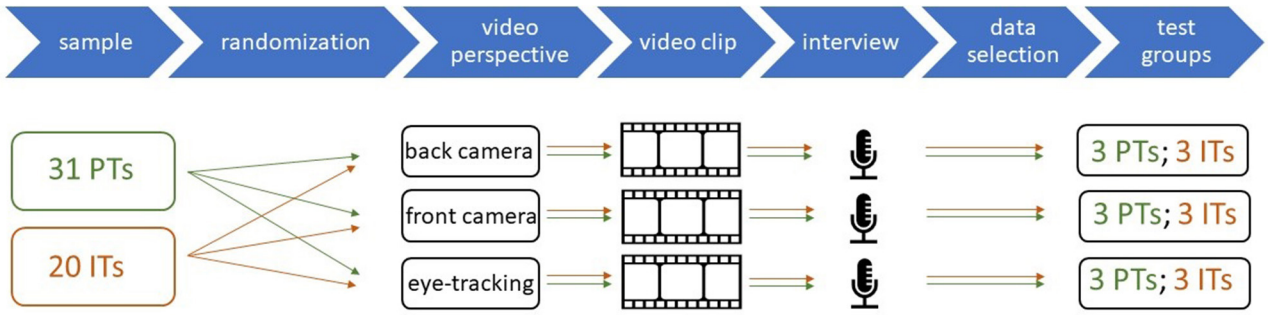

FIGURE 1
Overview of data collection.

not specifically related to the teaching and learning process, (e.g., number of students or appearance of the classroom or individuals) were coded "no focus." The two main categories and four codes were determined deductively.

Videos enhance teachers' capacity to identify pertinent events of teaching as they provide the opportunity to deliberately focus on student learning (Gaudin and Chaliès, 2015). According to Cortina et al. (2018), eye-tracking videos are beneficial for shifting the focus of the analysis to the students. The code "student" was therefore of particular interest and examined more closely in terms of content. Statements about students' actions were inductively categorized in subcodes (e.g., "students are working"; "students are looking at the tablet"). In total, 13 subcodes were defined.

Statements that went beyond mere description and contained conjectures, judgments, further thoughts, and alternative actions were coded with the category "explanation" (Muhonen et al., 2023) and, again, categorized inductively. Among the topics found were alternative actions, evaluations of the teacher's actions, speculations about the teacher's possible thoughts and intentions, and comments on the students' learning level. Ten subcodes were defined inductively. Analogous to the video codings, for each person, the number of times each code was given was counted and the proportion of each code in relation to the total number of codes given per person (relative number) was determined.

Analyses regarding the research questions

To answer RQ1, data from PTs and ITs were contrasted regarding the number of fixations and interview statements using an independent-sample *t*-test. Moreover, the codings of the verbal data of the PTs and ITs were compared by means of cross-tabulations (see Supplementary Tables 1–3).

Regarding RQ2, differences in the number of fixations and interview statements among the three perspectives were analyzed using an ANOVA or the Kruskal–Wallis test if the assumptions for parametric analyses were not met. The codings of the verbal data regarding the three video perspectives were compared by means of cross-tabulations (see Supplementary Tables 4, 5).

Considering RQ3, the content focus of the visual data (fixations) and verbal data (interview statements) were compared using repeated-measures ANOVA or Friedman's test if the assumptions for parametric analyses were not met. Moreover, the visual fixations were contrasted with the interview statements using a paired sample *t*-test.

Data analyses

Comparison of ITs and PTs (RQ1)

PTs and ITs did not differ in how often (relative number) they verbally described or visually fixated on the teacher, students, or material (all $p > 0.05$; see Figure 2) but did differ in the total number of descriptive statements (absolute number) they made during the interview. ITs made more descriptive statements than PTs ($t_{16} = 3.38$, $p = 0.004$, d = 1.59; ITs: M = 28.67, SD = 8.12; PTs: M = 17.67, SD = 5.41).

The cross-tabulations (see Supplementary Tables 1–3) performed on the verbal data show that the ITs described more aspects of the classroom, in more detail, than the PTs. For example, in the code "student," only the ITs mentioned specific learning-relevant aspects of the teaching, such as fidgeting students or learners having not yet started the assignment. The PTs' statements were more general and mainly concerned with the surface structure of the lessons, indicating, for example, that the students are working with tablets or are quiet. Moreover, the ITs made statements about alternative actions or possible thoughts and intentions of the observed teacher, but the PTs did not. Overall, ITs provided significantly more explanations than PTs ($t_{16} = 4.40$, $p < 0.001$, d = 2.07; ITs: M = 4.78, SD = 1.64; PTs: M = 2.11, SD = 0.78).

Comparison of video perspectives (RQ2)

Given that the teacher is barely visible in the eye-tracking perspective (only her arms and hands), the participants fixated on the teacher significantly less often (lower relative number of fixations) in this perspective than in the other two perspectives ($H_2 = 11.51$, $p = 0.003$, d = 2.68; eye-tracking: M = 1.5%, SD = 0.8%; front camera: M = 20.03%, SD = 8.6%; back camera: M = 21.5%, SD = 7.3%). Moreover, they fixated more often (higher relative number of fixations) on the material when viewing the

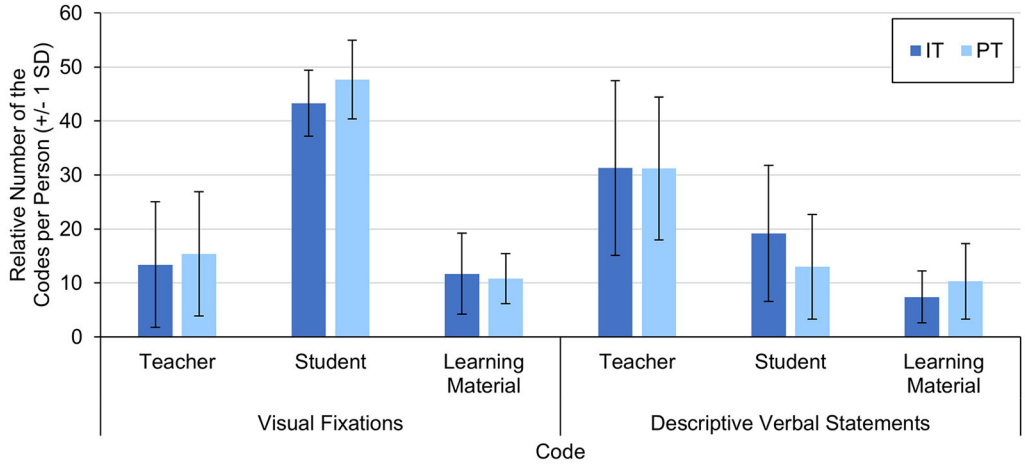

FIGURE 2
Comparison of ITs and PTs regarding the focus of their visual fixations and verbal statements.

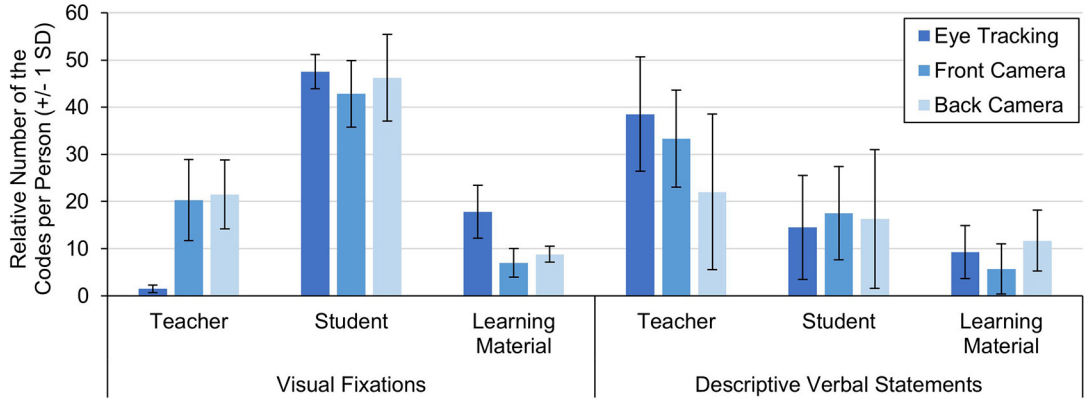

FIGURE 3
Comparison of the video perspectives regarding the focus of the visual fixations and verbal statements.

eye-tracking video than the videos from the observer's perspective ($F_{2,15} = 14.03$, $p < 0.001$, d = 2.73; eye-tracking: M = 17.8%, SD = 5.6%; front camera: M = 7.0%, SD = 3.0%; back camera: M = 8.8%, SD = 1.7%). No statistically significant differences between the perspectives occurred with respect to the relative number of fixations on the students ($p > 0.05$). No differences were found in the verbal data in the category "description," which had about the same relative number of codings per code for all three video perspectives (all $p > 0.05$) (see Figure 3).

Looking at the code "student" in the verbal data, remarkable differences between the perspectives become evident (see Supplementary Tables 4, 5). Participants who had viewed the video of the front camera and eye-tracking perspective reported that the students looked at the tablets, instead of listening to the teacher, while participants who had viewed the clip of the back camera perspective emphasized that the learners listened attentively to the teacher. Accordingly, the same teaching situation was perceived differently by the participants when viewing this video perspective.

Comparison of visual and verbal data (RQ3)

Overall, the participants fixated more often (higher relative number of fixations) on the students than on the teacher or material when viewing the video clips ($\chi^2_2 = 27.07$, $p < 0.001$, $W_{Kendall} = 0.75$; students: M = 45.5%, SD = 6.9%; teacher: M = 14.4%, SD = 11.2%; material: M = 11.2%, SD = 6.0%). In the interviews, however, they described more often (higher relative number) the teacher and her actions than the students or learning material ($F_{2,34} = 16.77$, $p < 0.001$, d = 2.00; teacher: M = 31.3%, SD = 14.3%; student: M = 16.1%, SD = 11.4%; learning material: M = 8.9%, SD = 6.0%) (see Figure 4).

To find an explanation for this discrepancy, the verbal data were reviewed more closely. It emerged that the participants often commented on the seating arrangement and number of students. As these are not actions of the students, such statements were not assigned to the "student" code but to the "no focus" code. It can be assumed that the participants often fixated on the students to gather information about the arrangement of the students and

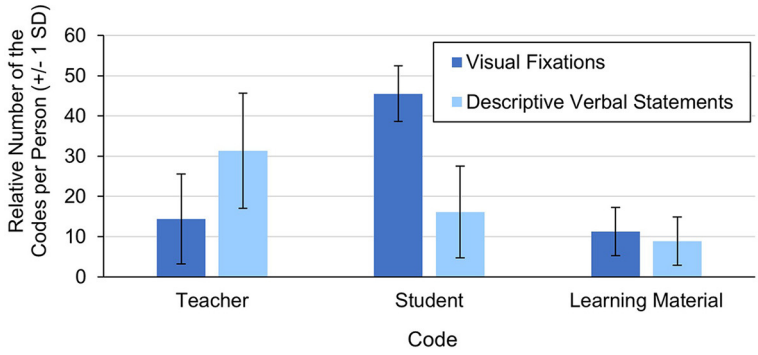

FIGURE 4
Comparison of visual and verbal data for the three codes teacher, student, and learning material.

the classroom. They seemed to pay less attention to the actions of individual students, which they described rather sweepingly; indeed, the students seem to have been perceived predominantly as a collective crowd. In contrast, the teachers' actions were usually the focus of attention and described in detail.

Discussion

This exploratory study uses a mixed-methods approach to examine the professional vision of PTs and ITs and investigates whether these groups differ in what aspects of a classroom they observe and describe (RQ1), whether the perspective of the video they viewed influenced their observations and descriptions (RQ2), and to what extent gaze behavior and verbal reports differ (RQ3).

Regarding RQ1, the results show differences in the professional vision of PTs and ITs. However, the differences could only be found in the verbal statements, but not in the visual data, in contrast with the findings of studies that identified differences in gaze behavior (e.g., Wolff et al., 2016; Kosel et al., 2021; Stahnke and Blömeke, 2021). Possible explanations for this difference could be that the participants in our study were not given a specific task while watching the video and there were no critical incidents in the classroom, as occurred in the aforementioned studies. Inconsistent results, however, have also been found in previous studies (e.g., Pouta et al., 2021; Seidel et al., 2021; van Driel et al., 2021). The differences in study results may be explained by the different task settings, as gaze patterns can be highly influenced by the specific task (Kaakinen, 2021). To identify differences in competence between novice and experienced teachers, the situation to be observed should be sufficiently complex as only then top-down processes typical of expertise will become relevant (Biermann et al., 2023).

As shown in other studies (e.g., Wolff et al., 2016; Meschede et al., 2017; Gegenfurtner et al., 2020), differences between the verbal statements of ITs and PTs were found. ITs overall made more statements in the interviews, describing more aspects of the classroom and giving more detailed descriptions and more explanations than the PTs. Moreover, only ITs mentioned possible thoughts and intentions of the observed teacher. These results indicate that ITs can grasp situations relevant to learning and better relate them to their job-specific knowledge (Gegenfurtner et al., 2020).

With respect to RQ2, we found differences between the three video perspectives. When viewing the eye-tracking video, participants fixated less often on the teacher than when viewing the other two perspectives as the teacher is barely visible in the eye-tracking video; instead, participants fixated more often on the learning material when viewing the eye-tracking video. They fixated on the students at the same frequency in all video perspectives. The findings indicate that, depending on the video perspective, different objects and individuals are brought into the viewer's focus.

The verbal data reveal no difference among the three perspectives regarding the number of codings per category. Although participants fixated significantly less frequently on the teacher when viewing the eye-tracking video than the videos from the observer's perspective, when interviewed they still talked at the same frequency about the teacher as for the other perspectives. This result is inconsistent with the findings of Cortina et al. (2018); however, in their study, the participants worked with their own eye-tracking videos, whereas the participants in the present study viewed video clips of other teachers. Nevertheless, the findings are remarkable. They indicate that the participants strongly consider teaching from the teacher's perspective (Sherin and Han, 2004), regardless of the camera perspective. As other scholars have observed (Blomberg et al., 2014), our results confirm that work with classroom videos should be guided and accompanied by appropriate prompts to increase the focus on student learning. The results also raise the question of how "noticing" and "knowledge-based reasoning" are related. It would thus be highly appreciated if future research studies were to focus more on this question.

Concerning RQ3, the results show that gaze behavior and verbal reports are not necessarily consistent. The participants fixated more often on the students than the teacher or the material when viewing the video clips. When interviewed, however, they talked more often about the teacher than the students or the learning material. This finding indicates that it is not always possible to draw clear conclusions about the focus of attention from gaze behavior. An important difference between eye-tracking data and verbal data is that eye-tracking captures both conscious and unconscious processes, while verbal data are limited to conscious, verbalizable processes (Godfroid et al., 2020). Visual data alone are therefore

insufficient to draw conclusions about professional vision, but teacher's gaze can provide very valuable additional information (Minarikova et al., 2021).

In interpreting the results, some limitations must be considered. Due to technical problems with the eye-tracking recordings, the final number of participants was small. Although eye-tracking technology has continuously improved, there are still certain technical hurdles. Careful monitoring of data collection is thus advisable. Moreover, the participants worked with clips from a single teaching lesson. Consequently, the study must be characterized as an exploratory study. It is necessary to explore the results further with larger samples and more and different classroom clips. As the small number of participants was unforeseen, we will expand the study with additional participants. Nevertheless, the study revealed some valuable findings that provide a basis for future research as well as teacher education. When working on professional vision, the video perspective to be used should be taken into account, and it also seems useful to consciously choose a particular perspective, considering the advantages and disadvantages of each perspective in the context of fostering professional vision. An important finding is that as gaze behavior and verbal reports give different indications of and insights into a person's professional vision, combining these types of data is valuable. Moreover, the use of qualitative and quantitative methods is advantageous. Combining these different data provides a promising way to explore the relationship between "noticing" and "knowledge-based reasoning" as well as to better support novice and experienced teachers in developing their professional vision competencies.

Data availability statement

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

Author contributions

CW: Conceptualization, Funding acquisition, Project administration, Writing – original draft, Writing – review & editing. KB: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. SM: Conceptualization, Formal analysis, Funding acquisition, Investigation, Project administration, Visualization, Writing – original draft, 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.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1282992/full#supplementary-material

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