

Pre-service teachers' visual attention to student performance in physical education classes: Insights from eye-tracking technology

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Abstract:

Introduction: Visual attention is critical for effective teaching, particularly in Physical Education, where monitoring motor competence and classroom behaviour is essential. Despite extensive research on teacher gaze in pedagogical context, the visual behaviour of Physical Education teachers in dynamic movement settings remains underexplored. **Objective:** This study examined how pre-service Physical Education teachers allocate their visual attention when observing students' motor performance and off-task behaviour, using mobile eye-tracking technology. **Methodology:** A sample of first-year Physical Education teacher trainees observed a video-recorded 9th grade class while wearing Tobii Pro Glasses 3. Two motor tasks (closed-skill circuit and open small-sided game) were analysed for fixation patterns. Students' motor competence was assessed via teacher rating, while off-task behaviour was identified through post-viewing questionnaire. **Results:** Pre-service teachers exhibited stronger visual attention toward students with lower motor competence during the closed task, with significant differences between competence levels. No such correlations emerged during the open task. Despite longer fixations on on-task students, off-task behaviour identification accuracy was low, with no significant gaze-behaviour correlations. **Discussion:** Findings highlight task-dependent effects, aligning with cognitive load theory, as pre-service teachers prioritised salient cues in structured tasks but struggled in dynamic environments. The discrepancy between gaze patterns and off-task identification underscores a gap in translating visual attention into effective classroom management, contrasting with expert teachers' integrated professional vision. **Conclusions:** This study underscores the need for targeted training to enhance pre-service teachers' dual-focused attention in Physical Education. Integrating eye-tracking feedback into teacher education could scaffold skill observation and behaviour monitoring, bridging the expert-novice gap.

Key Words: Eye-tracking; learning; motor competence; off-task behaviour; school; teacher training.

Introduction

The role of teachers' visual attention in the teaching-learning process has gained increasing interest in the educational area of research (Li et al., 2024). Several studies indicated that the way they distribute their visual focus can significantly impact their instructional effectiveness (Chaudhuri et al., 2022; Mendes et al., 2025).

Understanding teachers' gaze behaviour is particularly important in practical subjects such as Physical Education, by providing valuable insights into how they attend to students' actions, assess their performance and manage classroom engagement (Smidekova et al., 2020). In this context, eye-tracking technology has emerged as a powerful tool to study teachers' visual behaviour, offering objective data on where and for how long they direct their attention (Sadamatsu, 2023).

Previous research has investigated, not only in-service teachers' visual behaviour during classes, but also how pre-service teachers allocate their visual attention, especially when observing student performance through video-based scenarios (Stahnke & Blömeke, 2021). Indeed, pre-service teachers are at a crucial stage in their professional development, as they refine their pedagogical skills and learn to interpret classroom dynamics effectively (Hinojosa-Torres et al., 2025). Their ability to notice and respond to key elements of student performance is fundamental to their future teaching effectiveness (Barnhart et al., 2024).

On the other hand, motor competence and student engagement are central. As the former is a key indicator of learning and progression and reflects the effectiveness of instructional strategies, teachers must continuously and efficiently assess students' movements to provide appropriate feedback and adapt teaching methods accordingly (Han et al., 2022). At the same time, managing student engagement is critical, as off-task behaviour can disrupt learning and reduce instructional time, being important to monitor and identify instances of off-task behaviour (Zulfqar et al., 2025). The ability to focus on relevant aspects of student performance while avoiding distractions is essential for promoting meaningful learning experiences (Wyss et al., 2023). However, the extent to which pre-service teachers prioritise student motor competence or classroom management aspects (e.g., off-task behaviour) remains an open question (Gabel et al., 2025).

Eye-tracking studies in education have primarily examined teachers' visual behaviour in classroom settings, with findings indicating that expert teachers tend to allocate their gaze more efficiently than novices, focusing on critical aspects of student learning and behaviour (Kosel et al., 2021). In contrast, novice teachers often exhibit a more scattered gaze pattern, potentially missing key instructional cues. This discrepancy highlights the importance of structured training to enhance visual attention and decision-making skills among pre-service teachers (Daumiller et al., 2025). Furthermore, the use of video-based methodologies has gained prominence in teacher education, allowing trainees to observe and analyse classroom scenarios in a controlled manner. Video-based eye-tracking offers a unique opportunity to examine how pre-service teachers process visual information and what aspects of student performance they prioritise when not actively engaged in teaching (Duvivier et al., 2024). Understanding how pre-service teachers visually attend to these two dimensions - motor competence and off-task behaviour - can inform teacher training programmes, helping to develop targeted interventions that improve their observational and analytical skills (Gabel et al., 2023). Hence, mobile eye-tracking technology provides an innovative approach to studying visual behaviour in dynamic environments. Unlike static or laboratory-based eye-tracking systems, mobile eye-tracking allows for more naturalistic data collection, capturing real-time gaze patterns in educational settings (Telgmann & Müller, 2023).

In Physical Education, motor competence is defined as the proficiency to execute a wide range of motor tasks, including gross and fine motor skill coordination, movement quality and control (Estevan et al., 2021; Lorås, 2020). Conversely, off-task behaviour refers to student conduct that is disengaged and unrelated to the ongoing learning task (Ludyga et al., 2022; Broad et al., 2023). The teachers' ability to monitor these elements simultaneously is a hallmark of professional vision - the integrated capacity to notice and interpret significant classroom events (Stahnke & Blömeke, 2021). Recent publications (e.g., Hinojosa-Torres et al., 2025) have further highlighted the importance of real-time feedback and practical interventions in Physical Education teacher training, underscoring the relevance of the present study.

Although eye-tracking research on teacher noticing has proliferated in classroom settings (Stahnke & Blömeke, 2021; Kosel et al., 2021), its application to dynamic, movement-based subjects like Physical Education remains scarce. A review of the literature revealed no prior studies in Physical Education addressing this specific topic, underscoring the innovative nature of this research (Mendes et al., 2025). This is particularly evident concerning pre-service teachers, whose developing professional vision requires investigation in ecologically valid contexts. To bridge this methodological and contextual gap, our study aimed to analyse pre-service teachers' visual behaviour on student performance in Physical Education classes using mobile eye-tracking technology. We applied this device to investigate pre-service teachers' visual behaviour while watching a video recording of a Physical Education class with students in the 9th grade, from the 3rd Cycle of Portuguese Basic Education, in order to 1) analyse the association between pre-service teachers' visual behaviour and the motor competence level of observed students in both closed and open motor tasks, 2) compare pre-service teachers' visual attention towards students exhibiting on-task versus off-task behaviour and 3) examine the relationship between pre-service teachers' visual attention patterns and their accuracy in identifying students displaying off-task behaviour. By analysing their gaze patterns, we seek to understand the perceptual and cognitive processes when observing student performance and the different aspects pre-service teachers prioritise visually. We hypothesise a statistically significant correlation between their visual attention distribution and student performance, predicting increased fixation on students demonstrating both lower motor competence (Chaudhuri et al., 2022) and greater off-task behaviour (Shinoda et al., 2021).

Material & methods

Research Design

This study followed an observational design with a correlational-causal approach. We employed mobile eye-tracking technology to examine the association between pre-service teachers' visual behaviour (dependent variables) and specific student characteristics - namely, motor competence level and engagement behaviour (independent variables). The design allowed for the measurement of gaze patterns in response to standardised video stimuli.

Participants

The sample included 30 pre-service teachers [7 female, 23 male; average 22.37 years (standard deviation - SD - ± 1.38)] enrolled in the first year of a Portuguese master's programme for the initial training of Physical Education teachers for primary and secondary education.

Participants were selected randomly via purposive sampling, representing a specific cohort at a crucial stage of their professional development where foundational observational skills are being formed. The sample size is consistent with previous eye-tracking research in teacher education employing similar methodological and analytical approaches (e.g., Kosel et al., 2021), providing a robust basis for the correlational and comparative analyses conducted.

This study has been approved by the Ethics Committee of the Faculty of Sports Sciences and Physical Education, University of Coimbra (reference CE/FCDEF-UC/00142024) and was conducted in accordance with the principles outlined in the Helsinki Declaration and the Oviedo Convention regarding research involving human subjects. Furthermore, all participants provided written informed consent.

Instruments

Video camera

A video camera with a recording capacity of up to 60 fps (Hirotaka et al., 2022) was used to film two motor practice tasks during a Physical Education class (Kosel et al., 2021).

Motor competence level assessment scale

To assess 9th grade students' motor competence level during the didactic unit taught in the recorded class, a 6-point Likert scale was used, ranging from “*Very low performance*” to “*Very high performance*” (Holler & Schübler, 2024).

Eye-tracker glasses

Pre-service teachers' visual behaviour across areas of interest (AOI) was collected using Tobii Pro Glasses 3 and analysed with Tobii Pro Lab software, version 1.207.

Off-task behaviour identification questionnaire

Off-task behaviours were identified through a two-step procedure: i) participants were asked, “*Do you know which students displayed off-task behaviours?*”; ii) for affirmative responses, they were then presented with a photograph of the 9th grade class during the task and asked to identify specific students (“*Which ones?*”) (Yamamoto & Imai-Matsumura, 2013; Shinoda et al., 2021).

Procedure

The study design was conducted in two phases:

First phase

A 60-fps video camera recorded a 1-minute segment of an authentic 9th grade Physical Education class (Shinoda et al., 2021; Hirotaka et al., 2022). Following Goldberg et al. (2021) and Kosel et al. (2021), the recording captured two motor practice moments from a football didactic unit:

i) closed task: ball control circuit (dribbling, passing and receiving); ii) open task: small-sided game (2x2). The observed class and the didactic unit were selected in collaboration with the responsible teacher, considering both the academic calendar and the annual curriculum planning, particularly the distribution of content across available school facilities.

Following the class, the teacher (an experienced tenured teacher with 36 years of service) was instructed to complete the *Motor competence level assessment scale* to evaluate students' motor competence in the football didactic unit (Holler & Schübler, 2024). Motor competence was defined as the ability to proficiently execute a wide range of motor tasks, including both fine and gross motor skill coordination, along with movement quality and control (Estevan et al., 2021; Lorås, 2020). The students' motor competence was assessed by their regular teacher, who possessed an in-depth, longitudinal understanding of their abilities. This approach was adopted to maximise ecological validity, as it directly mirrors the typical assessment context in school settings.

Second phase

Aligned with Kosel et al. (2021) and Shinoda et al. (2021), pre-service teachers viewed the video once on a computer screen (1920 × 1080-pixel resolution) while wearing Tobii Pro Glasses 3 eye-trackers (Tobii Pro AB, 2014) to record their visual behaviour. The associated cameras captured eye movements and tracked pupil position continuously, determining gaze direction. Gaze measurement followed standardised procedures: i) participants were seated approximately 60 cm from the eye-tracker, with height adjusted to centre their eye position on the screen; ii) after calibration using a target point, participants received instructions about the recorded 9th grade Physical Education class, including football instructional unit details (lesson number and didactic purpose) and key lesson components (tasks, critical elements and success criteria). A 3-second central fixation cross (“+”) appeared before both video segments began, in order to fixate participant’s gaze (Shinoda et al., 2021).

Our analysis employed the fixation metrics established by Holmqvist et al. (2015), with individual fixations typically ranging between 200-300 milliseconds (ms) in duration. Following systematic coding of eye-tracking data to assess pre-service teachers' visual attention patterns, we extracted three key metrics per participant: total fixation duration, average fixation duration, and fixation count. Both total and average fixation durations were recorded in ms, while fixation counts were quantified as discrete integers (Gegenfurtner et al., 2011; Holmqvist et al., 2015; Chaudhuri et al., 2022).

Following the video visualisation, pre-service teachers received a definition of off-task behaviour (disengaged conduct unrelated to the ongoing learning task) (Ludyga et al., 2022; Broad et al., 2023). Subsequently, they completed the aforementioned *Off-task behaviour identification questionnaire* to detect

students exhibiting such behaviours (previously identified) (Yamamoto & Imai-Matsumura, 2013; Shinoda et al., 2021).

Variables

Independent variables

The independent variables comprised: (1) the motor competence level of 9th grade students, (2) their observed off-task behaviour, and (3) pre-service teachers' identification of off-task students (Shinoda et al., 2021).

Dependent variables

The dependent variables comprised the distribution of Physical Education pre-service teachers' visual behaviour, including the number of fixations, total fixation duration (ms) and average fixation duration (ms) on areas of interest (AOI) corresponding to 9th grade students (Chaudhuri et al., 2022).

Data analysis

For data analysis, AOI were designated for each 9th grade student (AOI1 to AOI8). Each AOI was defined using Tobii Pro Lab software (version 1.207) by outlining the students. The number of fixations, as well as the total and average duration of fixations on each AOI, were recorded.

To analyse the association between Physical Education pre-service teachers' visual behaviour variables and the observed class's motor competence level, Spearman's rank correlation coefficient (r) was used, as well as to assess the relationship between visual patterns and disruptive behaviour for each of the two motor practice moments and between participants' identification of off-task 9th grade students and their gaze behaviour. The strength of the correlations was classified based on Tabachnick and Fidell (2021): weak ($r < 0.3$), moderate ($0.3 \leq r < 0.5$) and strong ($r \geq 0.5$).

Differences in pre-service teachers' visual attention across class motor competence levels were evaluated using a one-way ANOVA (Kroes & Finley, 2023). Eta squared (η^2) effect size was interpreted as weak ($\eta^2 < 0.06$), moderate ($0.06 \leq \eta^2 < 0.14$), or strong ($\eta^2 \geq 0.14$).

For comparisons between the two pre-service teacher groups regarding noticing students' off-task behaviour, an independent samples T-test was conducted after verifying normality assumptions, as well as to assess gaze patterns toward 9th grade students based on their behaviour during both motor practice moments (Pallant, 2020). Cohen's d effect size was classified as: weak ($d < 0.2$), moderate ($0.2 \leq d < 0.5$), strong ($0.5 \leq d < 0.8$) and very strong effect ($d \geq 0.8$). This analysis compared visual behaviour metrics categorised by student task engagement within the same participant cohort.

All statistical analyses were performed using IBM SPSS Statistics (version 29; Armonk, NY, USA) at a 5% significance level (p).

Results

The results presented are organised according to the objective and subcategories of analysis.

Pre-service teachers' visual behaviour and observed motor competence level

The analysis of the Physical Education pre-service teachers' visual behaviour variables and the observed class's motor competence level (Sufficient, High and Very high) revealed several statistically significant findings, as detailed in Table 1 and Table 2.

In task 1, significant differences were observed in all visual behaviour variables, with greater focus on the lowest level of motor competence. The total fixation duration exhibited a strong negative correlation ($r = -.270$, $p = .001$) with motor competence levels, classified as weak in strength. Additionally, the one-way ANOVA indicated significant differences ($p = .001$) between the Sufficient level and both the High and Very high levels, with a strong effect size ($\eta^2 = .201$). Similarly, the average fixation duration showed a weak negative correlation ($r = -.133$, $p = .039$) and significant differences between Sufficient and higher competence levels ($p = .001$), though the effect size was moderate ($\eta^2 = .076$). The number of fixations also demonstrated a weak negative correlation ($r = -.158$, $p = .014$) and significant differences ($p = .001$) with a moderate effect size ($\eta^2 = .109$).

Table 1. Statistical correlation - Visual behaviour and Students' motor competence level (Sufficient, High and Very high).

Task	Visual behaviour	Sufficient	High	Very high	Correlation	
		Average SD	Average SD	Average SD	P valueR	ES
Task 1	Total fixation duration (ms)	4101.82 ± 1936.40	2000.17 ± 1338.74	2455.35 ± 1543.20	.001*	-.270 Weak
	Average fixation duration (ms)	684.08 ± 458.78	440.90 ± 278.97	493.41 ± 258.52	.039*	-.133 Weak
	Number of fixations	6.67 ± 2.85	4.03 ± 2.72	4.96 ± 2.69	.014*	-.158 Weak
Task 2	Total fixation duration (ms)	1505.83 ± 1195.58	1576.15 ± 1227.30	1581.35 ± 1363.66	.972	-.002 Weak
	Average fixation duration (ms)	349.77 ± 231.96	394.30 ± 314.94	356.47 ± 269.28	.832	-.014 Weak
	Number of fixations	4.02 ± 2.84	3.90 ± 2.74	3.87 ± 2.70	.864	-.011 Weak
Total	Total fixation duration (ms)	5607.65 ± 2558.81	3576.32 ± 2089.61	4036.70 ± 2434.79	.004*	-.185 Weak
	Average fixation duration (ms)	549.72 ± 238.19	435.68 ± 201.03	449.33 ± 192.54	.039*	-.133 Weak
	Number of fixations	10.68 ± 4.21	7.93 ± 4.38	8.82 ± 4.52	.093	-.109 Weak

*Significant correlation, $p < .05$.

In task 2, visual behaviour is somewhat similar across different levels of motor competence. In contrast to the associations observed in relation to task 1, with significant differences and moderate to strong effect sizes, in task 2, no significant correlations or differences were found in any visual behaviour variables (total fixation duration: $r = -.002$, $p = .972$; average fixation duration: $r = -.014$, $p = .832$; number of fixations: $r = -.011$, $p = .864$), with weak effect sizes ($\eta^2 \leq .004$) and non-significant relationship p-values ($p \geq .609$).

Table 2. Statistical comparison - Visual behaviour and Students' motor competence level (Sufficient, High and Very high).

Task	Visual behaviour	Sufficient	High	Very high	Comparison		
		Average SD	Average SD	Average SD	P value	N ²	ES
Task 1	Total fixation duration (ms)	4101.82 ± 1936.40	2000.17 ± 1338.74	2455.35 ± 1543.20	.001 ^{ab}	.201	Strong
	Average fixation duration (ms)	684.08 ± 458.78	440.90 ± 278.97	493.41 ± 258.52	.001 ^{ab}	.076	Moderate
	Number of fixations	6.67 ± 2.85	4.03 ± 2.72	4.96 ± 2.69	.001 ^{ab}	.109	Moderate
Task 2	Total fixation duration (ms)	1505.83 ± 1195.58	1576.15 ± 1227.30	1581.35 ± 1363.66	.929	.001	Weak
	Average fixation duration (ms)	349.77 ± 231.96	394.30 ± 314.94	356.47 ± 269.28	.609	.004	Weak
	Number of fixations	4.02 ± 2.84	3.90 ± 2.74	3.87 ± 2.70	.941	.001	Weak
Total	Total fixation duration (ms)	5607.65 ± 2558.81	3576.32 ± 2089.61	4036.70 ± 2434.79	.001 ^{ab}	.095	Moderate
	Average fixation duration (ms)	549.72 ± 238.19	435.68 ± 201.03	449.33 ± 192.54	.003 ^{ab}	.047	Weak
	Number of fixations	10.68 ± 4.21	7.93 ± 4.38	8.82 ± 4.52	.002 ^{ab}	.050	Weak

^aSignificant differences between Sufficient and High levels, $p < .05$; ^bSignificant differences between Sufficient and Very high levels, $p < .05$; ^cSignificant differences between High and Very high levels, $p < .05$.

When considering the total scores across both tasks, the total fixation duration displayed a weak negative correlation ($r = -.185$, $p = .004$) and significant differences between Sufficient and higher competence levels ($p = .001$), with a moderate effect size ($\eta^2 = .095$). While these correlations are statistically significant, their weak strength suggests that the relationship between visual attention and motor competence, as well as with students' behaviour described below, though observable, may be one of several factors influencing gaze patterns. The average fixation duration showed a weak negative correlation ($r = -.133$, $p = .039$) and significant differences ($p = .003$), albeit with a weak effect size ($\eta^2 = .047$). The number of fixations did not yield a significant correlation ($r = -.109$, $p = .093$) but exhibited significant differences ($p = .002$) with a weak effect size ($\eta^2 = .050$).

Pre-service teachers' visual behaviour towards students' on-task and off-task behaviour

The analysis of gaze patterns in relation to student behaviour (off-task vs on-task) during the two motor practice moments revealed distinct trends, with on-task behaviours having a higher volume of fixation, as summarised in Table 3.

In task 1, the total fixation duration exhibited a weak but statistically significant positive correlation with behaviour ($r = .154$, $p = .017$), indicating marginally longer fixations during on-task episodes. The T-test confirmed significant differences between off-task ($M = 1970.60 \pm 1224.21$ ms) and on-task ($M = 2864.97 \pm 1829.71$ ms) conditions ($p = .001$), with a strong effect size ($d = -.506$). For average fixation duration, no significant correlation emerged ($r = .111$, $p = .087$), and group differences were non-significant ($p = .088$, $d = -.334$, moderate effect). The number of fixations also showed no correlation ($r = .060$, $p = .357$) or significant group differences ($p = .292$, $d = -.206$, moderate effect).

Table 3. Statistical correlation and comparison - Visual behaviour and Students' behaviour (Off-task and On-task).

Task	Visual behaviour	Off-task	On-task	Correlation			Comparison		
		Average SD	Average SD	P value	R	ES	P value	D	ES
Task 1	Total fixation duration (ms)	1970.60 1224.21	± 2864.97 1829.71	± .017*	.154	Weak	.001 ^a	-.506	Strong
	Average fixation duration (ms)	429.93 ± 280.63	541.95 ± 341.75	.087	.111	Weak	.088	-.334	Moderate
	Number of fixations	4.63 ± 3.01	5.23 ± 2.87	.357	.060	Weak	.292	-.206	Moderate
Task 2	Total fixation duration (ms)	988.80 ± 625.77	1642.94 ± 1334.40	.020*	.150	Weak	.001 ^a	-.515	Strong
	Average fixation duration (ms)	375.73 ± 272.74	362.61 ± 272.92	.888	-.009	Weak	.806	.048	Weak
	Number of fixations	2.57 ± 1.57	4.10 ± 2.82	.005*	.180	Weak	.001 ^a	-.571	Strong

*Significant correlation, $p < .05$; ^aSignificant differences, $p < .05$.

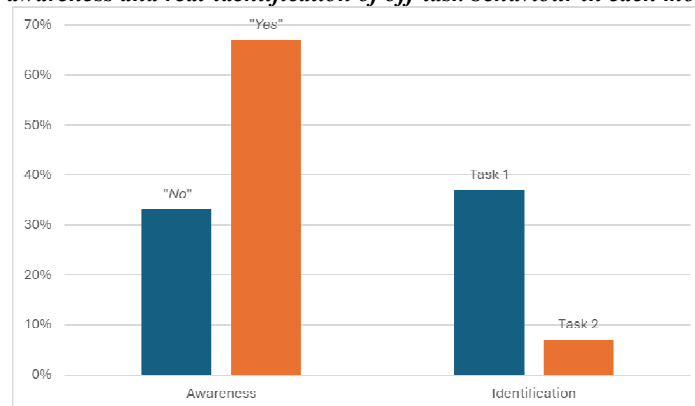
For task 2, the total fixation duration again demonstrated a weak positive correlation ($r = .150$, $p = .020$) and significant differences between off-task ($M = 988.80 \pm 625.77$ ms) and on-task ($M = 1642.94 \pm 1334.40$ ms)

behaviours ($p = .001$, $d = -.515$, strong effect). The average fixation duration revealed no correlation ($r = -.009$, $p = .888$) or group differences ($p = .806$, $d = .048$, weak effect). The number of fixations correlated weakly but significantly with behaviour ($r = .180$, $p = .005$), with fewer fixations during off-task ($M = 2.57 \pm 1.57$) versus on-task ($M = 4.10 \pm 2.82$) episodes ($p = .001$, $d = -.571$, strong effect).

Pre-service teachers' visual attention patterns and off-task behaviour identification

This study also examined the relationship between teachers' visual attention patterns and their ability to identify off-task behaviours in 9th grade students during motor practice exercises. The results are presented in two parts: (1) self-reported awareness and identification of off-task behaviours (Fig. 1), and (2) statistical analysis of gaze behaviour metrics (Table 4).

Fig. 1. Self-reported awareness and real-identification of off-task behaviour in each motor practice exercises.



Source: Off-task behaviour identification questionnaire.

The questionnaire data revealed distinct patterns in teachers' awareness and actual identification of off-task behaviours (Fig. 1). While a significant proportion of teachers reported awareness of off-task behaviours (67%), the accuracy of their subsequent identification was notably lower (task 1 - 37%; task 2 - 7%).

Statistical analysis of gaze metrics (Table 4) showed no significant differences in visual attention patterns between instances where teachers reported off-task behaviours ("Yes") versus those where they did not ("No").

Table 4. Statistical correlation and comparison - Visual behaviour and Off-task behaviour identification ("No" and "Yes").

Task	Visual behaviour	“No”	“Yes”	Correlation			Comparison		
		Average SD	Average SD	P value	R	ES	P value	D	ES
Task 1	Total fixation duration (ms)	2763.35 ± 1837.75	2706.53 ± 1559.10	.879	.010	Weak	.851	.032	Weak
	Average fixation duration (ms)	529.24 ± 346.13	522.05 ± 290.30	.974	-.002	Weak	.899	.021	Weak
	Number of fixations	5.16 ± 2.90	5.12 ± 2.86	.854	-.012	Weak	.925	.016	Weak
Task 2	Total fixation duration (ms)	1537.42 ± 1231.13	1669.98 ± 1520.05	.950	.004	Weak	.595	-.103	Weak
	Average fixation duration (ms)	361.34 ± 270.63	377.60 ± 283.04	.749	.021	Weak	.723	-.060	Weak
	Number of fixations	3.93 ± 2.67	3.84 ± 3.06	.612	-.033	Weak	.843	.033	Weak
Total	Total fixation duration (ms)	4300.77 ± 2506.05	4376.51 ± 2490.63	.658	.029	Weak	.858	-.030	Weak
	Average fixation duration (ms)	469.41 ± 215.00	478.37 ± 194.16	.676	.027	Weak	.801	-.042	Weak
	Number of fixations	9.09 ± 4.46	8.95 ± 4.77	.882	-.010	Weak	.856	.031	Weak

*Significant correlation, $p < .05$; *Significant differences, $p < .05$.

For task 1, all variables demonstrated weak, non-significant correlations (total fixation duration: $r = .010$, $p = .879$; average fixation duration: $r = -.002$, $p = .974$; number of fixations: $r = -.012$, $p = .854$) and negligible effect sizes ($d \leq .032$). Similar results emerged for task 2 (total fixation duration: $r = .004$, $p = .950$; average fixation duration: $r = .021$, $p = .749$; number of fixations: $r = -.033$, $p = .612$), with weak effects ($d \leq .103$). When combining data across both tasks (total), the pattern persisted: no variable correlated significantly with behaviour identification (all $p \geq .658$, $|r| \leq .029$), and group comparisons revealed trivial effects ($|d| \leq .042$).

Discussion

The findings of this study provide novel insights into the visual behaviour of pre-service Physical Education teachers, particularly in relation to their attention distribution during motor skill observation. By employing mobile eye-tracking technology, this research addresses a critical gap in the literature, as highlighted by Mendes et al. (2025), which identified a shortage of studies focusing on Physical Education contexts.

The results reveal task-dependent effects on gaze patterns, with pre-service teachers exhibiting stronger visual attention to students with lower motor competence during the closed task but failing to correlate gaze

patterns with off-task behaviour identification. These results are somewhat aligned, although not entirely, with the existing literature on teachers' visual attention in educational environments, as analysed below.

The observed negative correlation between fixation measures (duration and count) and motor competence during the closed task ($r = -0.16$ to -0.27 , $p < .05$) suggests that pre-service Physical Education teachers prioritise students who struggle with structured activities. This conclusion is consistent with studies conducted in academic classrooms, which reveal that teachers' visual attention is often directed towards students exhibiting difficulties (Chaudhuri et al., 2022; Kosel et al., 2021), and that novice teachers often fixate on salient cues, such as incorrect movements, due to their limited ability to distribute attention efficiently (Kosel et al., 2021; Chaudhuri et al., 2022).

Experienced teachers efficiently allocate attention to critical classroom events, such as student misunderstandings or disruptions, while novices tend to focus on salient but less pedagogically relevant cues (Stahnke & Blömeke, 2021; Wyss et al., 2023). However, the absence of such correlations during the open task (e.g., small-sided games) in our study introduces a nuanced perspective.

This discrepancy may stem from the dynamic and unpredictable nature of the open tasks, which demand simultaneous monitoring of multiple dynamic elements and likely overwhelm pre-service teachers' observational capacity, a finding consistent with Kosel et al. (2021), who noted that novices exhibit scattered gaze patterns in complex scenarios. This aligns with the emphasis on task complexity as a moderating factor in visual attention (Kosel et al., 2023), but extends it to Physical Education-specific motor tasks, a previously underexplored area. A striking result of this study is the lack of significant correlation between gaze patterns and off-task behaviour identification, despite large effect sizes in on-task versus off-task fixation differences ($d = 0.51$ – 0.57). This suggests that while pre-service teachers visually attend to on-task students more frequently, they do not necessarily translate this attention into accurate behavioural monitoring. This finding contrasts with the report stating that experienced teachers excel at detecting off-task behaviour due to their refined professional insight (Stahnke & Friesen, 2023), which calls into question the lack of experience of the participants in the study.

Goldberg et al. (2021) found that pre-service teachers' attention is often captured by active, engaged students, neglecting subtler off-task cues - a pattern mirrored in our participants' low off-task identification accuracy (37% in task 1, 7% in task 2). Shinoda et al. (2021) also found that experienced teachers identified off-task behaviours more accurately and swiftly than novices, attributing this to their ability to integrate contextual and behavioural cues. Our results underscore a critical deficit in pre-service teachers' ability to leverage visual attention for classroom management, a skill identified as developable through targeted training (Telgmann & Müller, 2023). This gap highlights the need for eye-tracking-informed pedagogical interventions in Physical Education teacher education.

The results further illuminate the differences between pre-service and in-service teachers' visual strategies. While expert teachers exhibit distributed attention across multiple students and cues (Kosel et al., 2021; Murtonen et al., 2023), pre-service teachers in this study displayed a more fragmented gaze pattern, particularly in the open-task scenario. This aligns with Goldberg et al. (2021), who noted that novices often fixate on overt behaviours (e.g., active participation) while overlooking subtler cues (e.g., disengagement).

Expert teachers' gaze is guided by top-down processes rooted in pedagogical knowledge, whereas novices rely on bottom-up, stimulus-driven attention (Kosel et al., 2023; Seidel et al., 2021). Our study extends this framework to Physical Education, suggesting that the dual demands of motor skill assessment and behaviour monitoring in dynamic and complex environments exacerbate novice teachers' cognitive load, thereby hindering effective attention distribution. In this sense, the observed weak correlations, despite their statistical significance, indicate that the practical impact of pre-service teachers' visual attention on accurately identifying students' needs in dynamic environments may be limited, weakening the direct link between gaze and pedagogical interpretation. The methodological difference regarding the experience of the participants may also justify the discrepancy between our results and the suggestion that visual attention correlates with student engagement (Yang et al., 2023). While pre-service teachers in our study fixated longer on on-task students, this did not translate into accurate behavioural identification, implying that gaze duration alone is insufficient for effective monitoring.

Additionally, some of the differences between our findings and prior literature may stem from the unique dynamics of Physical Education subject settings, where the fluid, spatially distributed nature of the classes - compared to traditional classroom environments - demands heightened teacher attention to simultaneously monitor skill execution, safety, task engagement and behavioural management, potentially exacerbating cognitive load and altering gaze patterns in pre-service teachers (Grube et al., 2018).

However, the use of mobile eye-tracking in naturalistic Physical Education settings represents a methodological strength. Although the overreliance on video-based or simulated environments (Witt et al., 2024), while video-based studies dominate the literature (e.g., Duvivier et al., 2024; Horlenko et al., 2024), our approach captures real-time gaze behaviour during authentic motor tasks, enhancing ecological validity. Despite the cautions against the challenges of naturalistic eye-tracking, such as data variability and the need for robust analytical frameworks (Ashraf et al., 2018), our study mitigates these issues through standardised task design and fixation metrics (Holmqvist et al., 2015).

This study reinforces the cognitive load theory's applicability to teacher visual attention, particularly in high-complexity tasks. It also introduces a Physical Education-specific dimension to the professional vision framework, which has been predominantly explored in other academic subjects (Stahnke & Blömeke, 2021). Mendes et al. (2025) further highlight that expert teachers outperform novices in dual attention to skill execution and classroom management. So, our results, though revealing distinct patterns in novice teachers' visual behaviour, should be interpreted as indicative rather than conclusive, as the modest effect sizes caution against overstating the immediate practical applications. However, the observed task-dependent differences provide a justified rationale for exploring targeted interventions to enhance teacher training (Schindler & Lilienthal, 2019).

The discrepancy between gaze patterns and behavioural identification underscores a potential area for development in pre-service training. While our study does not provide definitive evidence for the efficacy of eye-tracking feedback, it lends support to future research investigating whether technologies like mobile eye-tracking could be used to scaffold the development of dual-focused professional vision in Physical Education trainees (Gabel et al., 2023; Telgmann & Müller, 2023), helping them bridge the gap between seeing and interpreting (Kosel et al., 2023).

Conclusions

This investigation, employing mobile eye-tracking technology to examine gaze patterns during motor skill observation and classroom management, addresses a critical gap in the literature, by providing new insights into the visual behaviour of pre-service Physical Education teachers. The findings reveal task-dependent effects, with pre-service teachers demonstrating heightened visual attention toward students with lower motor competence during structured, the closed task (e.g., ball control circuits), as evidenced by significant negative correlations and strong effect sizes. This aligns with prior research suggesting novice teachers prioritise salient cues, such as incorrect movements, due to limited attentional efficiency. However, these patterns did not occur in the dynamic, open task (e.g., small-sided games), likely due to the cognitive overload imposed by simultaneous monitoring of multiple unpredictable elements - a finding that extends cognitive load theory to Physical Education-specific contexts. Given the above, the marked discrepancy in visual behaviour between the closed and open tasks underscores the inherent limitation in extrapolating findings from structured to dynamic settings. Consequently, the attentional patterns identified in the closed-skill circuit are context-specific and should not be generalised. A critical direction for future inquiry is to determine how pre-service teachers' professional vision can be developed to cope with the complexity of open tasks.

A discrepancy emerged between gaze behaviour and off-task behaviour identification. While pre-service teachers fixated longer on on-task students, their accuracy in identifying off-task instances remained low, underscoring a critical deficit in translating visual attention into effective classroom management. This contrasts with expert teachers' ability to integrate contextual and behavioural cues and highlights the need for targeted training to bridge this gap. The study's methodological strength lies in its ecological validity, using mobile eye-tracking in authentic Physical Education settings, yet it also reveals limitations in pre-service teachers' professional vision, particularly in complex environments. The results provide novel insights into the allocation of pre-service teachers' visual attention in Physical Education. Notably, the observed task-dependent effects underscore the complexity of professional vision in this dynamic domain and substantiate the need for further research on targeted support within teacher training programmes. Building on successful models from other disciplines, such evidence-based interventions, could expedite the acquisition of expert-like visual strategies. In summary, this study establishes a foundational understanding of pre-service teachers' visual perception in Physical Education, identifies task complexity as a critical moderating factor, and pinpoints actionable gaps in current teacher training methodologies.

Limitations and Future Research

The focus on first-year pre-service teachers restricts the generalisability of the findings across different stages of professional development. Additionally, the assessment of motor competence by a single rater, though contextually appropriate, introduces a potential source of bias that could be mitigated in future studies through multi-rater assessment. Future research should include more advanced trainees or in-service teachers to compare visual behaviour and trace its evolution, in order to provide a broader perspective on how visual attention evolves with experience, and aim to utilise larger sample size and mobile eye-tracking in real-time teaching practice, to strengthen the ecological validity of the findings.

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