Teacher gaze and attitudes toward student gender: evidence from eye tracking and implicit association tests

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Abstract

Previous research has examined teacher attitudes toward student gender and teacher eye movements when looking at girls and boys in classrooms. However, to date, these two lines of research are rather separated. To better understand the co-occurrence of visual and attitudinal preferences, we investigated whether pre-service teachers' attitudes are associated with their selective attention allocation toward girls and boys. Grounded in the cognitive theory of visual expertise, this multi-method study invited $n = 105$ pre-service teachers to watch a classroom video while their gaze was recorded. In addition, feeling thermometers measured their explicit gender attitudes and an implicit association test (IAT) measured their implicit gender attitudes. Findings revealed that female and male teachers implicitly and explicitly favored girls over boys. The results also demonstrated that, independent of teacher gender, girls were fixated more frequently than boys. When examining the correlation between attitudes and fixations, the study found that pre-service teachers' implicit attitudes and their number of fixations on girls were positively correlated. These results confirm the assumption that attention tends to be directed more on information that is consistent (rather than inconsistent) with underlying teacher attitudes, especially in complex tasks, possibly to reduce mental effort. Future research can consider the context of the observation (language lessons), as teachers' expectations in different disciplinary fields and observation contexts may influence the co-occurrence of attitudes and gaze in the classroom. Further directions on the use of eye tracking as a tool to reflect on gender biases are discussed.

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1 Introduction

A central challenge in the teaching profession is to process many different visual impressions in the classroom and to decide which events are relevant at that moment. In order not to overload teachers' cognitive capacities for this process, automatic decision-making and perception processes usually become involved (Wyer, 2022). Based on the competence-continuum model by Blömeke (2025), affective (e.g. motivation) and cognitive (e.g. knowledge, attitudes) dispositions are related to teachers' situation-specific abilities to perceive and interpret teaching situations and to make decisions about future actions. However, these dispositions – such as teacher attitudes – can also bias their perception.

Previous research has examined teacher attitudes toward student gender (for a meta-analytic review, see Pit-ten Cate & Glock, 2017) as affective components of teacher dispositions. Previous research has also explored teachers' gaze when looking at girls and boys in classrooms (for a meta-analytic review, see Keskin et al., 2024) as a component of teachers' situation-specific skills. However, to date, these two lines of research are rather separated. From a theoretical perspective, studies are needed to investigate how teacher attitudes and teacher gaze correlate to better understand the connection between the affective dispositions and their visual perception as a basis for teacher actions. From a practical perspective, revealing the confluence of attitudinal and visual foundations of gender inequalities in the classroom can contribute to a more profound understanding of gendered teacher practices and classroom management strategies (Glock & Kleen, 2017). For example, some studies showed that teachers tend to punish boys harsher than girls for the same classroom disruptions (Ebright et al., 2021; Glock, 2016; Glock & Kleen, 2017). One possible explanation for gendered and thus, unequal classroom management practice could be teachers' attitudes towards gender, and possibly related to this, their increased or decreased distribution of attention. For this reason, this study offers initial insights on the role of teachers' gaze and the favored or rejected actions of certain groups of students by investigating attitudinal and visual co-occurrence.

Grounded in theories on gaze avoidance and information consistency as well as social identity theory (Taifel & Turner, 2004), the present study addressed how pre-service teachers' visual attention corresponds with their attitudes. Using a multimethod design that integrates eye-tracking technology, implicit association tests, and feeling thermometer scores, we analyzed if attitudinal preferences and visual preferences on girls and boys correlated for female and male pre-service teachers when watching authentic classroom videos.

1.1 Teacher attitudes toward male and female students in classrooms

Attitudes are defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993, p. 1). Attitudes can be divided into implicit and explicit attitudes. While people express explicit attitudes consciously and deliberately, they process implicit associations automatically and unconsciously (Greenwald et al., 2003). Based on the dual-attitudes theory (Wilson et al., 2000), both attitudes can coexist independently of each

other. The extent to which implicit attitudes influence explicit attitudes depends on the level of awareness (Dovidio et al., 2002; Wilson et al., 2000). For example, a teacher may have acquired negative attitudes towards boys over the years of her work and experience, which she is not aware of, and at the same time have developed a positive personal attitude towards this social group. Her implicit attitude would be spontaneously activated when interacting with a male student and be reflected in uncontrolled, non-verbal behavior (e.g. gaze avoidance). In contrast, her controlled behavior (e.g. verbal expressions) would be much more positive.

Moreover, if both explicit and implicit attitudes differ and people are aware of this, social desirability effects can occur when people are asked about their explicit attitudes—for example, when they are asked how warm or cold they feel toward a particular social group on a feeling thermometer scale (Alwin, 2007)—as they can make conscious statements that not always have to be true. For this reason, it is important to consider both attitude measurements.

To avoid this social desirability effect, implicit association tests (IAT) were developed as a method to measure attitudes indirectly (Denessen et al., 2022; Greenwald et al., 2003; Greenwald & Lai, 2020). Those tests are computerized assessments where participants categorize stimuli as rapidly as possible (Denessen et al., 2022). This quick and spontaneous reaction strategy encourages participants to make decisions automatically and unconsciously (Denessen et al., 2022; Greenwald & Lai, 2020). Typically, an IAT has two group categories (e.g., female and male) and two attribute categories (e.g., good and bad). To measure implicit attitudes, participants need to categorize group and attribute pairs across a series of blocks in which (a) the group categories and the attributes are consistent to the participants' attitudes (e.g., male=bad) and (b) in which the group categories and the attributes are inconsistent with the participants' attitudes (e.g., female=bad). The underlying test theory assumes that attribute stimuli that are closely related and consistent with the group category are processed more quickly than those that are less related or inconsistent (Sherman et al., 2000). In other words, the stronger the implicit association between an attribute is, the faster the velocity at which a participant categorizes the presented stimuli (Greenwald et al., 2015).

In education, teacher attitudes can influence their teaching practices (Blömeke, 2025). To promote gender equity in the classroom, teachers would ideally have an equally neutral or positive attitude toward girls and boys, with neither group being favored or disadvantaged. However, research shows that this is not always the case (for a meta-analysis, see Pit-ten Cate & Glock, 2017). To date, empirical evidence is ambiguous and differs in various contexts.

On one hand, some studies revealed systematic disadvantages for girls when it comes to STEM education. For example, Copur-Gencturk et al. (2023) showed that teachers attribute higher competence to male students in mathematics, even if this difference is not reflected in their actual performance. Moreover, this bias implicates long-term effects over time: a more positive (negative) evaluation of boys (girls) in maths education has a long-term impact on the overall performance of boys (girls) in that subject (Lavy & Sand, 2018).

Another context is students' classroom behavior. Here, the situation is reversed. Glock and Kleen (2017) showed that pre-service teachers implicitly associate male

students with negative student behavior and female students with positive student behavior. Male students are often associated with negative stereotypical behaviors such as impulsivity, autonomy, and antisocial behavior (Ewing & Taylor, 2009; Split et al., 2012; Zahn-Waxler et al., 2008) and tend to be perceived as more disruptive than girls (Arbuckle & Little, 2004; Beaman et al., 2007; Hendrickson, 2018). These associations can also influence teacher interactions with boys and girls (Blömeke, 2025; Glock, 2016) and bias their intervention strategies – to the boys' disadvantage: studies indicated that teachers applied more sanctions when male students disrupt the classroom than female students (Arbuckle & Little, 2004; Ebright et al., 2021; Glock, 2016; but see Glock & Kleen, 2022, study 1, for an exception). Glock and Kleen (2017) also reported that negative implicit associations toward male students correlated with harsher intervention strategies.

In conclusion, the body of evidence is rather ambiguous. In STEM education, boys seem to be advantaged, but when it comes to classroom behavior, the evidence seems to suggest that teachers have more positive attitudes toward girls than boys.

Based on in-group favoritism (Tajfel & Turner, 2004), it is plausible to assume that teachers' gender could influence their attitudes toward male and female students. For example, we could expect male teachers to have a more positive attitude toward male students and, vice versa, we could expect female teachers to have a more positive attitude toward female students. Kleen and Glock (2018), however, reported that teacher gender did not influence implicit and explicit attitudes. Still, previous studies showed that teachers— both male and female—reported having overall more difficult relationships with boys than with girls (Ewing, 2009; Split et al., 2012). It therefore remains unclear whether teachers' gender is related to their attitude toward girls and boys, calling for more research. Future studies are also needed to address how teacher gender is linked to teacher gaze behavior in the classroom.

1.2 Relations between teachers' attitudes and their gaze behavior

Teachers' gaze behavior is an important component of situation-specific skills as teachers base their situation-specific interpretations and further decisions for action on their visual perception (Blömeke, 2025; Gegenfurtner et al., 2023a; Seidel et al., 2025). Depending on the context (e.g. during classroom management vs. explaining a mathematical concept), teachers' gaze can have different intentions and purposes: McIntyre et al. (2017) distinguish between an information-seeking gaze (attentional gaze) and an information-giving gaze (communicative gaze). While teaching in real life can include both types of gazes (McIntyre et al., 2017), teachers show rather attentional gaze when observing lessons (Keskin et al., 2024).

Since teacher attitudes can affect teacher behavior in the classroom (Blömeke, 2025; Denessen et al., 2022), it is important to investigate how teachers' attitudes are reflected in their gaze behavior and how they allocate their visual attention to male and female students in terms of an attentional gaze. Furthermore, investigations on the relation between attitudes and gaze might unveil how teachers support, interact, and engage with particular social groups of students in the classroom in terms of a communicative gaze (Ebright et al., 2021; Keskin et al., 2023; Pajares et al., 1992).

The cognitive theory of visual expertise (see Fig. 1) assumes that different knowledge types—declarative, procedural, and meta-cognitive—are integrated into a mental model of a perceived situation (Gegenfurtner et al., 2023). Declarative knowledge holds a variety of information stored as different memory elements: one obvious element is knowledge per se, such as episodic knowledge and experiential knowledge (Baddeley, 2013), or the fusion of episodic and experiential knowledge as knowledge encapsulations (Boshuizen et al., 2020). Another element are stereotypes and attitudes that, sometimes implicitly (Greenwald & Banaji, 2017), affords a basis for understanding new situations or in making behavioral decisions and judgements (Wyer, 2022). Blömeke (2025), in a refined version of her often-cited PID model, argues for an influence of individual dispositions on the situation-specific perception of situations—individual dispositions that encompass, in our conceptualization, an attitude or a stereotype toward a particular social group stored as declarative knowledge in memory. Consequently, and grounded in the cognitive theory of visual expertise, we hold that attitudes and stereotypes of a teacher toward particular students will influence how this teacher perceives a classroom situation through the integration of declarative knowledge, particularly attitudinal knowledge, in their mental model of the perceived classroom situation.

Eye-tracking research has started to examine how student characteristics such as gender or ethnic minority status can influence teacher eye movements (for a review, see Keskin et al., 2024). In this context, the number of fixations and fixation durations are often used parameters. Number of fixations indicates the allocation of attentional resources (Grub et al., 2020; Just & Carpenter, 1976), whereas fixation duration indicates mental effort (Jarozdka et al., 2023; Reingold & Charness, 2005). For example, Sümer et al. (2018) and Nyström (2019) reported that pre- and in-service teachers had more and longer fixations on boys than girls. Hendrickson (2018) and Ebright et al. (2021) indicated that teachers fixated more on boys than girls and more on black than white students regardless of showing on-task or off-task behavior. Keskin et al. (2023) demonstrated that pre-service teachers fixated longer on ethnic minority than ethnic majority students; they also showed that fixations correlated with teachers' explicit attitudes toward ethnic minority students. Research on the correlation between gender attitudes and gaze is yet missing but with regard on the existing evidence on student ethnicity, we could assume that attitudes influence fixations also in the case of student gender. In this case, the number of fixations seems to be a suitable
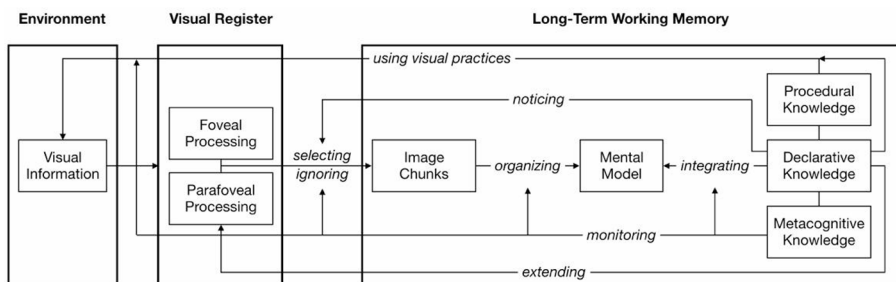

Fig. 1 Cognitive theory of visual expertise

parameter for investigating a bottom-up and saliency-driven allocation of attentional resources (Grub et al., 2020; Just & Carpenter, 1976).

If it is true that teachers' attitudinal preferences correlate with their visual preferences, there are two lines of argumentation. On one hand, attitudes might be associated with selective attention due to antipathy. Based on a social psychological perspective, associations related to antipathy allocate more and longer attentional resources than neutral associations (Donders et al., 2008; Fox et al., 2001; Koster et al., 2004). In classrooms, teachers may also look more and longer at students whose behavior they monitor because they expect negative off-task behavior from these (groups of) students (Keskin et al., 2024). We could therefore argue that negatively associated stimuli attract more visual attention and thus more and longer fixations.

On the other hand, negative associations might lead to gaze avoidance. As Sherman et al. (2000, p. 155) noted: "Because consistent information is easier to encode than inconsistent information, perceivers will actively direct their attention toward consistent and away from inconsistent information". In implicit association tests, reactions to consistent vs. inconsistent information are used as indicators of positive vs. negative implicit attitudes (Denessen et al., 2022; Greenwald et al., 2003; Greenwald & Lai, 2020). This assumption would imply that teachers would allocate fewer attentional resources toward inconsistent or negatively perceived information. In classrooms, this might lead to a biased teacher's gaze, as it would focus primarily on those groups of students that are consistent and thus, positively associated with the teacher's attitude – regardless of their expected behavior. Research also suggests that humans fixate more and longer on people they like or find attractive (Leder et al., 2010; Schotter et al., 2010). Sympathy or physical attractiveness evoke positive evaluations, which allows us to conclude that these stimuli also represent positive or consistent information. Based on the assumption, that positive and consistent information attract more attention than negative and inconsistent information, we assume that teachers' positive evaluations in terms of their attitudinal preferences toward a social group might be also visible in their gaze behavior – for example by paying more visual attention toward the positive evaluated student group. Still, without further evidence, it would be premature to conclude on the possible (positive or negative) association between teachers' attitudinal and visual preferences toward particular social groups in classroom settings.

2 The present study

This multi-method study investigated the following research question: to what extent are pre-service teachers' attitudes toward student gender and their gaze behavior associated? Three hypotheses were tested. First and based on previous studies in the context of classroom management, we expected both female and male pre-service teachers to have more positive explicit (Hypothesis 1a) and implicit (Hypothesis 1b) attitudes toward girls compared to boys. Second, based on the assumption that consistent and positive evaluated information is more likely processed, and thus, more likely to attract attention, we expected both male and female teachers to fixate more often on girls than on boys (Hypothesis 2). Third, we assumed that in terms of a more

positive attitude toward girls, teachers process these student group as consistent and more relevant. As a result, they might visually focus on this student group more likely because it aligns with their attitudinal preferences. For this reason, we expected implicit and explicit attitudes to correlate (positively or negatively) with the number of fixations on girls (Hypothesis 3a) and boys (Hypothesis 3b).

3 Methods

3.1 Sample

From the pool of pre-service teachers enrolled in a large teacher education program in southern Germany, a convenience sample of $N=135$ people (108 women) was recruited. Participants were on average 20.8 years ($SD=2.6$) old and in their second study semester ($SD=1.7$). Consequently, we may presume that they have less biased attitudes and perceptions toward gender differences and stereotypes, in contrast to in-service teachers with many years of experience. Participation in the study was voluntary and compensated with course credit. Written consent was obtained before data collection; anonymity and confidentiality were guaranteed for all measures.

3.2 Measures

3.2.1 Explicit attitudes

We used two 101-point feeling thermometers (Alwin, 2007) adapted from Gegenfurtner (2021) to measure pre-service teachers' explicit attitudes toward female and male students, respectively. The instruction was: "Think of an imaginary thermometer with a scale from zero to 100. The warmer or more favorable you feel toward female (male) students, the higher the number you should give it. The colder or less favorable you feel, the lower the number. If you feel neither warm nor cold toward female (male) students, rate it 50." Lower ratings (minimum=0) indicated more negative feelings and higher ratings (maximum=100) indicated more favorable feelings.

3.2.2 Implicit attitudes

We used an implicit association test (IAT; Greenwald et al., 1998) to measure pre-service teachers' implicit attitudes toward female and male students, respectively. The group category included five female and five male first names (Paula – Paul; Julia – Julian; Lea – Leo; Jana – Jan; Emilia - Emil). We deliberately chose these names for similarity to minimize confounding effects due to length, syllable number, and sound. The attribute category included five pleasant and five unpleasant adjectives (hard-working – lazy, good – bad, moral – immoral, beautiful – ugly, healthy – sick). We calculated a d-score from participants' response times (Greenwald et al., 2003), with a higher d-score reflecting more positive associations toward female students. The Spearman-Brown coefficient as a proxy of the IAT's internal consistency was 0.82.

3.2.3 Fixations

We used a Tobii Pro Eye-Tracker Nano with a 60 Hz sampling rate with a velocity threshold of 30°/s to measure pre-service teachers' fixations on female and male students while watching a classroom video. This parameter serves as an indicator of attentional focus and therefore represent a suitable parameter in contrast to fixation duration, for example, which is more a reflection of mental effort (Grub et al., 2020; Jarodzka et al., 2023; Just & Carpenter, 1976; Szulewski et al., 2019). We manually created dynamic areas of interest (AOI) and controlled for classroom behavior and pixel size – ensuring that the boys and girls were equally visible and did not show disruptive behavior. Figure 2 presents a static screenshot of the AOIs superimposed on the video material.

3.3 Procedure and material

One week before the laboratory data collection, participants completed an online questionnaire measuring feeling thermometers sand demographic information (age, gender, number of semesters). At the beginning of the laboratory data collection (individual sessions of approx. 30 min), participants were seated about 60 cm in front of a 1920×1080px TFT monitor and asked to watch a classroom video. To connect to the focus of previous research on gender-specific attitudes in the context of classroom management, we adapted the observation setting accordingly. The participants were asked: "Please observe the classroom video and identify relevant classroom management situations." The analysis scene in the video had a length of 21 s and showed secondary school students (7th /8th grade) working in pairs during a lesson in "German as a second language" that introduced new vocabulary around the season "summer". We chose this scene because there were no classroom disruptions, and the students showed similar behavior. It is in the nature of the subject that the students in

Fig. 2 Areas of interest of three girls (red) and three boys (blue) in the classroom video

the video all had a migration background. This means that possible intersectionality effects due to students with and without a migration background can be ruled out. Before watching the video, we conducted a 9-point calibration on the eye tracker to ensure high data quality. After watching the video, we tasked participants to complete the IAT. Data collection closed with a short debriefing about the study goals.

3.4 Analysis

For the analysis, we excluded IAT trials with latencies below 300ms and above 10,000ms as these reactions were exceptionally fast or slow and thus considered random or conscious reactions (Glock & Kleen, 2017; Greenwald et al., 2003). Due to the removal of IAT trials below and above these threshold levels and insufficient quality of the eye-tracking data for some participants, we had to exclude 31 cases from our analyses. The final sample size was thus $n=105$ pre-service teachers (82 women). To answer the research questions, we calculated parametric and non-parametric tests (due to pre-service teachers' gender imbalance) for mean value comparisons and Pearson correlations for the relationships between attitudes and gaze behavior.

4 Results

The first hypothesis was that pre-service teachers showed more favorable attitudes toward female than male students. Table 1 presents the feeling thermometer scores. The findings indicate that pre-service teachers had significantly higher thermometer scores for girls than boys, $t(104)=2.452$; $p=.016$ ($d=0.07$), albeit with a weak effect. Focusing on teacher gender, female pre-service teachers significantly favored girls over boys, $t(81)=2.182$; $p=.032$ ($d=0.07$), while the difference for male pre-service teachers was non-significant, $p=.206$. However, the group of female pre-service teachers did not differ significantly from the group of male pre-service teachers in terms of their thermometer scores for girls ($U=726.000$, $Z=-1.691$; $p=.091$) and for boys ($U=749.000$, $Z=-1.514$; $p=.131$). In addition to these results on explicit attitudes, the d-scores as a measure of implicit attitudes also signaled that pre-service

Feeling thermometer	M	SD	T	df	p
All pre-service teachers (N=105)					
For girls	77.41	19.98	2.452	104	**0.016**
For boys	76.12	19.26			
Male pre-service teachers (N=23)					
For girls	71.13	19.81	1.303	22	0.206
For boys	70.30	19.69			
Female pre-service teachers (N=82)					
For girls	79.17	19.79	2.182	81	**0.032**
For boys	77.76	18.94			

Table 1 Explicit attitudes toward girls and boys measured by feeling thermometer (Alwin, 2007)

teachers showed a moderate preference for girls (M_{IAT} = 0.57; SD=0.41). Female pre-service teachers had even more positive implicit attitudes toward girls (M_{IAT} = 0.72; SD=0.27), while the d-scores of male pre-service teachers were more neutral (M_{IAT} = 0.02; SD=0.32). This difference was significant between male and female pre-service teachers (U=85.000, Z = -6.647; p<.001; d=2.49) with a strong effect. Overall, these findings indicate slightly more positive, explicit attitudes toward girls, thus confirming hypothesis 1b. For implicit attitudes, again attitudes towards girls were more positive, but with a large effect size. These results confirm hypothesis 1a.

The second hypothesis tested the assumption of the visual preference of pre-service teachers for girls over boys. Table 2 presents the mean estimates of the eye-tracking data. The findings confirmed that girls were fixated more frequently than boys from all pre-service teachers, t (104)=10.971; p<.001; d=1.17, from the female pre-service teachers, t (81)=10.231; p<.001; d=1.22, and from the male pre-service teachers, t (22)=4.165; p<.001; d=1.06, with a strong effect. Differences between female and male pre-service teachers were significant for fixations on girls (U=639.000, Z = -2.358; p=.018; d = -0.57) but not significant for fixations on boys (U=856.000; Z=−0.677; p=.502). To conclude, pre-service teachers had more fixations on girls than on boys with a strong effect size, thus confirming hypothesis 2.

The third hypothesis was that attitudes and fixations would correlate. Table 3 shows a correlation matrix of all variables. Analyses revealed a positive and statistically significant correlation between the d-score and the number of fixations on girls, r=.25 (p=.012). Other correlations were non-significant. To further investigate whether pre-service teachers' gender influenced this correlation, we conducted a moderation analysis. The findings did not show a significant moderation effect of their own gender regarding their implicit attitudes and their fixation number on girls (ΔR^2 = 0.5%, F (1, 101)=0.52, p=.47, 95% CI [-5.226; 2.441]). Overall, the results partially confirmed hypothesis 3a as we found a significant positive correlation between pre-service teachers' implicit attitudes and their fixations on girls. Explicit attitudes showed no correlation with fixations.

Table 2 Pre-service teachers' gaze fixations on girls and boys	Number of fixations	M	SD	T	df	p
	All pre-service teachers (N=105)					
	On girls	5.19	2.44	10.971	104	**<0.001**
	On boys	2.25	2.57			
	Male pre-service teachers (N=23)					
	On girls	4.13	2.19	4.165	22	**<0.001**
	On boys	1.84	2.12			
	Female pre-service teachers (N=82)					
	On girls	5.49	2.44	10.231	81	**<0.001**
	On boys	2.36	2.68			

Table 3 Correlations between pre-service teachers' attitudes and number of fixations

	Fixation number on girls	Fixation number on boys	d-Score (IAT)	Feeling thermometer (girls)	Feeling thermometer (boys)
Fixation number on girls	.				
Fixation number on boys	*r*=**.398** *p*<**.001**	.			
d-Score (IAT)	*r*=**.245** *p*=**.012**	*r*=.071 *p*=.470	.		
Feeling thermometer (girls)	*r*=−.066 *p*=.500	*r*=−.074 *p*=.451	*r*=.121 *p*=.219	.	
Feeling thermometer (boys)	*r*=−.072 *p*=.462	*r*=−.085 *p*=.390	*r*=.132 *p*=.180	*r*=**.963** *p*<**.001**	.

5 Discussion

From a theoretical perspective, we know that affective dispositions such as attitudes can influence teachers' situation-specific skills and, thus, teacher noticing (Blömeke, 2025; Gegenfurtner et al., 2023a; Gegenfurtner, 2025). This study was a first exploration into understanding how pre-service teachers' implicit and explicit attitudes toward particular student characteristics—here: student gender—are associated with teachers' gaze behavior. To answer the research question, this multi-method study examined measures using feeling thermometers (Alwin, 2007), implicit association tests (Greenwald et al., 2003), and eye tracking (Keskin et al., 2024).

The findings signal that pre-service teachers—independently of their gender—had more positive explicit and implicit attitudes toward girls than toward boys. These findings are in line with previous studies and demonstrate a certain degree of favoritism toward girls (Glock & Kleen, 2017; Split et al., 2012). The fact that explicit and implicit attitudes both showed a more positive orientation towards girls (albeit for explicit attitudes with a weak effect), we can conclude that the pre-service teachers might be aware of their implicit attitudes when they express them explicitly (Wilson et al., 2000). However, the differences in effect sizes also indicate that the measurement of implicit attitudes can be useful for depicting attitudes in a differentiated and nuanced manner. Interestingly, female teachers showed a stronger implicit preference for girls than boys, whereas male teachers had no significant gender preference. While this finding could be attributed to the unevenly distributed sample composition, the preference of female participants for female students could also have resulted from in-group favoritism and self-categorization bias (Tajfel & Turner, 2004; Turner & Reynolds, 2012).

In addition to an attitudinal preference, we also found a visual preference in pre-service teachers' gaze: the number of fixations on girls was significantly higher than on boys. This finding contrasts with previous eye-tracking studies that reported more fixations on boys than girls (Nyström, 2019; Sümer et al., 2018) possibly because teachers monitored boys more closely as they expected boys to show more off-task

behavior (Ebright et al., 2021). The visual preference for girls in our study might have resulted from video clips that did not show any salient off-task situations, so pre-service teachers were free and unprompted during their visual observation of the material. Furthermore, the present study suggests that attitudes and fixations on girls were correlated, indicating that implicit preferences may influence the gaze behavior of pre-service teachers when observing classroom scenes. At the same time, teachers' gender had no moderation effect, ruling out in-group favoritism (Tajfel & Turner, 2004) for the relation between attitudes and gaze, which confirms prior research (Kleen & Glock, 2018).

To our knowledge, this is the first study that explored how attitudes and fixations may interrelate and co-produce both attitudinal and visual inequalities which, in this case, favored girls over boys. Bridging the gap to teachers' actions, associating boys with negative behavior can lead to stricter classroom management practices. Our findings may relate to Glock and Kleen's (2017) gendered classroom management practices, suggesting that teachers tend to systematically punish boys harsher than girls. Future research may wish to use the present findings to investigate how teachers' visual attention, and their gendered attitudes correlate when interacting with girls and boys in the classroom. Future research can also explore how teachers' visual and attitudinal preferences are consequential for student learning.

In terms of educational implications, reflecting on one's gaze behavior and attitudes toward certain student groups could help raise awareness of perhaps unconscious visual preferences or implicit attitudinal biases (Keskin et al., 2023; Pajares, 1992; Pit-ten Cate & Glock, 2017). Here it would be further interesting to investigate whether a change in attitudes results in a change in gaze behavior – or vice versa – whether interventions for changing teachers' gaze patterns change their attitudes. One possibility would be to show teachers their gaze replays, that is: their fixations visualized as cursors or fixation points and superimposed on authentic classroom videos. Such a reflection could potentially lead to conceptual change and a change in fixation patterns (Kaminskienė et al., 2023; Keskin et al., 2024; Lehtinen et al., 2020) and might represent an important first step toward higher levels of gender equity in the classroom by reducing gender stereotypes, both in teacher education programs for pre-service teachers and in teacher professional development for in-service teachers.

In addition to watching video clips in the lab of other teachers teaching, it would be interesting to use a mobile eye-tracker while teaching in a real classroom to enable a deepened understanding of teachers' communicative gaze and their interactions with boys and girls resulting from attitudinal and visual preferences and also teachers' goals behind their gaze behavior (Daumiller et al., in press; Glock, 2016; Glock & Kleen, 2017; Keskin et al., 2024; McIntyre et al., 2017). Future studies may also want to consider other characteristics of student heterogeneity, for example, social class, ethnic minority status, or sexuality and gender identity (Alijagic et al., 2024; Gegenfurtner, 2021; Gegenfurtner et al., 2023b; Glock & Kleen, 2022; Keskin et al., 2023; Tobisch & Dresel, 2022). Furthermore, future research could combine eye-tracking data, IATs, think-aloud protocols, and retrospective interview data in multi- or mixed-method designs to better understand teachers' cognitive reasoning processes alongside their visual attention allocation (Biermann et al., 2023; Kosel et al., 2024; Stahnke & Gegenfurtner, in press).

5.1 Limitations

The present study had some limitations that should be noted. The first limitation concerns the sample composition which included only pre-service teachers at the beginning of their study program. On one hand, this was an important sample for a first insight into this co-occurrence as the participants' experience – which often varies widely among in-service teachers– needs to be controlled in the study of attitudes and gaze behavior. However, it became apparent that even pre-service teachers, who have little teaching experience, show differences in gender attitude and their gaze distribution. On the other hand, future research may wish to replicate the findings reported here with a sample of experienced in-service teachers to investigate whether attitudes and fixations also co-occur as teaching experience increases. Along these lines, it would also be interesting to investigate longitudinally whether attitudinal preferences change during the transition from pre-service to in-service teaching. A second limitation concerns the length and context of the video clips. For reasons of internal validity, we have chosen a scene in which girls and boys are equally visible in terms of AOI size and in which they exhibit comparable classroom behavior. Still, future research may wish to replicate the present findings with video stimuli that are more extended or more complex, perhaps illustrating different kinds of social classroom settings such as individual work vs. group work (Stahnke & Blömeke, 2021) or complex classroom management situations (Gabel et al., 2023; Gabel et al., in press). Moreover, as the theoretical section of this paper illustrates, teachers' gender attitudes vary in different contexts. In this video, all students had a migration background, which might also bias or reinforce the gender-specific attitudes of pre-service teachers (Glock, 2016). In addition, this study was framed in the context of classroom management, where teachers primarily associate positive attitudes toward girls and negative attitudes toward boys (Arbuckle & Little, 2004; Beaman et al., 2007; Glock & Kleen, 2017; Hendrickson, 2018). In STEM education, teachers have more positive attitudes and competence attributions toward boys (Copur-Gencturk et al., 2023; Lavy & Sand, 2018). Therefore, the results must be viewed in context and imply replication studies in the context of STEM subjects.

6 Conclusion

To conclude, this study is among the first to investigate co-occurrences between pre-service teachers' gaze behavior and their implicit and explicit attitudes. Our findings tend to indicate that, when watching classroom situations, attitudinal and visual preferences co-occur, with pre-service teachers allocating more attentional resources to girls than boys, arguably as a result of their implicit preference for female students. Future research is encouraged to extend these first steps reported here to help develop a deepened understanding of the role of implicit attitudes for directing teacher gaze in diverse classrooms.

Declarations

Competing interests The authors have no relevant financial or non-financial interests to disclose.

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