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Professional vision in teaching: review of methodological concepts using eye-tracking

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Abstract
Eye-tracking (ET) has become an essential tool for studying professional vision (PV) in education. It provides objective, real-time data on where and when teachers direct their gaze, making visible professional noticing processes that are otherwise inaccessible through self-report methods. However, methodological guidance for its use remains limited. This article examines approaches adopted in PV studies using ET through a comparative analysis of 27 publications, structured around four dimensions: the purpose of studies (what?), target populations (for whom?), data collection and analysis methods (how?), and media and technological tools employed (with what?). The analysis reveals dominant methodological trends, including a strong reliance on fixation measures at the expense of other eye-movement indicators such as saccades, as well as a marked under-representation of socio-cultural theoretical frameworks. These patterns point to potential blind spots in how PV is currently conceptualised. The article concludes with targeted recommendations aimed at advancing methodological transparency and expanding the conceptual scope of ET-based PV research.

Keywords Professional vision · Eye-tracking · Methodology · Integrative review · Recommendation

1 Introduction and issues

The tools for observing teaching practice have long been limited (Laurent et al. 2022). To address this, observation methods have diversified, increasing both the quantity and variety of data collected to characterise teaching practice with greater precision and objectivity.

Among these, eye-tracking (ET) plays an increasingly prominent role (Jarodzka et al. 2021). By objectively quantifying where teachers look (Skuballa & Jarodzka 2022), ET offers unprecedented access to constructs once difficult to capture—particularly fixation, selection, and decision-making processes (Keskin et al. 2024). In essence, ET reveals how

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and to what stimuli teachers are visually sensitive and what they report noticing when making instructional decisions (Lachner et al. 2016; Skuballa & Jarodzka 2022).

ET is especially employed to study professional vision in teaching (PV), akin to professional observation. This skill—processing and selecting the most relevant cues in an information-rich classroom in real time—has, until now, been examined through subjective methods and high-inference tools (Weyers et al. 2023; Grub et al. 2024). By delivering objective measures, ET reduces the subjectivity of these approaches, allows precise identification of what teachers actually perceive (Weyers et al. 2023), and captures the real-time dynamics of PV (Weyers et al. 2023). Furthermore, its integration has enriched theoretical frameworks of PV (Jarodzka et al. 2021), to the point that ET is now recommended by many scholars (Weyers et al. 2023; Grub et al. 2024; Jarodzka et al. 2021; Duvivier 2025; Gegenfurtner et al. 2019).

However, a lack of methodological conventions persists in both the design and analysis of ET studies (Holmqvist et al. 2022; Keskin et al. 2024). Moreover, reviews such as those by Beach & McConnel (2019) focus on a limited number of studies, offering only a fragmentary understanding of the methods used to study PVT with ET.

Given the rapid expansion of ET research and persistent gaps in methodological transparency, this article compares existing approaches through four guiding questions:

- What theoretical frameworks underpin PV studies using ET?
- Who are the teachers under investigation (categories, levels, disciplines, contexts)?
- How are ET and verbal data collected and analysed?
- With what media, tools, and measures is PV studied via ET?

To answer these questions, an integrative literature review was conducted (Torraco 2005), through which 27 studies, published between 2014 and 2024,[1] employing ET to explore PV were selected. Each publication was analysed to identify and compare the methodological approaches adopted, with the findings forming the basis for the recommendations presented at the end of the article.

The article is structured as follows: Sect. 2 outlines the theoretical framework; Sect. 3 details the review methodology; Sect. 4 analyses findings via what, who, how, and with what; and the conclusion notes gaps and suggests transparent ET practices.

2 Theoretical framework

2.1 Professional vision and its approaches

The notion of PV was initially formulated by Goodwin (1994), who defined it as a visual skill rooted in social and material discourses, characteristic of professions such as archaeology, oceanography and geochemistry. Sherin (1998) adapted this notion to the field of education, examining how teachers perceive classroom dynamics and interpret them, in particular by identifying critical elements. In collaboration with Van Es, the authors define PV through two constitutive and interdependent processes, sharing a common overall structure

[1] This timeframe reflects both the rapid development of ET technologies and the formal adoption of the PV construct in education research.

(Leontiev, 1984): 'noticing' significant aspects of the classroom environment and 'interpreting' these observations by linking them to their experience (Lachner et al. 2016) as well as to theoretical frameworks in education (Van Es & Sherin 2002).[2] More recently, Van Es and Sherin (2021) developed the notion of 'shaping', which describes teachers' ability to engage in interactions that refine their observation and reasoning in response to classroom events.

These foundations laid by Van Es and Sherin (2008) led to the emergence of other theoretical frameworks that have continued to enrich and diversify our understanding of PV and its constituent processes. König et al (2022) highlighted this diversity by identifying four main theoretical approaches to PV.

- The first approach, the sociocultural (SO) approach, emphasises the social dimensions and contexts in which the process of 'noticing' takes place. It is based on the idea that the ability to perceive a significant event is not just an individual psychological process, but a socially embedded activity (Goodwin 1994), developed through the interactions and discursive exchanges of practitioners.
- The second approach, known as the cognitive and psychological (CP) approach, studies both the mental (cognitive) mechanisms and the emotional and behavioural (psychological) influences that come into play in the two processes of PV among teachers.
- The third approach, the disciplinary orientation (DI) approach, considers teacher observation not only as an act of 'noticing' relevant details of their environment, but also as a process leading to professional awareness (Mason 2002). It emphasises the importance of self-examination and reasoning in teaching practice (Mason 2002).
- The fourth approach is based on the cognitive theory of visual expertise (EX), based on the significant contributions of Berliner (1988, 2001, 2004) and related research (Carter et al. 1988; Sabers et al. 1991). This work explores how teachers' expertise manifests itself in teaching practice, particularly through the two PV processes.

2.1.1 Noticing

The first process, 'noticing', concerns teachers' professional observation competence (Vifquin 2017). This skill is linked to ocular dynamics. This competence, linked to ocular dynamics, reflects selective attention (Flandin & Gaudin 2014; Vifquin 2015), i.e. the teacher's ability to focus on a specific element despite distractions (Mazeau 2005) in order to identify relevant elements in the classroom. Selective attention in teachers entails choosing relevant information, discarding extraneous details, and guiding focus via prior knowledge (Keskin et al. 2024).

2.1.2 Reasoning

The second process relates to 'reasoning' based on prior observation. The term 'reasoning' here refers to the way in which the teacher apprehends the events of a class in an active approach that goes beyond mere perception. For Van Es and Sherin (2008), the teacher's 'reasoning' process breaks down into three distinct stages: the teacher describes to himself what he observes; then he links this observation to a judgement, which is evaluated and justified; finally, he examines the implications of his observations by anticipating pos-

[2] These two processes (noticing and reasoning) are explored in greater detail below.

sible developments in the educational situation. Teachers' reasoning relies on "program scripts"—pre-stored action and decision patterns that speed choices in class (Lachner et al. 2016). Vifquin & Frenay (2018) add a reflexive layer, prompting teachers to critique their own pedagogical beliefs. Keskin et al. (2024) link reasoning to visual interpretation across four dimensions: organizing visual elements, integrating them with prior knowledge, interacting via visual strategies, and maintaining constant surveillance.

2.2 Fixed and mobile eye-tracking

2.2.1 Definition

Eye-tracking (ET) records teachers' eye movements in real time as they engage with visual stimuli, allowing researchers to determine what is observed (Duvivier et al. 2024). The teacher whose gaze is tracked is referred to as the Observing Teacher (OBT), and the one depicted in the video as the Teacher Observed on-Screen (TOS). Grounded in the mind–eye hypothesis, ET assumes that gaze direction reflects ongoing cognitive processes (Just & Carpenter 1976), thereby providing access to the OBT's attentional focus and information selection (Keskin et al. 2024).

ET devices are generally classified into two categories: fixed ET and mobile ET. Each device allows PV to be explored in a variety of contexts, ranging from laboratory micro-analysis to in situ observations, each offering complementary perspectives. They can be used independently or combined for more comprehensive analyses. On the one hand, fixed ET (Fig. 1) allows data to be collected with a high degree of precision in a controlled environment, generally in the laboratory, on static stimuli (e.g. an image) or dynamic stimuli (e.g. a video) presented on a screen. A fixed infrared camera is placed under the screen to track the eye movements of the ET, who must remain still and seated in front of the screen (Lappi 2015). On the other hand, mobile ET, often integrated in the form of glasses (Fig. 2),

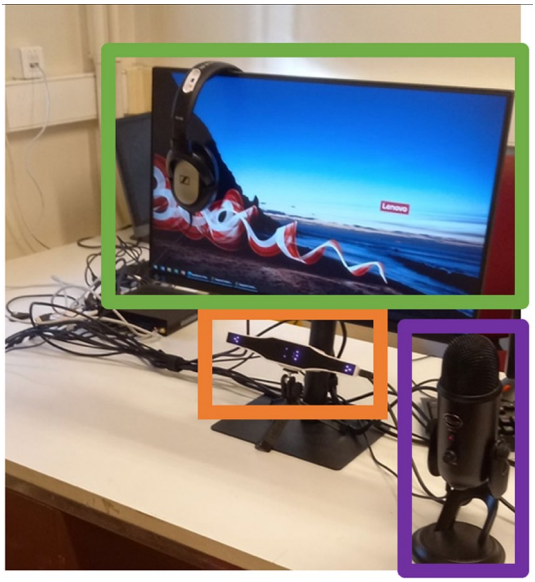

Fig. 1 Exemple of fixed eye-tracking (Gazeoint 3HD). Legend for the components of the recording device: In green, a screen showing an image, video or web page that the teacher is viewing. In orange, the tracer used to follow the teacher's gaze. In mauve, the microphone used to record the teacher's words

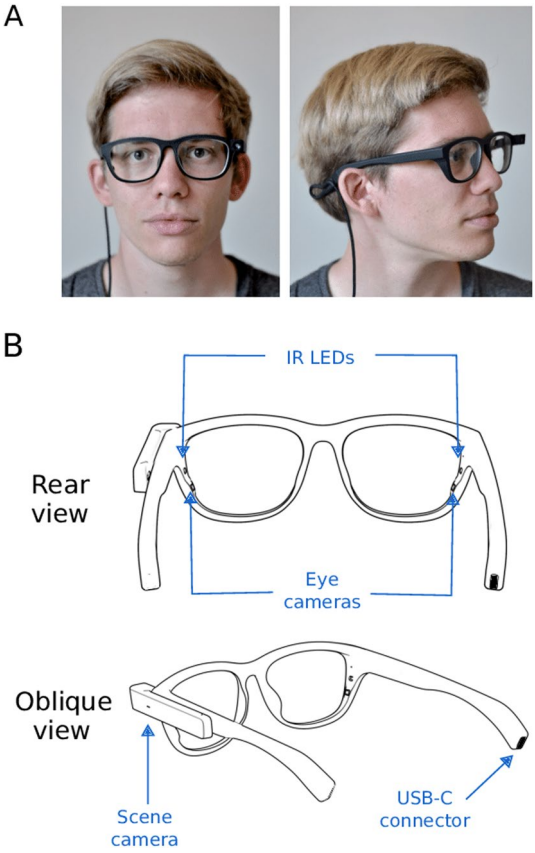

Fig. 2 Mobile eye-tracking in the form of glasses (image taken from Tonson & Baumann, 2020). Legend for photo **A**: Portrait of a person wearing ET glasses (invisible pupils) on their face. Legend for photo **B**: Description of the cameras integrated into the glasses and the USB-C connector to which a companion mobile phone is connected by a cable

captures the eye movements of teachers in real, dynamic contexts, such as classrooms (Jardozka et al. 2021). The glasses, equipped with several cameras and microphones, record their field of vision, from a subjective point of view, as well as the teacher's words and surrounding noise.

2.3 Media used in eye-tracking[3]

In the context of fixed eye-tracking, three types of media are employed to examine teachers' visual strategies:

First, static images are used to study, for example, how teachers observe a student's worksheet. Second, video recordings can be integrated into fixed ET. These recordings add a temporal dimension, allowing the study of how teachers' attention evolves when faced with dynamic content, in real classroom settings or simulations. The integration of mobile ET videos into fixed ET allows teachers to review their own actions or those of others. Another application of fixed ET with videos captured by ET glasses involves incorporating an Eye Movement Modelling Example. This model uses a red target to trace and illustrate the visual

[3] For the sake of clarity, Sects. 2.3 (Media Used in Eye-Tracking) and 2.4 (Eye-Movement Data) are presented separately; however, they are conceptually interdependent, as both are used jointly to analyse the visual strategies of the OBT.

strategies of expert teachers, thereby guiding the observation of Pre-service Teacher (PST) for exemple. Finally, web pages are used to analyse how teachers search for online resources and interact with digital interfaces, particularly in the context of online courses.

2.4 Eye-movement data

Areas of interest. In the media we have just discussed, the researcher determines segments which may or may not contain significant events. In each segment, certain elements are identified as areas of interest (AOI) according to the specific characteristics of the experiment or video. AOIs can take different shapes (e.g., rectangular, oval, polygonal, or detailed contours), corresponding to varying levels of precision. The choice of AOI shape often depends on the functionalities and constraints of the eye-tracking software used, meaning that researchers are partly bound by the technical possibilities of their analytical tools. These AOIs are defined either before data collection, based on research hypotheses, or after analysis of the data collected. They constitute reference points for examining OBT's visual strategies in a structured way (Fig. 3).

a) Oculometric indicators

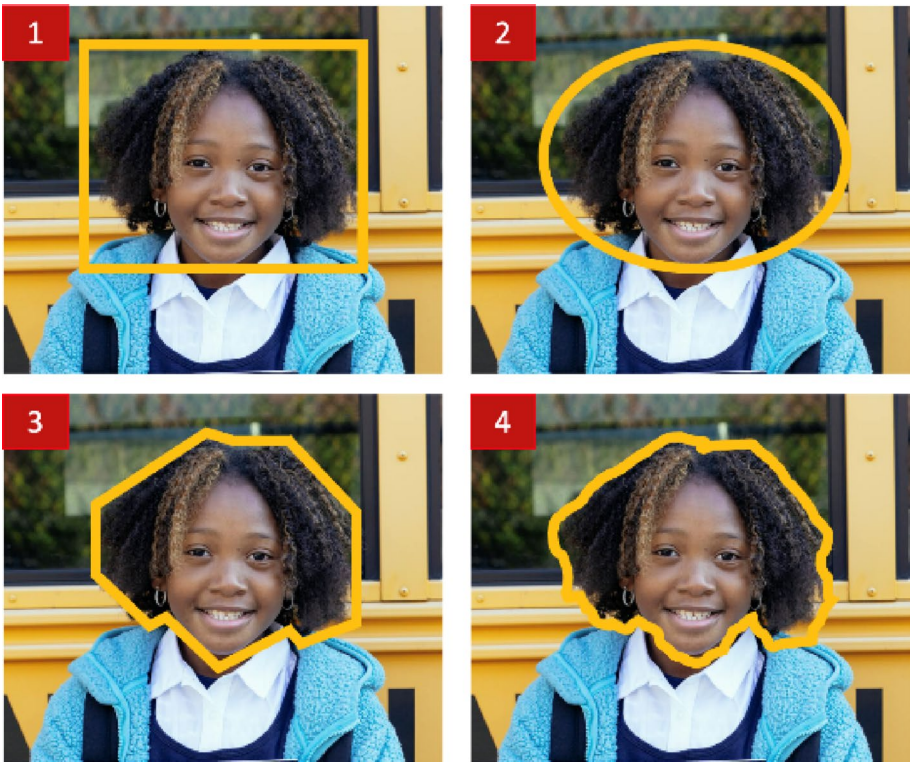

Fig. 3 Different methods for delineating an area of interest (AOI): (1) rectangular, (2) oval, (3) polygonal, and (4) detailed contour. *Note* Original illustration created by the author using a free-to-use image from Pexels (https://www.pexels.com/fr-fr/photo/ecoliere-noire-souriante-avec-manuel-5896948/)

Table 1 Fixation sub-indicators

Fixation duration	Measures the time during which the EO's gaze remains stationary on an AOI. Fixations lasting 0.2 to 0.6 s indicate interest in the AOI. The total fixation duration aggregates the time spent on an AOI, assessing overall engagement with it (Findlay & Walker 2012)
Fixation frequency	Counts the number of times the EO's gaze fixates on an AOI. A high frequency suggests particular importance of the AOI for the EO
First view	Measures the time elapsed before the EO's gaze fixates on an AOI for the first time, indicating the speed of visual attraction
Number of visits	Counts the number of times the EO's gaze lands on an AOI, indicating monitoring or reevaluation of it. Revisits refer to returns to an AOI previously viewed (Kim et al. 2012)

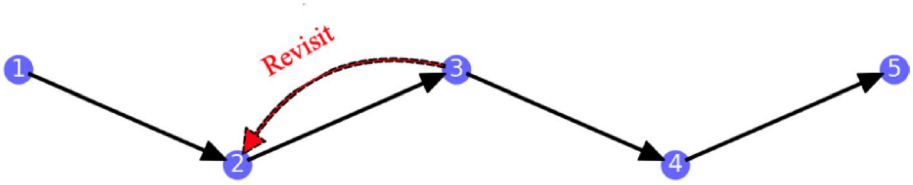

Fig. 4 Examples of fixations (circle) and saccades schematically (straight arrow) and return from one fixation to another (curved arrow)

The structured examination of AOIs is conducted using eye-movement indicators (cf. Li et al. 2019 for a summary), which essentially represent the "language of the eyes." Analysing teachers' visual strategies requires a flexible and combined use of eye-movement indicators. The most common eye-movement indicators are *fixations* and *saccades*[4] (Holmqvist et al. 2011).

Fixations represent moments where the gaze remains stationary on an element, signalling focused attention on an AOI (Ju et al. 2019) and cognitive engagement (Duchovsky 2017). From fixation data, several sub-indicators can be derived to perform a more detailed analysis of teachers' visual strategies (Table 1).

Furthermore, *saccades* (Fig. 4) represent rapid transitions of the EO's gaze. They indicate the EO's attention strategies as well as their ability to process multiple visual elements simultaneously (Ju et al. 2019).

It is worth noting that eye-movement data may occasionally be missing due to "blinks" or measurement errors caused by eye blinks or tracker malfunctions, which can disrupt recording and reduce data accuracy (Carette 2020).

b) Method for analysing oculometric data

Two analysis methods are used to examine teachers' visual strategies: global analysis and sequential analysis (Huang 2018). On the one hand, global analysis makes it possible to

[4] Given the complexity of visual processing, an exhaustive analysis of teachers' visual strategies requires the combined, flexible and multidimensional use of OI.

visualise the main AOIs through heat maps, showing the areas receiving the most fixations and revealing attention patterns. For example, in a classroom, a heat map may indicate that teachers spend more time looking at pedagogical elements on one part of the board than the TOS may do.

On the other hand, sequential analysis, also referred to as "chain editing," provides a detailed perspective by tracking eye movements in their order of occurrence (Kosel et al. 2021). This type of analysis enables comparisons of eye-scanning trajectories in classrooms between novice and expert teachers. To achieve this, the Levenshtein distance (Levenshtein, 1966) is employed to measure dissimilarities between gaze paths (e.g., Mathôt et al. 2012). A more robust method, MultiMatch (Dewhurst et al. 2012), incorporates fixation duration into the analysis, offering enhanced insights into gaze behaviours.

2.4.1 Verbal protocols

During an exam, a teacher's gaze may track students while their thoughts drift to other concerns, showing that ET alone cannot capture professional vision (PV), which involves both noticing and reasoning (Ruckpaul et al. 2015). Combining ET with think-aloud protocols (TAP) enriches analysis (Ericsson 2018).

TAP prompts teachers to verbalise their real-time perceptions and reasoning, verifying whether they accurately report and evaluate salient visual information (Roussel 2017). It assumes faithful expression of silent thought (Ericsson 2018). Roussel et al. (2017) distinguish two TAP modes:

- Concurrent TAP: Teachers speak as they view ET media, capturing immediate reactions. This spontaneity can slow observation—hence a two-phase method: silent viewing followed by live commentary.
- Retrospective TAP: Teachers reflect after viewing, revealing insights they might not articulate in real time.

With *fixed ET*, TAP data are retrospective and reflective, supporting deep analysis of pedagogical choices. With *mobile ET*, TAP occurs in situ, producing spontaneous, context-embedded verbal data. Coding schemes (Jarodzka et al. 2021) then classify statements by linguistic form (Ericsson 2018), cognitive process (description vs. evaluation), or referent (student vs. worksheet).

3 Methodology and data breakdown

3.1 Data collection method

An integrative review of the literature was carried out.[5] This approach, recognised for its ability to enrich existing knowledge on a given topic, consists of an in-depth synthesis of several scientific publications (Torraco 2005). Based on a methodology that unifies various pieces of information from studies (Snyder 2019; Torraco 2005, 2016), this review goes

[5] This review is integrative and thematic rather than systematic, as its purpose is interpretative rather than exhaustive.

beyond a simple traditional review by going beyond the enumeration of previous research. The aim of an integrative review is thus to identify recurring thematic lines and to highlight trends between the research studied (Snyder 2019; Torraco 2016).

In order to complement this integrative approach, we also conducted a thematic review following the method proposed by Thomas and Harden (2008). The objective of this phase was to identify and articulate the main methodological concepts related to eye-tracking in an educational context. Specifically, each study was coded by a single researcher to ensure coherence and conceptual consistency across the corpus. The coding followed four dimensions—*What, Who, How,* and *With what*—to extract key themes such as theoretical frameworks, teacher profiles, data collection and analysis methods, and technological configurations (Appendix Table 6). This thematic synthesis enabled us to group results into coherent clusters, providing a clear map of the evolution of methodological practices.

The synthesis presented here is based on a corpus of theses, journal articles, and conference proceedings in French and English, published between January 2014 and January 2024. Given the rapid evolution of eye-tracking technologies, we limited our selection period to the past ten years. Combinations of keywords such as 'eye-tracking OR oculometrics AND teaching AND professional gestures AND professional vision' were implemented in 9 databases. Among these databases, five French-language databases or search engines were consulted, including OpenEdition, SUDOC, ERUDIT, Cairn and Pascal & Francis. Four international databases or search engines were also surveyed, including Google Scholar, Springer, ERIC and Scopus.[6] The search strategy was expanded by adopting an iterative approach similar to a snowball effect: the references identified were used as anchor points for new explorations, in particular via the Connected Papers online software, making it possible to identify peripheral works and thus broaden the scope of our literature review.[7] This snowball technique allowed us to identify three additional studies that met the inclusion criteria.

The breakdown of the data is as follows: excluding duplicates, we collected 29 articles published between January 2014 and January 2024 (Appendix Table 7).

The analysis of the table reveals an irregular annual distribution of studies on professional vision using eye-tracking. From 2013 to 2019, publications were sparse and infrequent ($n=8$), with only one or two studies per year. After 2020, the field saw a marked increase, with 21 studies published between 2021 and 2023—including 14 in 2021 alone, likely reflecting the post-COVID-19 research surge. The years that followed (2022 and 2023) show a somewhat steadier output (1 in 2022; 6 in 2023).

The studies are heavily weighted toward Europe (21), with Germany (8), Finland (5), and the Netherlands (3) most strongly represented. The United States also makes a significant contribution (4), with smaller numbers from Japan (2), France, the Czech Republic, Switzerland, Belgium, Lithuania, and South Korea. Nearly all of these works (27) appear as journal articles, underscoring their validation and dissemination within formal academic channels.

[6] The detailed search strings used in each database can be provided upon reasonable request to the corresponding author.

[7] No formal assessment of the methodological quality of the included studies (MMAT, CASP, etc.) was carried out. It is therefore important to note that this thematic review should be considered an exploratory synthesis of methodological practices.

4 Results and interpretation

To improve clarity, the results are presented according to the research questions in Sect. 3.1. Each results section is followed by an interpretation, integrating the data into the context of the study.

4.1 "What" (QR.1)

Our analyses are based on the classification of König et al. (2022), comprising the cognitive and psychological (CP), socio-cultural (SO), disciplinary (DI), and expertise-centred (EX) trends (see above). Some studies fall into more than one category (e.g., CP+EX), which explains the total number of occurrences is 43.

According to Table 2, the CP ($n=22$) and EX ($n=18$) approaches dominate, showing a strong interest in cognitive processes and expertise in the observation of PV. Far behind, the DI approach is poorly represented ($n=2$), and only one study addresses the SO approach.

These trends highlight the importance of expertise (EX) as a key factor in PV, as noted by Jardozka et al. (2021), Lachner et al. (2016), and Keskin et al. (2024). The limited representation of DI and SO perspectives indicates a lack of attention to these dimensions, despite the fact that Van Es and Sherin's (2008) theoretical approaches were developed within a specific disciplinary framework for mathematics education, and earlier theoretical frameworks, such as Goodwin's (1998), are rooted in the SO approach.

Additionally, 16 out of 29 studies combine multiple perspectives, often CP and EX, indicating that PV is a complex phenomenon where expertise plays a significant role in teachers' perception and interpretation in classrooms. Only one study combines CP and SO, reflecting a lack of focus on the impact of social interactions and cultural contexts on PV. This trend may also suggest a preference for a more individualistic approach to PV, centred on teachers' internal cognitive processes. This highlights the challenge of adopting a broader perspective, which requires integrating social and cultural influences with individual cognitive processes. It is also worth noting that researchers rarely provide explicit explanations for these methodological choices.

4.2 "For whom" (QR.2).

4.2.1 Category of teachers studied

Some key points emerge from the analysis of Table 3.[8]

- Predominance of expert teacher (EE): the majority of studies focus on expert teach-

Table 2 Classification of the studies analysed according to the four main trends (percentages are based on 43 identified theoretical trends)

Trend	Cognitive and psychological (CP)	Socio-cultural (SO)	Disciplinary (DI)	Expertise (EX)
$n=$	22	1	2	18
%	51,16%	2,32%	4,65%	41,86%

[8] Several studies included more than one participant group (e.g., both PSTs and EEs).

Table 3 Occurrence of participant groups (based on these occurrences)

Group in samples	Pre-service teacher	Novice Teacher	Expert teacher	Internal teacher trainer[a]	External teacher trainer (mentor)[b]	Total	Percentage
Pre-service teacher	4	1	6	2	1	14	32.55%
Novice teacher	1	1	5	0	0	7	16.27%
Expert teacher	7	6	8	0	0	19	48.83%
Internal teacher trainer	2	0	0	0	0	2	4.65%
External teacher trainer	1	0	0	0	0	1	2.32%
Total	14	7	19	2	1	43	100%

[a]In-house teacher trainers are trainers specifically attached to the training establishment for Pre-Service Teachers and who carry out their duties there on a regular basis

[b]External' teacher trainers are trainers of Pre-Service Teachers who are not attached to the training establishment (see note 5). For the purposes of this study, this includes placement supervisors. A placement supervisor is an experienced teacher who welcomes, guides and supervises Pre-Service Teachers during their practical placement in a real classroom

ers ($n=19$), reflecting a strong research inclination towards studying PV in those with classroom experience. Gegenfurtner et al. (2023) suggest that these expert teachers offer an optimal model of teaching competencies. Moreover, experience influences teachers' patterns of attention and visual strategies (Keskin et al. 2024), as well as their pedagogical interpretation (Wolff et al. 2016).

- Interest in PST: the second most studied group comprises PST ($n=14$), highlighting an interest in PV during initial teacher training. This focus can be attributed to:
  - PSTs exhibiting less dynamic visual strategies compared to expert teachers (e.g., Duvivier et al. 2024),
  - PSTs focusing on different attention targets (e.g., van Den Bogart, 2013; Cortina et al. 2015), while managing the vast amount of classroom information is considered a challenge for recent graduates.
- Limited studies on novice teacher (NT): NT ($n=7$) are less frequently studied compared to EEs and PSTs, potentially because:
- Limited support for novice teachers restricts their participation in studies (Carpentier et al. 2019).
- Novice teachers, facing reality shock at the beginning of their careers (Lothaire 2021), may be less available or willing to participate in research, unlike EEs who are more established in their routines (Kagan 1992).
- External and internal trainers: studies on external trainers ($n=2$) and internal trainers ($n=1$) are rare, despite their critical role in the development of teachers' professional competencies. Teacher trainers and mentors observe lessons delivered by PSTs and provide feedback (Cohen et al. 2013), aligning their mission closely with PV processes.

4.2.2 Discipline and school subjects

Most studies reported teachers handling few subjects. Across the 29 studies, a total of 65 subject occurrences were identified. Seven involved one subject, six covered two, one cov-

ered three, five covered four, none covered five, and two covered six. Six studies did not specify subject counts, indicating a need for clearer reporting. Although a range of disciplines was examined (Fig. 5), mathematics dominated ($n=19$), a trend that can be attributed to the historical roots of PV research in mathematics education.

4.3 The "How?"

4.3.1 Methodological plans (QR.3.1.)

a) Prevalence and implications of mixed, quantitative, and qualitative methods. The review results of the 29 studies indicate a predominance of mixed methods ($n=16$) over quantitative methods ($n=12$), with no purely qualitative studies. This highlights the value of mixed methods, which leverage the strengths of both quantitative and qualitative approaches to address the two PV processes (noticing and interpreting). For example, Maatta et al. (2021) employed mobile ET to study the gaze patterns of six teachers, combining eye-movement data with verbal recordings. Quantitative methods, on the other hand, assess teachers' visual strategies solely based on eye-movement indicators. In this context, Shinoda et al. (2021) examined the ability of 223 EE and PST to identify inappropriate student behaviours.

b) Group analysis and methodologies. Experimental designs involve either a single group of teachers ($n=12$), two groups ($n=14$), or rarely three groups ($n=1$). When multiple groups are studied, each group follows an identical experimental protocol, enabling

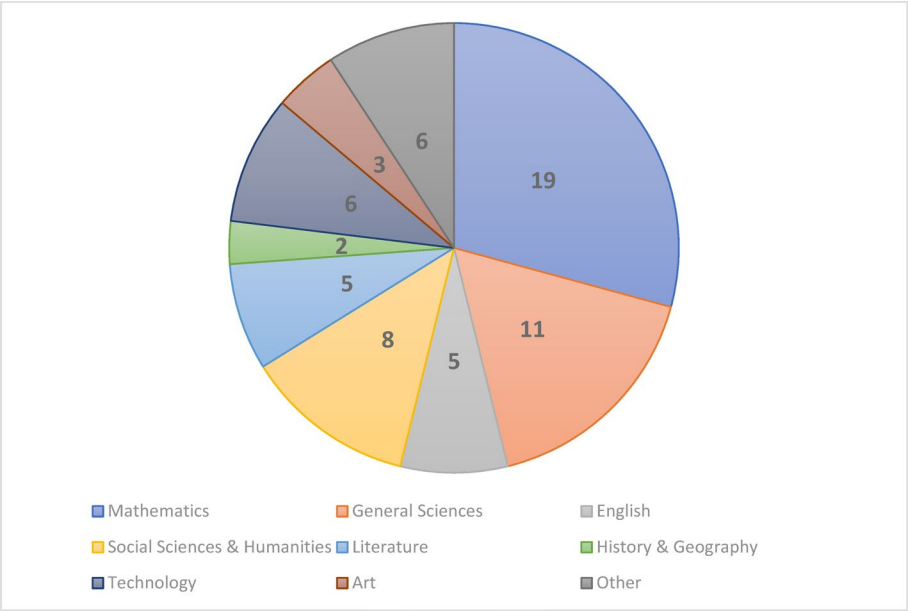

Fig. 5 Distribution of School Subjects by Frequency (Raw Counts, multiple subjects per study possible)

comparison of results between groups. Furthermore, experimental plans[9] primarily include the collection of eye-movement indicators combined eye-movement indicators with think-aloud protocols (TAP) ($n=15$), followed by the collection of eye-movement indicators data alone ($n=10$) (Table 4).

4.3.2 Sample sizes (QR.3.2)

Sample sizes show a wide disparity, ranging from 3 to 76 for EE and from 4 to 147 for PST. This variability reflects the diversity of research contexts and objectives but also raises concerns about the comparability of results.

4.3.3 Eye-movement data analysis (QR.3.3.)

About the type of analysis, and among the 29 studies, 24 conducted a global analysis of teachers' visual strategies, focusing on fixation patterns and key Areas of Interest (AOIs) for the entire video or specific segments. This approach identifies areas where gaze is concentrated, the distribution of visual attention, and general eye movement trends.

Four sequential analyses are presented in the works of McIntyre and Foulsham (2018), Kosel et al. (2021, 2023), and Duvivier et al. (2024). These studies combine global and sequential analysis for part of their data. Unlike Kosel et al. (2021), who used *smi2ogama software* to convert fixations into sequential chains and calculate Levenshtein distances, McIntyre and Foulsham (2018) analysed gaze trajectories based on the first ten eye behaviours.

About the areas of interest, most studies specify the type of eye-movement indicators analysed within AOIs or, more rarely, within Time-Based Objects of Interest (TOIs). Examples include:

- Timing of AOI definition: AOIs are often defined either *a priori* (before data collection) or *a posteriori* (after data collection), though this is often underreported. For example, Chaudhuri et al. (2022) defined AOIs before data collection, while Dessus et al. (2016) defined them after collection using software tools.
- AOI selection strategy: AOIs can be selected through software analysis (Strümer et al., 2017) or using tools such as TDOP+ or CLASS (Dessus et al. 2016; Cortina et al. 2015).

Table 4 Occurrence of methodological plans by type of data (on 29 studies)

Types of data	Occurrence Of methodological plans
OI	10
OI+other	3
TAP	0
TAP+other	0
OI+TAP	15
OI+TAP+other	1

[9] In this section, only the complete experimental plans, as described in the articles, have been taken into account. In other words, the analysis is not limited solely to the published data, but extends to all the experimental protocols detailed in the publications.

Several methodological aspects related to AOIs remain unclear. For example, the definition of AOIs (manual vs software-based) and the verification of their reliability vary. Duvivier et al. (2024) employed multiple coders to define AOIs and calculated a reliability score, which is particularly important for mobile ET videos where teacher movement complicates AOI definition. Additionally, studies often do not specify the shape of AOIs used in data analysis, despite the impact of AOI shape on fixation collection (Papa et al. 2021).

About the types of eye movement indicators and sub-Indicators, fixations dominate the eye, movement indicators used in PV research, appearing in 48 analyses (Table 5). Among their sub-indicators, fixation occurrence within an AOI is most common ($n=25$), followed by fixation duration within an AOI ($n=21$) and chronological transitions between AOIs ($n=6$). These figures underscore fixations as the cornerstone of ET studies on professional vision.

By contrast, saccades are far less frequent, with only 5 occurrences. Researchers most often measure saccade length ($n=3$), while amplitude and direction each appear in just one study. This scarcity likely reflects both a lower priority for saccade metrics in PV research and the greater complexity involved in coding and interpreting saccadic patterns.

"Visit" metrics-capturing how gaze returns to or moves between areas of interest-feature in 10 analyses, distributed across four sub,.

- First view of an AOI/TOI ($n=3$)
- Visits to an AOI/TOI ($n=2$)
- Jumps between AOIs/TOIs ($n=2$)
- Smooth pursuit within an AOI/TOI ($n=1$)

Finally, blinks-the sole "Other" indicator-are reported in 2 studies. Together, these measures illuminate not only where teachers look but also how they interact dynamically with defined observation zones, aligning analytical precision with research objectives.

Although saccades hold significant interest, their usage is limited, with only 5 occurrences reported. *Saccade length* is the most frequently measured parameter ($n=3$), while *amplitude* and *direction* are each mentioned once. This limited frequency likely reflects a lower priority for saccades compared to fixations in the study of PV through ET. The situa-

Table 5 Frequency of use of metrics in analyses (on 29 studies)

Ocular indicator	Numbert of analyses	Number of ocular sub-indicator	Number of works
Fixation	48	Occurrence in an AOI	25
		Duration in an AOI	21
		Chronological transitions between AOIs	6
Saccade	5	Length	3
		Amplitude	1
		Direction	1
Visit	10	Visit count per AOI/TOI	2
		Jumps between AOIs/TOIs	2
		First view of an AOI/TOI	3
		Smooth pursuit within an AOI/TOI	1
Other	1	Blinks	2

tion may also be attributed to the complexity of saccade analysis, which requires advanced coding techniques, particularly during sequential analyses.

About diversity in visit measures, there is a notable variety in visit measures, with a relatively balanced distribution across different subcategories:

- blinking ($n=2$),
- visits to an AOI ($n=2$),
- jumps between AOIs ($n=2$),
- first view of an AOI ($n=3$), and
- smooth pursuit within an AOI ($n=1$).

These measures highlight how EOs "interact" with AOIs, which are often selected based on the study's research objectives.

About statistical use of eye-movement indicators. Eye-movement indicators are frequently employed for statistical analysis, enriching the interpretation of data based on study objectives. Various statistical methods are applied, with three main techniques standing out:

- Gini coefficient: Measures the equity of gaze distribution among participants, ranging from 0 (equal distribution) to 1 (concentration on a single student). This method is useful for evaluating the distribution of attention in classrooms (e.g., Chaudhuri et al., 2021; Cortina et al. 2015; Dessus et al. 2016).
- Wilcoxon test: Used to compare distributions in contexts where data are not normally distributed. It is often combined with ANOVA and the Kruskal–Wallis test for more nuanced analysis (e.g., Strümer et al. 2017; Grub et al. 2022).
- T-test: Applied to compare means between two groups, useful for assessing the impact of different pedagogical interventions on teachers' visual attention (e.g., McIntyre and Foulsham 2018; Duvivier et al. 2024).

4.3.4 Verbal data analysis (QR.3.4.)

Across the 15 reviewed studies on 29, and as referenced by Roussel (2017):

- *Ten studies* implemented a *post-hoc TAP protocol*, often referred to as a stimulated retrospective recall interview. Two of these studies (Cortina et al. 2015; Grub et al. 2022) asked participants to verbalise what they saw on-screen using a timestamp as a reference point.
- *Five studies* employed *simultaneous TAP protocols*, such as Keller et al. (2021), where researchers prompted participants during the process.

These findings suggest a preference for retrospective reflection, where teachers are invited to revisit their actions and thoughts based on what they observed. The use of timestamps indicates a focus on synchronising comments with observed events, improving data reliability. Simultaneous TAPs, although less common, aim to achieve similar goals by capturing real-time thoughts, enhancing the alignment of participants' comments with observed events.

Moreover, ten TAP analysis methods were identified among the reviewed studies. *Content analysis* is the most common approach, often conducted inductively, following the framework of Braun and Clarke (2006; as cited in Braun et al. 2019). For instance:

- Inductive approach: Stahnke and Blömeke (2021) and Hinonen et al. (2023) applied content analysis inductively to uncover patterns and themes from data.
- Deductive approach: Some analyses used theoretical frameworks to classify reasoning types used by participants. For example, Pouta et al. (2021) categorised verbal excerpts into descriptive, evaluative, and interpretive processes.

In rarer cases, verbal data is cross-referenced with the two dimensions of PV: the object observed and the reasoning applied (e.g., Minarikova et al. 2021). Conversely, Wolff et al. (2016) employed a *quantitative method*, measuring the frequency of specific lemmas in participants' verbal reports.

Another point concerns the *integration with Eye-movement data*. Verbal data analysis was integrated with eye-movement data in *9 out of 15 studies*. The remaining publications focused exclusively on eye-movement indicators ($n=3$) or TAPs alone ($n=2$). The literature on integrating eye-tracking data with verbal data remains limited, but two main approaches were identified:

- Systematic and chronological approach: this method aligns participants' verbal statements with their eye-movement data. It provides a detailed understanding of the interaction between gaze and speech, revealing underlying cognitive processes.
- AOI-based and verbal validation approach; this approach identifies the AOIs viewed by participants, followed by interviews to validate the analyses and understand the individual's conscious responses.

These integration techniques highlight the importance of combining both verbal and eye-tracking data to achieve a comprehensive understanding of professional vision processes.

4.4 Media and technological tools used (with what?)

4.4.1 Type of eye-tracker

As shown in Table 7, 12 studies used fixed eye-trackers and 17 used mobile systems, with mobile ET use rising steadily from 2015 onward as devices became more compact and affordable.

Fixed ET-such as the SMI RED 250/500 and Tobii 1750-remain valued for their high precision and sampling rates (up to 250–500 Hz), despite their greater cost and lack of portability. By contrast, mobile systems (e.g. Tobii Pro Glasses 2/3, ASL Mobile Eye Tracker, ViewPoint Eye Tracker¬Æ) typically sample at 30–60 Hz but offer the flexibility to track gaze in authentic classroom settings.

Each ET platform brings its own software strengths:

- Gazepoint GP3HD (mobile) allows rapid drawing of rectangular or oval AOIs.
- SMI BeGaze 3.4 (fixed) supports fine-grained gaze-path visualization and advanced filtering.

These variations underscore the trade-offs researchers face-balancing precision, cost, and ecological validity-when selecting an ET system for professional vision studies.

4.4.2 Types of media

As shown in Table A2, all studies utilize video footage, typically captured in classrooms ($n=25$) and occasionally scripted ($n=2$), reflecting an interest in authentic dynamics. Some videos are reused across multiple studies ($n=5$), highlighting the analytical challenges posed by eye-movement indicators, particularly due to the complexity and volume of eye-movement indicators and sub-indicators.

The type of video varies depending on the ET and research objectives:

- Fixed ET: Videos adopt an objective, "third-person" perspective ($n=12$), focusing on the teacher, the class, one or more students, or a combination of these elements.
- Mobile ET: Videos provide a subjective perspective from the teacher's point of view.

Some protocols ($n=3$) combine ET glasses with objective cameras. However, the motivations and benefits of this approach are rarely detailed, limiting methodological understanding. Clarifying these aspects would help better understand the methodological justifications and facilitate more precise replication of studies.

Video durations range from less than a minute to 55 min, raising the issue of "analysis granularity." Short videos enable detailed analysis but may lack sufficient context, while longer videos offer a broader overview but risk obscuring critical details. Balancing these considerations is crucial for effective analysis and interpretation.

5 Conclusion

PV—which can be understood as a form of professional observation in a school setting is teachers' capacity to focus on and interpret classroom cues (Van Es & Sherin 2008; Vifquin & Frenay 2018). Effective teaching demands filtering a torrent of information to act on critical cues; ET reveals this "teacher's gaze" objectively, overcoming fragmented frameworks and subjective methods.

To address them, we conducted an integrative and thematic review of 29 studies to identify major methodological trends with the findings forming the basis for the recommendations presented in this section of the article. The findings highlight that protocols favour the use of videos, both objective and subjective, in ecological contexts to capture real teaching dynamics, despite the utility of scripted videos for precise control of variables. Another key point is the notable variability in protocols across several aspects, such as research topics, sample sizes, taught disciplines, teaching levels, and video durations. These methodological differences often reflect the specific objectives of the studies, while underscoring the

need for further consideration on how to standardise approaches to improve cross-study comparability.

Several gaps in the current literature warrant attention in future research, along with corresponding recommendations:

- Theoretical frameworks: PV research is primarily grounded in the framework of Van Es and Sherin (2008). To enrich and broaden this understanding, researchers could draw on other theoretical perspectives that remain underrepresented, particularly those of Goodwin, Koschmann, and Lindwall, in order to anchor PV within a situated, socio-cultural approach *supported by ethnographic methods* (e.g., *combining mobile ET with micro-ethnographic analysis of classroom interaction*).
- Verbal data analysis: A synchronised, mixed-methods approach is essential to align verbal and visual data. Simultaneous TAPs could strengthen this integration, while distinctions between interviews and Stimulated Recall Interviews remain unclear. Since only nine of fifteen studies combine ET and verbal data, current designs capture noticing but only partially reveal reasoning, offering an incomplete view of PV.
- Inclusion of teacher trainers: Studies often compare PV in EE and PST. However, teacher trainers are rarely studied, despite their central role in observation and feedback for PSTs. Including trainers could offer richer insights into PV in initial teacher training.
- Sample sizes and inclusion of students: The wide variation in sample sizes complicates result comparisons and is a major challenge for meta-synthesis. Additionally, including students in PV research could provide valuable perspectives on their perceptions of teaching dynamics and the elements that capture their attention. Comparing teachers' and students' visual observations might reveal necessary adjustments in teaching strategies.
- Familiarisation with ET tools: Few protocols include an active phase of familiarisation with ET equipment. Investigating whether this phase improves the experience and data quality for EOs would be worthwhile.
- Expansion of eye-movement indicators and analysis techniques: Studies on PV mainly focus on fixations as eye-movement indicators, which reflects a narrow view of teachers' visual strategies. Expanding analyses to include other indicators, such as saccades, scanpaths, and gaze dynamics, could provide a more holistic understanding of how teachers visually explore and interpret classroom scenes. While global analysis is commonly preferred, sequential analyses hold significant potential for examining the coherence of gaze movements.
- AOIs and ET software: Ambiguities remain regarding the shape, definition, attribution, and impact of ET software on AOIs are a central methodological flaw in the literature. The absence of clear reporting standards severely hinders cross-study comparability and replication.Clarifying these aspects could enhance the comparability and understanding of studies, particularly those involving mobile ET videos.
- Double-blind coding: Coding of videos, AOIs, or verbal data is rarely conducted with a double-blind approach. Adopting this method and systematically reporting inter-rater reliability scores would strengthen the credibility and rigour of results, reducing potential biases in data interpretation.

In conclusion, while ET proves invaluable in studying PV, it is crucial to clarify methodologies to enhance result comparability and minimise biases introduced by varied approaches. By addressing these gaps, the field can achieve greater consistency and reliability in its findings.

6 Discussion

In this discussion, we highlight challenges and opportunities beyond methodology—assuming each protocol suits its objectives and materials. Three cross-cutting themes emerge:

First, studies use video ranging from one-minute clips to 45-min segments, covering routine lessons and unexpected incidents. These "peculiarities" shape observations and complicate direct comparisons across studies. This variation also raises the issue of analysis granularity, illustrating the fundamental trade-off between experimental control achieved with short, scripted clips and ecological validity offered by longer, authentic lessons.

Second, research focuses solely on visual aspects of PV, yet teachers also draw on auditory, gestural, and contextual cues. Duvivier's (2025) BRRA model[10] exemplifies this richness: like those with "eyes in the back of their heads," teachers integrate multiple information channels (withitness). This visual focus thus constitutes a key limitation of the reviewed studies—and of this review—since PV inherently exceeds what ET alone can capture. Furthermore, the quality of the studies included in the literature remains uneven and is rarely discussed in the field. This constitutes a limitation of the present review. This methodological gap may also explain the heterogeneity observed across protocols and the varying levels of transparency in reporting practices.

Finally, AOI selection and eye-movement analysis are guided by researchers' theoretical frameworks. Examining these filters—by profiling researchers' self-efficacy, epistemic beliefs, and metacognitive strategies—and transparently detailing AOI definitions and coding schemes would improve clarity. Researcher training in ET and practical methodological guidance also demand attention.

Future research could explore dual teacher–student eye-tracking to capture attentional coupling during instruction (Duvivier 2025) (see Dessus 2022). This approach would reveal how teachers adjust their gaze in response to students while raising methodological challenges of synchronising gaze streams and defining shared AOI.

Considering both methodological and broader dimensions will help ET research build more robust knowledge while staying grounded in classroom complexity.

Appendix

See Tables 6 and 7.

[10] For a detailed discussion of the multimodal BRRA model and its implications for analysing teachers' professional vision, see Duvivier (2025).

Table 6 Key dimensions and research questions (detailed)

Key dimensions	Research question
What?	In studies on PV using ET, what theoretical frameworks are employed according to the classification by König et al. (2022)?
From Whom?	In studies on PV using ET, what are the characteristics of the teachers in terms of (a) teacher categories, (b) teaching cycles, (c) subjects taught, and (d) cultural contexts?
How?	In studies on PV using ET, how are data collected and analysed ? QR3.1: What methodological plans are implemented in terms of: a) prevalence and implications of mixed, quantitative, and qualitative methods, b) groups and methodologies QR.3.2. What are the sample sizes? QR.3.3. How is eye-tracking data analysed in terms of: a) type of analysis, b) AOIs, c) eye-movement indicators, and d) statistical methods in PV studies using ET? QR.3.4. How are verbal data analysed?
With what?	In studies on PV using ET, what media, tools, and metrics are used to study PV? QR.4.1. What types of media and their characteristics are used in PV studies employing ET? QR.4.2.What type of ET (fixed or mobile) and sampling frequencies are prioritised in PV studies using ET?

Table 7 Works selected for our review, classified by publication date

No	References	Country	Publication type	Topic	Year	Controlled	Natural	Fixed ET	Mobile ET	Eye-tracker type	Sampling (Hz)
1	Yamamoto et al.	Japan	Journal article	Detecting students' misbehavior	2013	X		X		2 eye trackers (Tobii T60 & T120)	60
2	Van De Bogert et al.	The Netherlands	Journal article	Visual perception of classroom events	2014	X	–	X	–	Tobii 1750	15
3	Cortina et al.	United States	Journal article	Teacher's gaze direction during a lesson	2015	–	X	–	X	ASL Mobile Eye Tracker	Not specified
4	Dessus et al.	France	Conference proceedings	Teachers' perception of student behavioral signals	2016		X	–	X	ASL Mobile Eye Tracker	Not specified
5	Wolff et al.	The Netherlands	Journal article	Detecting and managing critical incidents (classroom management)	2016	X	–	X	–	SMI remote	250
6	McIntyre & Foulsham	UK & China	Journal article	Teachers' gaze pathways and cultural influences	2017		X	–	X	Tobii 1.0	30

Table 7 (continued)

No	References	Country	Publication type	Topic	Year	Controlled	Natural	Fixed ET	Mobile ET	Eye-tracker type	Sampling (Hz)
7	Strümer et al.	Germany	Journal article	Attention processes based on classroom objects	2017	X	X	–	X	SMI-Senso-Motoric Instruments	Not specified
8	Huang	United States	Thesis	Relationship between teacher expertise and gaze movements in real classroom situations	2018						
9	Pouta et al.	Finland	Journal article	Visual attention, interpretation, and professional gestures to aid understanding of fractions	2021	–	X	–	X	Tobii Pro Glasses 2	50

Table 7 (continued)

No	References	Country	Publication type	Topic	Year	Controlled	Natural	Fixed ET	Mobile ET	Eye-tracker type	Sampling (Hz)
10	Keller et al.	United States	Journal article	Detecting and evaluating teaching strategies including professional gestures	2021	–	X		X	ASL Mobile Eye Tracker	Not specified
11	Kosel et al.	Germany	Journal article	Teachers' gaze pathways	2021	X		X		SMI BeGaze 3.4	500
12	Minarikova et al.	Czech Republic	Journal article	Professional vision: teachers' gaze during and after teaching	2021	X	X	X	X	SMI wireless & SMI RED250	60
13	Seidel et al.	Germany	Journal article	Teachers' diagnostic skills observing student engagement	2021	X	–	X	–	SMI RED 500	500
14	Shinoda et al.	Japan	Journal article	Detecting off-task student behaviors in class	2021	X	–	X	–	Tobii T60	Not specified

Table 7 (continued)

No	References	Country	Publication type	Topic	Year	Controlled	Natural	Fixed ET	Mobile ET	Eye-tracker type	Sampling (Hz)
15	Stahnke & Blömeke	Germany	Journal article	Perception of classroom events: perception, interpretation, and decision-making	2021	X		X		Not specified	Not specified
16	Wyss et al.	Switzerland	Journal article	Detecting critical incidents in class (classroom management)	2021	X	–	X	–	GazePoint GP3HD	60
17	Grub et al.	Germany	Journal article	Teachers' perception and reaction in classroom management by expertise	2021	X	–	X	–	Tobii Pro	250
18	Goldberg et al.	Germany	Journal article	Detecting student task engagement	2021		X	–	X	Not specified	

Table 7 (continued)

No	References	Country	Publication type	Topic	Year	Controlled	Natural	Fixed ET	Mobile ET	Eye-tracker type	Sampling (Hz)
19	Huang et al.	United States	Journal article	Relationship between teacher expertise and gaze movements in real classroom situations	2021		X	–	X	ASL Mobile Eye Tracker	30
20	Schnitzler et al.	Germany	Journal article	Evaluating students' motivational and cognitive engagement characteristics	2021	X		X		SMI RED 500	500
21	Määttä et al.	Finland	Journal article	Teachers' visual targets at lesson opening	2021		X	–	X	Not specified	30
22	Chaudhuri et al	Finland	Journal article	Influence of stress on teachers' attention	2021		X	–	X	Tobii Pro 2	25

Table 7 (continued)

No	References	Country	Publication type	Topic	Year	Controlled	Natural	Fixed ET	Mobile ET	Eye-tracker type	Sampling (Hz)
23	Van Driel et al.	The Netherlands	Journal article	Interactive cognitions of novice and experienced teachers	2022		X	–	X	SMI glasses	60
24	Duvivier et al.	Belgium	Journal article	Detecting off-task students and incidents (in progress)	2023	X			X	GazePoint GP3HD	150
25	Hinonen et al.	Finland	Journal article	Interpreting pedagogical incidents and misconceptions about professional gestures	2023	X			X	Tobii Pro Spectrum	50
26	Kaminsky et al.	Lithuania	Journal article	Professional vision and professional reasoning	2023			X		Tobii Pro Glasses 3	100

Table 7 (continued)

No	References	Country	Publication type	Topic	Year	Controlled	Natural	Fixed ET	Mobile ET	Eye-tracker type	Sampling (Hz)
27	Kosel et al	Germany	Journal article	Teachers' visual attention to students raising their hands	2023	X		X		SMI RED 500	500
28	Muhonen et al.	Finland	Journal article	Teachers' visual interaction during exchanges with students	2023		X	–	X	Tobii Pro Glasses 2	50
29	Byeon & Kwon	South Korea	Journal article	Classroom scanning to maintain interaction with students	2023		X	–	X	Goggle-style View-Point Eye Tracker®	60

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