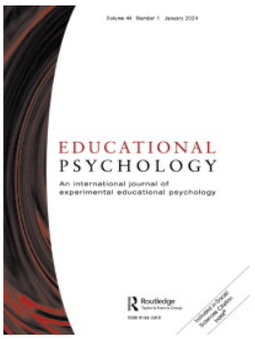

Routledge
Taylor & Francis Group

Educational Psychology

An International Journal of Experimental Educational Psychology

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/cedp20

Association between the teacher–student relationship and teacher visual focus of attention in Grade 1: student task avoidance and gender as moderators

Saswati Chaudhuri, Eija Pakarinen, Heli Muhonen & Marja-Kristiina Lerkkanen

To cite this article: Saswati Chaudhuri, Eija Pakarinen, Heli Muhonen & Marja-Kristiina Lerkkanen (08 May 2024): Association between the teacher–student relationship and teacher visual focus of attention in Grade 1: student task avoidance and gender as moderators, Educational Psychology, DOI: 10.1080/01443410.2024.2346104

To link to this article: https://doi.org/10.1080/01443410.2024.2346104

Published online: 08 May 2024.

EDUCATIONAL PSYCHOLOGY
https://doi.org/10.1080/01443410.2024.2346104

Routledge
Taylor & Francis Group

Association between the teacher–student relationship and teacher visual focus of attention in Grade 1: student task avoidance and gender as moderators

Saswati Chaudhuri[a], Eija Pakarinen[a,b], Heli Muhonen[a] and Marja-Kristiina Lerkkanen[a]

[a]Department of Teacher Education, University of Jyväskylä, Jyväskylä, Finland; [b]Norwegian Centre for Learning Environment and Behavioural Research in Education, University of Stavanger, Stavanger, Norway

ABSTRACT

This study investigated associations between quality of the teacher–student relationship (closeness and conflict) and teachers' ($N=48$) visual focus of attention in Grade 1 classrooms in fall and spring, and it explored to what extent students' ($N=650$) gender and task-avoidant behaviour moderated the associations. Results showed first that teacher–student closeness was positively associated with teachers' visual focus of attention in the fall and spring, whereas teacher–student conflict was positively associated with teachers' visual focus of attention only in the spring. In addition, the results of multigroup analysis showed that students' task-avoidant behaviour had a moderating effect on the association between the quality of the teacher–student relationship and teachers' visual focus of attention in the spring, but gender did not.

ARTICLE HISTORY
Received 18 August 2023
Accepted 18 April 2024

KEYWORDS
Teachers' visual focus of attention; teacher–student relationships; task-avoidant behaviour; gender; grade 1

Introduction

In the complex classroom environment, teachers visual focus of attention varies while interacting with students during classroom instruction to encourage student participation, and notice students' individual needs, and behaviours (van Es et al., 2022). Simultaneously, the effectiveness of teachers' instruction comes from building warm, caring, and supportive relationships with students in elementary grades (Hamre & Pianta, 2001). Previous research has shown that teachers' perception of the teacher–student relationship affects their classroom behaviour and their interaction with students (Stuhlman & Pianta, 2001). For instance, when teachers perceived more conflict than closeness in teacher–student relationships, they increased control over classroom activities and gave more negative feedback to students across elementary school (Hamre & Pianta, 2001; Stuhlman & Pianta, 2001). The present study considers the aspect of two time points wherein, at the beginning of first grade, it may be challenging for

CONTACT Saswati Chaudhuri saswati.s.chaudhuri@jyu.fi Department of Teacher Education, University of Jyväskylä, P.O. Box 35, 40014 Jyväskylä, Finland

teachers to build close relationships with students while noticing their academic skills and learning behaviours to ensure effective instruction compared to the end of the academic year. Previous eye-tracking studies conducted in the classroom have shown that while noticing students, teachers established eye contact to convey authority, dominance, friendliness, or affinity to students when interacting with them (Haataja et al., 2021; McIntyre et al., 2020). However, little is known about whether teachers' overall perception of teacher–student relational quality in terms of closeness and conflict with individual students could be linked to the way teachers focus their visual attention on them at the beginning and ending of first grade. Therefore, the present study investigated, first, the association between the quality of the teacher–student relationship and teachers' visual focus of attention in the fall and spring of Grade 1, and second, to what extent students' characteristics, such as gender and task-avoidant behaviour, moderate this association in authentic classroom settings.

Teachers' visual focus of attention

In the present study, teachers' visual focus of attention has been defined as teachers' duration of eye gaze, particularly on students during a lesson (van den Bogert et al., 2014). In this regard, mobile eye-tracking has been a useful tool in investigating teachers' cognitive processes and finding associations between teachers' visual focus of attention and student characteristics in authentic classroom settings (Jarodzka et al., 2021). Moreover, previous research has shown that teachers often use their prior knowledge and perceptions of teaching, learning, and student characteristics to make pedagogical adaptations in the classroom (Seidel et al., 2020). Previous research has shown that establishing eye contact between teacher and student helps teachers to communicate with students, enforce desired behaviours, and establish relationships (Hietanen et al., 2008; Ledbury et al., 2004). Furthermore, researchers have argued that teachers' interpersonal behaviour with students can characterise their visual focus of attention in the classroom. For example, an eye-tracking study by Haataja et al. (2021) in secondary classrooms revealed that teachers tend to initiate eye contact with students more often while giving instructions, whereas students initiate eye contact more often when teachers show affinity towards the students. Similarly, McIntyre et al. (2020) showed that teachers tend to convey more dominance towards students by increasing eye contact during questioning, whereas more friendliness was conveyed to students when teachers made eye contact during lecturing. Studies by Haataja et al. (2021) and McIntyre et al. (2020) have shown that teachers' nonverbal eye-gaze behaviour influences the way teachers interact with students during teaching in secondary classrooms. Previous research has shown that students' gender influences the amount of attention they receive from the teacher with regard to student behaviour. For instance, girls showing social withdrawal typically receive less attention than boys from teachers (McClowry et al., 2013). However, the influence of students' gender on the association between the teacher–student relationship and teachers' visual focus of attention has not been investigated.

Quality of teacher–student relationship

In early school years, the quality of teacher–student relationship contributes to students' school adaptation, academic and social development (Pianta, 1999; Pianta & Stuhlman,

2004), and learning motivation (Pakarinen et al., 2021). In the present study, the quality of the teacher–student relationship was investigated in terms of closeness and conflict in Grade 1. Closeness refers to teachers' perception of affection, warmth, and openness in the teacher–student relationship (Birch & Ladd, 1997), whereas teacher–student conflict refers to perceived negativity of the teacher towards the student (Jerome et al., 2009). Previous studies have shown the link between the teacher–student relationship and student characteristics, such as student behaviour (Doumen et al., 2008), and academic achievement (Hamre & Pianta, 2001). Research has shown that students' classroom behaviour is linked to teachers' perception of the quality of teacher–student relationships. For instance, students' problem behaviours in the classroom have been shown to be unfavourable for closeness and contributed to more conflict by adversely affecting the quality of the teacher–student relationship at the elementary school level (Doumen et al., 2008). Subsequently, researchers have argued that students' externalising behaviours are likely to increase conflict in teacher–student relationships and evoke negative feedback from the teacher, thereby reducing students' inclination to focus and put effort into the academic task (Nurmi et al., 2003; Stipek & Miles, 2008). However, little is known whether students' task-avoidant behaviour in the classroom moderates the association between teacher–student relationships and teachers' visual focus of attention.

Student characteristics could influence association between the teacher–student relationship and teachers' visual focus of attention

The association between teachers' perceptions of closeness and conflict and teachers' visual focus of attention in the classroom could be influenced by student characteristics, such as students' gender and task-avoidant behaviour, in the early school years. In terms of students' gender, previous studies showed that teachers typically report greater closeness and less conflict in the teacher–student relationship quality with girls than with boys during elementary school (Jerome et al., 2009). Accordingly, girls typically receive more positive attention from teachers than boys due to increased closeness in the teacher–student relationship (Hamre & Pianta, 2001). However, the influence of students' gender on the association between teacher–student relationship and teachers' visual focus of attention is unknown.

In the classroom setting, some students are seen to apply task-focused strategies characterised by persistence and engagement in challenging situations, whereas other students engage in task-avoidant behaviour by showing resistance to challenging situations, characterised by avoiding difficult tasks (Turner et al., 2002). Task avoidance refers to maladaptive behaviours that students display in response to challenges presented by academic tasks (Aunola et al., 2002). In the present study, students' task-avoidant behaviour was defined as the teachers' report of students avoiding challenging tasks instead of trying to attempt them (Zhang et al., 2011). Previous research has shown that teachers tend to adapt their interaction with students based on students' achievement behaviours (Pakarinen et al., 2014). Additionally, an eye-tracking study has shown that teachers focus immediate visual attention on students showing off-task and disruptive behaviour in elementary school (Goldberg et al., 2021; Shinoda et al., 2021; Yamamoto & Imai-Matsumura, 2013) and secondary

school classrooms (van den Bogert et al., 2014). Therefore, it is possible that when students show increased task-avoidant behaviour, teachers need to focus their visual attention on individual students to provide necessary feedback. When students show task-focused behaviour, it is possible that teachers provide positive feedback (Haataja et al., 2021), perceive more closeness, and give attention to students to encourage their learning approach (Pakarinen et al., 2011). Nevertheless, there is lack of prior empirical research regarding the associations between the teacher–student relationship and teachers' visual focus of attention in the early primary school context. Therefore, research is needed to investigate if teachers may modify their visual focus of attention during a lesson based on their overall perceptions of closeness or conflict towards individual students.

Aim of the study

The aim of this study was to explore the association between the quality of the teacher–student relationship (closeness and conflict) and teachers' visual focus of attention in authentic classroom settings of Grade 1 using mobile eye-tracking technology at two time points of the academic year, fall and spring. The two time points were included to explore if the said association varied between fall when the academic year begins and the spring when the academic year ends. In Finland, students begin elementary school at the age of seven. Grade 1 marks the first year of elementary school, wherein, in the fall, students typically meet their teacher for the first time. The first years of elementary school already lay an important foundation for students' successful schooling (Alexander & Entwisle, 1988). Thus, it is important to examine how teachers' perception of their relationships with students is linked to their visual focus of attention towards students in the classroom as teachers need to support students' academic and social development. This study was exploratory in nature, and to our knowledge, there is no prior research examining the phenomena being examined in this study. Therefore, the hypotheses for the research questions were generated cautiously.

The research questions and associated hypotheses for the present study were as follows:

1. To what extent is the quality of teacher–student relationship associated with teachers' visual focus of attention in the fall and spring of Grade 1?
   Hypothesis 1: Our preliminary exploratory hypothesis was that teachers' perception of teacher-student closeness is positively associated with their visual focus of attention in fall of Grade 1 and in the spring of Grade 1, we tentatively expected that teacher-student conflict is positively associated with teachers' visual focus of attention.
2. To what extent do student characteristics (gender and task-avoidant behaviour) moderate the association between the quality of the teacher–student relationship and teachers' visual focus of attention in the fall and spring of Grade 1?
   Hypothesis 2.1: We tentatively hypothesised that student's gender moderated the association between quality of the teacher–student relationship and teachers' visual focus of attention in the fall and spring of Grade 1.

Hypothesis 2.2: We tentatively hypothesised that student's task-avoidant behaviour moderated the association between quality of the teacher–student relationship and teachers' visual focus of attention in the fall and spring of Grade 1. In particular, we expected that at both fall and spring of Grade 1, this association will vary among students showing low, average, and high task-avoidant behaviours.

Methods

Participants and procedure

In the present study, 48 Finnish teachers (45 females, 3 males; M_{age} = 45.06 years, SD = 8.59) and their 650 students (326 females, 324 males; M_{age} = 6.94, SD = .31) participated in the fall of Grade 1, and 47 teachers (45 females, 2 males; M_{age} = 44.85, SD = 9) and their 630 students (318 females, 312 males; M_{age} = 7.27, SD = .47) participated in the spring of Grade 1. It is important to note that participants in fall and spring were largely the same. However, 5 teachers from the fall were not considered in the spring due to poor quality of eye-tracking video recordings and no response from questionnaires. Furthermore, 4 new teachers joined the study at spring. Despite the overlap between the samples from fall and spring, they were analysed separately as classroom conditions at both time points were not controlled or pre-decided to ensure authentic classroom settings for teacher's eye-tracking video recordings. The participating classrooms were from five municipalities of Central Finland, including both rural and urban areas. The teachers' average work experience was 16.54 years (SD = 9.29, Min_{exp} = 0.5, Max_{exp} = 39). All teachers had a master's degree in education for teaching in elementary school. The average class size was 13.54 students (SD = 5.51, Min = 1, Max = 22) in the fall and 13.40 students (SD = 5.36, Min = 1, Max = 23) in the spring.

The data presented in this study are part of a larger project that focused on the role of teacher and student stress and interaction in classroom (Lerkkanen and Pakarinen, 2016–2022). An approval from the university's ethical committee was obtained before the study was conducted in 2017. The data of the present study were collected from Grade 1 at two specific time points, in the fall of 2017, when the school year started, and in the spring of 2018, when the school year ended. Written consent to participate in the study was taken from voluntary teachers and the children's parents. Teachers rated students' task-avoidant behaviour and the quality of the teacher–student relationship with each of their students in their classroom who participated in the study. Mobile eye-tracking recordings were used to investigate teachers' visual focus of attention in authentic classroom settings. Teachers completed questionnaires related to their own background information and student factors typically after the mobile eye-tracking video recording day.

Measures

Teachers' visual focus of attention

The teachers wore Tobii Pro Glasses 2 (Tobii AB, Danderyd, Sweden) for a duration of 20–25 minutes starting from the beginning of the second lesson of a routine school day. In the present study, teachers' visual focus of attention towards students was

investigated in authentic classroom settings. Accordingly, the structure and content of the lessons were not controlled, teachers were given the freedom to choose how they wanted to conduct the lesson, and students' movements in the classroom during the eye-tracking video recording were not restricted. The eye-tracking video recordings in the fall consisted of 22 literacy lessons, 18 maths lessons, and 8 activity-based lessons. In the spring, there were 20 literacy, 23 maths, and 4 activity-based lessons.

According to Niehorster et al. (2020), gaze estimates of Tobii Pro Glasses 2 are stable when the eye-tracker moved based on small movements of the face. Subsequently, in the present study, the issues of eye-tracking glasses' calibration, accuracy, and precision were addressed during the process of teachers' eye-tracking video recording from the authentic classroom settings. The eye-tracking glasses were calibrated by two trained research assistants before each recording using 1-point calibration as suggested by the manufacturer. To ensure good data quality, the calibration was validated and rechecked by asking the teachers to look at three points on the wall. According to the manufacturer (see Tobii Connect, 2023), accuracy is the difference between the real-life gaze position and the eye tracker recorded gaze position. Next, research assistants checked for accuracy, wherein they ensured that the eye-tracking glasses mapped the gaze point correctly on the scene video as it is in the real-life situation using in the Tobii Pro Glasses Controller software on a tablet.

After the recordings were conducted, fixations were filtered from the video stream using the I-VT Attention filter setting on Tobii Pro Lab v.1.128 analysis software. This eye-movement filter is best suited for identifying fixations where the participant's physical movements are not restricted during the mobile eye-tracking video recordings. The fixation durations are defined as the time when the eye is relatively still and taking input from the environment for information processing (Holmqvist et al., 2015). In the present study, fixation metrics such as total fixation durations only on individual students were considered as an indicator for teachers' visual focus of attention and used for further analysis.

Teachers' visual focus of attention in the classroom was determined based on their areas of interest (AOIs). The AOIs were defined as the targets which the teacher looked at in the eye-tracking videos, such as students, instructional materials (e.g. teaching and learning materials), and noninstructional materials (e.g. tables, walls, curtains, etc.). Similar AOI codes have been utilised in prior studies using mobile eye-tracking technology with teachers in the classroom (see Chaudhuri et al., 2022a, 2022b). Fixations identified from the eye-tracking video recording on Tobii Pro Lab v.1.128 software were mapped on the respective AOIs by trained research assistants based on where the teacher focused their attention. For instance, if the teacher's visual focus of attention was targeted towards a particular student, as represented by a red circle on the video, then the gaze was manually mapped on the respective student snapshot and identified as the teacher's AOI.

Double coding was done with 20% of the videos from the whole dataset to check the intercoder reliability, which provided a double coding agreement average of 91.43% in the fall and 90.09% in the spring. After manual coding of the eye-tracking video recording, for further analysis, teachers' visual focus of attention in terms of total fixation duration on students only was considered. In authentic classroom

settings, it might not be possible to ensure optimal conditions for the best quality of eye-tracking data for the whole duration of recording as there are several unrestricted movements in addition to eye blinking that could lead to data loss. Therefore, a benchmark was set so that eye-tracking recordings with a gaze sample percentage of 70% and above were selected. Gaze sample percentage is the total percentage of the recording duration when one or both eyes were detected by the mobile eye-tracking glasses. In terms of data loss, in the present study, three eye-tracking video recordings from the fall of 2017 and the spring of 2018, respectively, were excluded due to gaze sample percentage less than 70%. It is possible that the low gaze sample percentage in these videos could be due to teachers' fast and unrestrained head movements, or excessive bright light in the classroom.

Typically, introducing a new technical gadget in a classroom can generate curiosity among students. Thus, at the beginning of the school day, research assistants informed the students about the study. Moreover, teachers who wore the eye-tracking glasses could have faced some implied changes in their visual gaze behaviour with the social presence of an eye-tracker even though they did not report it (Risko & Kingstone, 2011). However, the research assistants took utmost care to ensure that the teachers felt comfortable while wearing the glasses and there was least disruption in the classroom.

Quality of teacher–student relationship

Teachers completed the short form of the Student-Teacher Relationship Scale (STRS; Pianta, 2001; Finnish translation of STRS, Pakarinen et al., 2011, 2018), which measured the quality of the teacher–student relationship in terms of closeness and conflict. Each of the 15 items was rated on a 5-point scale from 1 = *Definitely does not apply* to 5 = *Definitely applies*. The closeness subscale consisted of eight items, such as, '*I have a close, warm relationship with this child*'. One item in the closeness subscale, particularly, '*This child experiences physical closeness or touch expressed by me as uncomfortable*' was reverse scored. Additionally, the conflict subscale consisted of seven items, such as '*There always seem to be difficulties between this child and me*'. The mean of each subscale was calculated for individual students. Spearman's rho correlation analysis showed that closeness associated with conflict in fall ($\rho = -.18$, $p < .001$) and spring ($\rho = -.28$, $p < .001$). Cronbach's alpha for the closeness subscale was .87 in the fall and .89 in the spring, and for the conflict subscale, it was .88 both in the fall and the spring.

Student characteristics

The teacher reported students' gender along with STRS ratings. Next, the extent of students' task-avoidant behaviour was rated by the teacher using the Behaviour Strategy Rating Scale (BSRS; Aunola et al., 2000; Zhang et al., 2011). Each of the five items in this scale was rated on a 5-point rating scale from 1 = *Never* to 5 = *Always*. Out of the five items, two were positively worded, such as '*Does the student actively attempt to solve even difficult situations and tasks?*' and three were negatively worded, such as '*Does the student have a tendency to find something else to do instead of focusing on the task at hand*'. The two positively worded items were reversed before calculating

the sum score. Cronbach's alpha for students' task avoidance was .95 in the fall and .96 in the spring.

Analyses

The data analyses consisted of three phases. First, as a preliminary analysis, IBM SPSS Statistics 27 (IBM, Armonk, NY, USA) was used to conduct Pearson and Spearman's rho correlation analyses to examine associations between the quality of teacher–student relationship (closeness and conflict) and teachers' visual focus of attention to students in terms of total fixation duration in the fall and spring. Second, using Mplus software (Version 8.7; Muthén & Muthén, 1998–2012) and structural equation modelling, path models were constructed wherein teacher visual focus of attention (in terms of total fixation duration in seconds) was regressed both on teacher-perceived closeness and conflict. Teacher-perceived closeness and conflict were let to correlate. Separate models were specified for fall and spring. The TYPE = COMPLEX option was used since the data were nested: teachers rated several students in the classroom with respect to the quality of the teacher–student relationship and students' task-avoidant behaviour. This option corrected for distortions in standard errors in estimates caused by the clustering of observations (Muthén & Muthén, 1998–2012; Williams, 2000).

As a final step, multigroup models were specified to estimate whether gender and task-avoidant behaviour moderated the associations between teacher–student relationship (closeness and conflict) and teachers' visual focus of attention in the fall and spring of Grade 1. Multi-group modelling was used to test whether the path coefficients differed significantly by group based on the Satorra–Bentler scaled chi-square difference test (Satorra & Bentler, 2001), which compared the constrained models (wherein all paths were restricted to be invariant by the groups) to the unconstrained models (wherein paths one by one were allowed to vary by group).

For moderation analyses, students were grouped according to their gender into girls (N_{Fall} = 325, N_{Spring} = 318) and boys (N_{Fall} = 323, N_{Spring} = 310). Second, to analyse whether task-avoidant behaviour moderates the link between teacher–student relationship and teachers' visual focus of attention, students were grouped in three groups in terms of their task-avoidant behaviour: low (N_{Fall} = 164, 25.38%; N_{Spring} = 163, 26.08%), average (N_{Fall} = 340, 52.63%; N_{Spring} = 308, 49.28%), and high (N_{Fall} = 142, 21.98%; N_{Spring} = 154, 24.64%). The cut off points were made based on the variable distribution in order to choose 20%–25% of the lowest and highest end in terms of students' task-avoidant behaviour, the other students belonging to the average group.

The goodness of fit of all the estimated models was examined using three indicators, that is, comparative fit index (CFI), root-mean-square error of approximation (RMSEA), and standardised root-mean-square residual (SRMR). Furthermore, cut-off criteria for fit indices by Hu and Bentler (1999) were used to determine a relatively good model fit using a cut-off value close to .95 for CFI, .06 for RMSEA, and .08 for SRMR. The model parameters were estimated using full information maximum likelihood (FIML) with robust standard errors maximum likelihood robust (MLR).

Results

Associations between the quality of teacher–student relationship and teachers' visual focus of attention

The descriptive statistics and the correlations between the study variables are shown in Table 1. Preliminary analysis of associations between classroom background factor such as class size and teachers' visual focus of attention in terms of total fixation duration showed that there was a significant association between class size and teachers' total fixation duration in spring ($r = -.48$, $p < .001$) and not in the fall: the larger the number of students in the classroom, the lower the duration of total fixation duration was on individual students. Furthermore, as previous studies reported the link between teachers' work experience on their professional vision, a preliminary analysis was conducted for confirming the association between teachers' work experience and the present study variables which showed no significant associations. The results also showed that task-avoidant behaviour correlated positively with teachers' fixation duration at both time points: the more a student showed task-avoidant behaviour, the longer the teacher focused their visual attention on the student. Furthermore, students' task-avoidant behaviour correlated negatively with teacher–student closeness in the fall: the more a student showed task-avoidant behaviour, the less closeness the teacher reported as having towards the individual student. However, students' task-avoidant behaviour correlated positively with teacher–student conflict in the fall: the more a student showed task-avoidant behaviour, the more conflict teacher reported in the teacher–student relationship.

The first research question examined the association between the quality of teacher–student relationship and teachers' visual focus of attention in the fall and spring of Grade 1. The results (Table 1) showed that closeness in the teacher–student relationship was positively associated with teachers' total fixation duration at both time points: the closer the relationship with the student that the teacher reported, the longer they focused attention on the student. Furthermore, the more the teacher experienced a conflicted relationship with the student in the spring, the longer they focused their visual attention on the student.

Students' characteristics moderating the association between the quality of the teacher–student relationship and teachers' visual focus of attention

The second research question investigated whether student characteristics, such as students' gender and task-avoidant behaviour, moderated the association between the quality of the teacher–student relationship and teachers' visual focus of attention in the fall and spring. The unconstrained model (with freely estimated paths) and the constrained model (with restricted paths) were estimated separately and then compared using the Satorra–Bentler scaled chi-square difference test to select the best fitting model (see Table 2 for model comparison).

First, the separate path models for the fall and spring were tested using students' gender as the moderator. The fit of the unconstrained model for the students' gender as a moderator in the fall was perfect (i.e. saturated): χ^2 (0) = 0, p = .00; TLI = 1.00; CFI = 1.00; RMSEA = .00; SRMR = .00. The fit of the constrained model for the

Table 1. Descriptive statistics and correlations between the study variables.

							Quality of teacher-student relationship				Teachers' visual focus of attention		Student characteristics	
	$M(SD)_F$	Min_F	Max_F	$M(SD)_S$	Min_S	Max_S	Clo (F)	Clo (S)	Con (F)	Con (S)	TFD (F)	TFD (S)	TAB (F)	TAB (S)
Student characteristics:														
Gender[†]	–	–	–	–	–	–	.228[η]	.190 [η]	.179[η]	.124 [η]	.091[η]	.006 [η]	.022 [η]	.023 [η]
Task avoidant behaviour (TAB)	2.58 (1.19)	1	5	2.37 (1.17)	1	5	−.207** −.179 [ρ]**	−.166** −.196[ρ]**	.535** .470 [ρ]**	.519** .472[ρ]**	.104**	.088*		
Teachers' visual focus of attention: Total fixation duration (TFD) in seconds	25.75 (18.06)	0.40	129.64	26.63 (20.16)	0.16	162.22	.125**.136 [ρ]**	.085* .087 [ρ]*	.067 .025 [ρ]	.177** .153[ρ]**				
Quality of student-teacher relationship:														
Closeness (Clo)	3.95 (0.67)	1.88	5	4.08 (0.69)	1.75	5								
Conflict (Con)	1.50 (0.71)	1	4.43	1.46 (0.70)	1	4.57								

Note.
**$p < .001$.
*$p < .05$.
F = Fall, S = Spring, [†]1 = female, 2 = male, [η]Eta-value, [ρ]Spearman's rho.

students' gender as a moderator in the fall was acceptable: χ^2 (2) = 2.68, p = .260; TLI = .898; CFI = .949; RMSEA = .033; SRMR = .030. The results of the Satorra–Bentler scaled chi-square difference test (Table 2) indicated that the constrained model fit the data better in the fall. The results further showed that gender did not moderate the association between teacher–student relationship and visual focus of attention in the fall of Grade 1 (Table 3). Teacher-perceived closeness was associated positively with teachers' total fixation duration for both boys and girls in the fall. Conflict, however, was not significantly related to teachers' total fixation duration either for boys or girls. Next, the fit of the unconstrained model with students' gender as the moderator in the spring was perfect: χ^2 (0) = 0, p = .00; TLI = 1.00; CFI = 1.00; RMSEA = .00; SRMR = .00. The fit of the constrained model for the students' gender as a moderating variable in the spring was perfect: χ^2 (2) = .763, p = .682; TLI = 1.00; CFI = 1.00; RMSEA = .00; SRMR = .02. Next, the unconstrained model was compared with the constrained model using the Satorra–Bentler scaled chi-square difference test, and the results (Table 2) indicated that the constrained model was also superior to the unconstrained model in the spring. The results (Table 3) showed again that gender did not moderate the link between the teacher–student relationship and teacher visual focus of attention in the spring of Grade 1: both closeness and conflict were positively associated with teachers' total fixation duration for both boys and girls in the spring. Also, in the spring, conflict was positively associated with teachers' total fixation duration for both boys and girls.

Second, the models were tested separately for the fall and spring by considering students' task-avoidant behaviour as a moderator. The fit of the unconstrained model with students' task-avoidant behaviour as a moderator in the fall was perfect: χ^2 (0) = 0, p = .00; TLI = 1.00; CFI = 1.00; RMSEA = .00; SRMR = .00, whereas the fit of the constrained multigroup model with students' task-avoidant behaviour as a moderator

Table 2. Goodness-of-fit statistics (Chi-square) for the nested models in Fall and Spring.

Model names	χ^2	*df*	Scaling correction index	Model comparisons with Satorra-Bentler-scaled χ^2 difference test
Constrained model with gender as moderator in fall—GF1	2.687	2	.885	GF1 vs GF2: $\Delta\chi^2$ (Δdf=2) = 2.687; p = .260
Unconstrained model with gender as moderator in fall—GF2	0	0	0	TABF1 vs TABF2: $\Delta\chi^2$ (Δdf=2) = .346; p = .841
Constrained model with task avoidant behaviour as moderator in fall—TABF1	.346	2	.841	
Unconstrained model with task avoidant behaviour as moderator in fall—TABF2	0	0	0	
Constrained model with gender as moderator in spring—GS1	.763	2	1.523	GS1 vs GS2: $\Delta\chi^2$ (Δdf=2) = .763; p = .682
Unconstrained model with gender as moderator in spring—GS2	0	0	0	TABS1 vs TABS2: $\Delta\chi^2$ (Δdf=4) = 37.327; p = **.000****
Constrained model with task avoidant behaviour as moderator in spring—TABS1	37.327	4	.573	
Constrained model with task avoidant behaviour as moderator in spring—TABS2	0	0	0	

Note. In bold—significant results at **p < .001.

Table 3. Students' gender and task-avoidant behaviour moderating the association between quality of teacher-student relationship and teachers' visual focus of attention.

	Students' gender				Students' task avoidant behaviour					
	Fall		Spring		Fall			Spring		
	Girls ($N=325$) β(SE)	Boys ($N=323$) β(SE)	Girls ($N=318$) β(SE)	Boys ($N=310$) β(SE)	Low ($N=164$) β(SE)	Average ($N=340$) β(SE)	High ($N=142$) β(SE)	Low ($N=163$) β(SE)	Average ($N=308$) β(SE)	High ($N=154$) β(SE)
Quality of teacher–student relationship → Teachers' visual focus of attention										
1. Closeness → Total fixation duration	.175(.04)**	.144(.04)**	.135(.05)*	.128(.05)*	.183(.05)**	.159(.04)**	.134(.03)**	**.187(.04)***	**.233(.07)***	**−.037(.07)**
2. Conflict → Total fixation duration	.059(.04)	.065(.05)	.209(.05)**	.198(.06)**	.007(.06)	.017(.05)	.021(.09)	**.315(.12)***	**.082(.06)**	**.246(.05)****

Note.
*p <.05.
p <.001. → = regression, β = Beta coefficient, (SE) = Standard Error, Coefficients from unconstrained model in **bold.

was satisfactory: χ^2 (4) = 5.05, p = .282; TLI = .892; CFI = .928; RMSEA = .035; SRMR = .042. Next, the unconstrained model was compared with the constrained model with the Satorra–Bentler scaled chi-square difference test (see Table 2 for model comparison). The restricted model provided the best fit. The model modification indices (MIs) of the restricted model suggested that the model fit could be improved by allowing the association between conflict and teachers' total fixation duration to be freely estimated for the students with an average (MI = 4.34) and high (MI = 4.37) amount of task-avoidant behaviour. After these modifications, the model fit was excellent: χ^2 (2) = .346, p = .841; TLI = 1.00; CFI = 1.00; RMSEA = .00; SRMR = .01. In the fall, the results (see Table 3) showed that task-avoidant behaviour did not moderate the association between the teacher–student relationship and teacher visual focus of attention: closeness was positively associated with teachers' total fixation duration for students with a low, average, and high amount of task-avoidant behaviour. Conflict, in turn, was not associated with teachers' total fixation duration for students with a low, average, or high amount of task-avoidant behaviour in the fall.

Finally, the moderation effect of task-avoidant behaviour in the spring was investigated. The fit of the unconstrained model with students' task-avoidant behaviour as a moderator in the spring was perfect: χ^2 (0) = 0, p = .00; TLI = 1.00; CFI = 1.00; RMSEA = .00; SRMR = .00. In turn, the fit of the restricted model was poor: χ^2 (4) = 37.32, p = .00; TLI = .004; CFI = .336; RMSEA = .20; SRMR = .09. The model MIs suggested that we free the path between conflict and teachers' total fixation duration for the students with low (MI = 20.59), average (MI = 9.99), and high (MI = 9.39) task-avoidant behaviour. After this, the fit of the selected model was excellent: χ^2 (1) = .564, p = .452; TLI = 1.00; CFI = 1.00; RMSEA = .00; SRMR = .02. Next, the unconstrained and constrained models were subjected to the Satorra–Bentler scaled chi-square difference test, and as a result, the unconstrained model was selected. In the spring, the results showed that task-avoidant behaviour moderated the associations between the teacher–student relationship and teacher visual focus of attention (see Table 3). Closeness was positively associated with teachers' total fixation duration for students with low and average task-avoidant behaviour, but not for students of high task-avoidant behaviour. Furthermore, conflict was positively associated with teachers' total fixation duration for students with low and high task-avoidant behaviour, but not for students with an average amount of task-avoidant behaviour.

Discussion

In the present study, associations between the quality of the teacher–student relationship and teachers' visual focus of attention in Grade 1 were examined. Additionally, it was examined to what extent students' gender and task-avoidant behaviour moderated this relationship. The results showed that, first, teacher–student closeness was positively associated with teachers' visual focus of attention to students in terms of teachers' total fixation duration in the fall and spring. However, teacher–student conflict was positively associated with teachers' total fixation duration only in the spring. Second, the results showed that students' gender did not have a moderation effect, but students' task-avoidant behaviour moderated the association between the quality of the teacher–student relationship and teachers' visual focus of attention in the spring.

Teacher–student closeness associated with teachers' visual focus of attention indicates that teachers give a longer visual focus of attention to students towards whom they perceive more closeness in both fall and spring. This result can be partly aligned with our hypothesis 1 stating that in the first school year, especially in the fall, teachers need to establish warm relationships with the new class of students and get to know them individually. Therefore, as suggested by McIntyre et al. (2020), it could be that teachers focus longer on students during teaching situations to convey warmth, communion, and affinity through establishing eye contact during classroom instruction. Furthermore, in the spring, teacher-perceived conflict was positively associated with teachers' total fixation duration to students, indicating that teachers focused longer visual attention on those students with whom they perceived to be experiencing more conflict. It is possible that by the spring of Grade 1, teachers have gotten to know their students more and have developed more negative perceptions towards certain students due to, for example, students' behaviour-related challenges. This could be in line with previous research showing that teachers give longer visual focus of attention to students showing disruptive behaviour while they are teaching in the classroom (Goldberg et al., 2021). In another eye-tracking study, it was shown that teachers looked longer at students while providing feedback in relation to students' task or behaviour (Haataja et al., 2021). Hence, also in the case of the present study, it could be that teachers look longer at students who require more of their feedback regarding their behaviour. However, teachers' reasoning and student behaviours supporting the newly found association between teachers' perception of teacher-student closeness and teachers' visual focus of attention needs further examination in certain classroom situations.

Next, we investigated the moderation effects of students' gender and task-avoidant behaviour on the association between teacher perceived teacher–student relationship quality and teachers' visual focus of attention. First, the results showed that students' gender did not moderate the association between the quality of the teacher–student relationship and visual focus of attention. Contradictory to our preliminary expectation, it is safe to reject our hypothesis 2.1 stating that students' gender moderates the association between teacher-student relationship and teachers' visual focus of attention.

Second, students' task-avoidant behaviour moderated the association between the quality of the teacher–student relationship and teachers' visual focus of attention in terms of teachers' total fixation duration only in the spring. This result partly met our tentative expectation as student's task-avoidant behaviour moderated the association between quality of the teacher–student relationship and teachers' visual focus of attention only in the spring and not fall of Grade 1. Accordingly, teacher-perceived closeness was positively related to teachers' visual focus of attention for students showing a low and average amount of task-avoidant behaviours in the spring. Additionally, teacher-perceived conflict was positively related to teachers' visual focus of attention for students with a low and high amount of task-avoidant behaviour. Furthermore, this result could be explained by the fact that teachers have more knowledge about students' achievement-related behaviour in the spring that could contribute to teacher-perceived closeness and conflict in the relational quality and thus guide teachers' visual focus of attention in the spring. This result can be discussed in two ways, based on how students show low task-avoidant behaviour. First, aligning

with previous research, when students with task-focused behaviour show interest in a given task, teachers perceive more closeness towards students and thereby further support students' achievement-related behaviour, and learning (Pakarinen et al., 2011) and show warmth and affinity towards the student by increasing eye contact (McIntyre et al., 2020). Second, students' low task-avoidant behaviour can be characterised by students showing more passive task-avoidance, such as showing shyness, withdrawal, less involvement in the learning task, and reduced interaction with the teacher (Pakarinen et al., 2014). Therefore, the relation between teacher–student conflict and teachers' visual focus of attention on students showing low task-avoidant behaviour could be supported by previous research showing that teachers could give longer visual focus of attention to monitor and give adaptive pedagogical support to students who show withdrawal from learning tasks during a lesson (Seidel et al., 2020). Furthermore, for students with an average amount of task-avoidant behaviour, only teacher-perceived closeness was related to teachers' visual focus of attention. This result could indicate that students with an average amount of task-avoidant show adequate focus on the given task. Therefore, it could be that teachers have an increased perception of closeness towards students with an average amount of task-avoidant behaviour and thus give them a longer visual focus of attention.

Finally, for students with a high amount of task-avoidant behaviour, only conflict was related to teachers' visual focus of attention in the spring. Previous research has shown that students' high task-avoidant behaviour could be characterised by learning-related maladaptive behaviour, such as attention deficit, low self-regulation and motivation, thereby reducing their focus on academic tasks (Olson et al., 2005). This could indicate that when students show high task-avoidant behaviour, the teacher perceives increased conflict with the student and needs to give longer visual focus of attention to provide adaptive support and monitor students. This could be in line with previous studies using eye-tracking showing that during teaching situations, teachers give a longer visual focus of attention to students to establish authority and control in the classroom situation (McIntyre et al., 2020) and when students do not respond to the teachers' instructions (Shinoda et al., 2021). Furthermore, it could be that when teachers perceive the relationship as conflicted, they need to provide more visual focus of attention in the form of instructional support to manage students' task-avoidant behaviour.

Implications of the study

The results gave new empirical understanding of the way teachers' visual focus of attention is associated with the top-down factor of teachers' overall perceptions of closeness and conflict in relationships with students and how this association varies at two time points of the academic year in Grade 1. In addition, the present study takes eye-tracking research in the classroom further by showing how this technology can be combined with teacher- and student- related measures. Specifically, the results showed that bottom-up factor of students' task avoidant behaviour and not gender moderated the association between teachers' perception of quality of teacher-student relationship and visual focus of attention only in the spring. In practice, these results call for improved awareness of teachers' perceptions of closeness and conflict towards

students. It could be possible that teachers' perception of more conflict over a long period of time towards students could reflect on their actual practices and interactions with students (Stuhlman & Pianta, 2001). To readily address this issue, incorporating teachers' visual focus of attention in pre- and in- service programs could increase teachers' awareness of specific students' learning-related behaviours that evoke unfavourable reactions from the teacher and increase teachers' perception of conflicts with the students.

Limitations and future directions

There are some limitations in relation to the present study. First, the eye-tracking videos were recorded in the first 20–25 minutes of the lesson, which may not have shown all the changing teaching situations encountered by the teacher. In further research, teachers' eye-tracking data could be processed in a way that captures the moment-to-moment changes in the whole lesson. Second, this study investigated whether only students' gender and task-avoidant behaviour moderated the association between the teacher–student relationship and teachers' visual focus of attention. In future research, other student characteristics such as students' motivation, engagement, and self-regulation in academic tasks could be considered as they are linked to teacher–student relationships (Hamre & Pianta, 2001; Pakarinen et al., 2021). Third, in the present study teachers participated on a voluntary basis and they were not selected based on their years of work experience. In the future, it could be beneficial to select teachers based on their level of work experience in order to have sufficient representation of novice and experienced teachers. Fourth, in order to ensure authentic classroom setting during teachers' eye-tracking video recordings, teacher-related top-down factors like subject and lesson structure were not controlled in the present study. Additionally, bottom-up factors like students' movements, seating arrangements, and class sizes were not restricted which may have had an influence on how teachers allocated their visual attention during teaching. In future research, controlled study settings should be considered to gain more fine-grained research evidence on the link between teacher–student relationship and teacher visual focus of attention. Due to the varying conditions, such as the school subjects and teachers' teaching strategies, specific classroom events in the eye-tracking videos were not classified as individual episodes in the present study but treated as a whole data pool. In future studies, it would be beneficial to investigate teachers' eye movement data from specific episodes of classroom events in combination with teacher-related factors from the specific classroom events. Finally, cross-sectional models were used to investigate the associations in the fall and spring separately. Therefore, no causal inferences could be made.

Conclusions

The present study showed that teachers' overall perception of closeness and conflict in the teacher–student relationship plays a role in the way teachers' focus their visual attention on students in the classroom. The results add to the existing literature on teachers' noticing by indicating that teachers' experience of students' achievement-related behaviour

in the classroom moderates the association between their perception of the teacher–student relationship and visual focus of attention during teaching at the end of Grade 1.

Acknowledgements

This work was supported by Academy of Finland: [Grant Number 317610]; Ella and Georg Ehrnrooth Foundation; Emil Aaltonen Foundation: [Grant Numbers 220139 and 230127]; and Työsuojelurahasto (Finnish Work Environment Fund). This study is also a part of the project EduR-ESCUE–The Resilient Schools and the Education System funded by the Strategic Research Council established within the Academy of Finland (#345196).

Disclosure statement

This is to disclose that certain parts of this manuscript bear a close resemblance to the first author's doctoral dissertation as the present research article was an original work included in her article-based doctoral dissertation. The thesis [Teachers' visual focus of attention and related factors in Grade 1 classrooms: Teacher stress, students' academic skills and teacher–student relationships, 2023] has been published in the electronic series JYU Dissertations in Jyväskylä University institutional repository JYX. Please see: https://jyx.jyu.fi/handle/123456789/92117 that the present manuscript was 'under review' at the time of the first author's doctoral defense.

ORCID

Saswati Chaudhuri http://orcid.org/0000-0003-0327-7550
Eija Pakarinen http://orcid.org/0000-0001-7190-6705
Heli Muhonen http://orcid.org/0000-0001-6199-7068
Marja-Kristiina Lerkkanen http://orcid.org/0000-0002-5709-5800

References

Alexander, K. L., & Entwisle, D. R. (1988). Achievement in the first 2 years of school: Patterns and processes. *Monographs of the Society for Research in Child Development*, *53*(2), 1–157. https://doi.org/10.2307/1166081

Aunola, K., Nurmi, J.-E., Niemi, P., Lerkkanen, M.-K., & Rasku-Puttonen, H. (2002). Developmental dynamics of achievement strategies, reading performance, and parental beliefs. *Reading Research Quarterly*, *37*(3), 310–327. https://doi.org/10.1598/RRQ.37.3.3

Aunola, K., Nurmi, J.-E., Parrila, R., & Onatsu-Arvilommi, T. (2000). *Behavioral Strategy Rating Scale*. University of Jyväskylä.

Birch, S. H., & Ladd, G. W. (1997). The teacher–child relationship and children's early school adjustment. *Journal of School Psychology*, *35*(1), 61–79. https://doi.org/10.1016/S0022-4405(96)00029-5

Chaudhuri, S., Muhonen, H., Pakarinen, E., & Lerkkanen, M.-K. (2022a). Teachers' visual focus of attention in relation to students' basic academic skills and teachers' individual support for students: An eye-tracking study. *Learning and Individual Differences*, *98*, 102179. https://doi.org/10.1016/j.lindif.2022.102179

Chaudhuri, S., Muhonen, H., Pakarinen, E., & Lerkkanen, M.-K. (2022b). Teachers' focus of attention in first-grade classrooms: Exploring teachers experiencing less and more stress using mobile eye-tracking. *Scandinavian Journal of Educational Research*, *66*(6), 1076–1092. https://doi.org/10.1080/00313831.2021.1958374

Doumen, S., Verschueren, K., Buyse, E., Germeijs, V., Luyckx, K., & Soenens, B. (2008). Reciprocal relations between teacher–child conflict and externalizing behavior in kindergarten: A

three-wave longitudinal study. *Journal of Clinical Child and Adolescent Psychology*, *37*(3), 588–599. https://doi.org/10.1080/15374410802148079

Goldberg, P., Schwerter, J., Seidel, T., Müller, K., & Stürmer, K. (2021). How does learners' behavior attract preservice teachers' attention during teaching? *Teaching and Teacher Education*, *97*, 103213. https://doi.org/10.1016/j.tate.2020.103213

Haataja, E., Salonen, V., Laine, A., Toivanen, M., & Hannula, M. S. (2021). The relation between teacher-student eye contact and teachers' interpersonal behavior during group work: A multiple-person gaze-tracking case study in secondary mathematics education. *Educational Psychology Review*, *33*(1), 51–67. https://doi.org/10.1007/s10648-020-09538-w

Hamre, B. K., & Pianta, R. C. (2001). Early teacher–child relationships and the trajectory of children's school outcomes through eighth grade. *Child Development*, *72*(2), 625–638. https://doi.org/10.1111/1467-8624.00301

Hietanen, J., Leppänen, J., Peltola, M., Linna-Aho, K., & Ruuhiala, H. (2008). Seeing direct and averted gaze activates the approach–avoidance motivational brain systems. *Neuropsychologia*, *46*(9), 2423–2430. https://doi.org/10.1016/j.neuropsychologia.2008.02.029

Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & DeWeijer, J. (2015). *Eye tracking: A comprehensive guide to methods and measures*. Oxford University Press.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Jarodzka, H., Skuballa, I., & Gruber, H. (2021). Eye-tracking in educational practice: Investigating visual perception underlying teaching and learning in the classroom. *Educational Psychology Review*, *33*(1), 1–10. https://doi.org/10.1007/s10648-020-09565-7

Jerome, E. M., Hamre, B. K., & Pianta, R. C. (2009). Teacher–child relationships from kindergarten to sixth grade: Early childhood predictors of teacher-perceived conflict and closeness. *Social Development (Oxford, England)*, *18*(4), 915–945. https://doi.org/10.1111/j.1467-9507.2008.00508.x

Ledbury, R., White, I., & Darn, S. (2004). The importance of eye contact in the classroom. *The Internet TESL Journal*, *10*(8), 11–21.

Lerkkanen, M.-K., & Pakarinen, E. (2016–2022). *Teacher and Student Stress and Interaction in the Classroom (TESSI)*. Finland: University of Jyväskylä. Unpublished data.

McClowry, S. G., Rodriguez, E. T., Tamis-LeMonda, T. S., Spellmann, M. E., Carlson, A., & Snow, D. L. (2013). Teacher/student interactions and classroom behavior: The role of student temperament and gender. *Journal of Research in Childhood Education*, *27*(3), 283–301. https://doi.org/10.1080/02568543.2013.796330

McIntyre, N. A., Mulder, K. T., & Mainhard, M. T. (2020). Looking to relate: Teacher gaze and culture in student-rated teacher interpersonal behaviour. *Social Psychology of Education*, *23*(2), 411–431. https://doi.org/10.1007/s11218-019-09541-2

Muthén, L., & Muthén, B. O. (1998–2012). *Mplus version 8.7 & Mplus users' guide*. Muthén & Muthén.

Niehorster, D. C., Santini, T., Hessels, R. S., Hooge, I. T. C., Kasneci, E., & Nyström, M. (2020). The impact of slippage on the data quality of head-worn eye trackers. *Behavior Research Methods*, *52*(3), 1140–1160. https://doi.org/10.3758/s13428-019-01307-0

Nurmi, J.-E., Aunola, K., Salmela-Aro, K., & Lindroos, M. (2003). The role of success expectation and task-avoidance in academic performance and satisfaction: Three studies on antecedents, consequences, and correlates. *Contemporary Educational Psychology*, *28*(1), 59–90. https://doi.org/10.1016/S0361-476X(02)00014-0

Olson, S. L., Sameroff, A. J., Kerr, D. C., Lopez, N. L., & Wellman, H. M. (2005). Developmental foundations of externalizing problems in young children: The role of effortful control. *Development and Psychopathology*, *17*(1), 25–45. https://doi.org/10.1017/S0954579405050029

Pakarinen, E., Aunola, K., Kiuru, N., Lerkkanen, M.-K., Poikkeus, A.-M., Siekkinen, M., & Nurmi, J.-E. (2014). The cross-lagged associations between classroom interactions and children's achievement behaviors. *Contemporary Educational Psychology*, *39*(3), 248–261. https://doi.org/10.1016/j.cedpsych.2014.06.001

Pakarinen, E., Kiuru, N., Lerkkanen, M.-K., Poikkeus, A.-M., Ahonen, T., & Nurmi, J.-E. (2011). Instructional support predicts children's task avoidance in kindergarten. *Early Childhood Research Quarterly*, *26*(3), 376–386. https://doi.org/10.1016/j.ecresq.2010.11.003

Pakarinen, E., Lerkkanen, M., Viljaranta, J., & Suchodoletz, A. (2021). Investigating bidirectional links between the quality of teacher-child relationships and children's interest and pre-academic skills in literacy and math. *Child Development*, *92*(1), 388–407. https://doi.org/10.1111/cdev.13431

Pakarinen, E., Silinskas, G., Hamre, B. K., Metsäpelto, R.-L., Lerkkanen, M.-K., Poikkeus, A.-M., & Nurmi, J.-E. (2018). The cross-lagged associations between problem behaviors and teacher–student relationships in early adolescence. *The Journal of Early Adolescence*, *38*(8), 1100–1141. https://doi.org/10.1177/0272431617714328

Pianta, R. C. (1999). *Enhancing relationships between children and teachers*. American Psychological Association.

Pianta, R. C. (2001). *Student–teacher relationship scale–short form*. Psychological Assessment Resources.

Pianta, R. C., & Stuhlman, M. W. (2004). Teacher–child relationships and children's success in the first years of school. *School Psychology Review*, *33*(3), 444–458. https://doi.org/10.1080/02796015.2004.12086261

Risko, E. F., & Kingstone, A. (2011). Eyes wide shut: implied social presence, eye tracking and attention. *Attention, Perception & Psychophysics*, *73*(2), 291–296. https://doi.org/10.3758/s13414-010-0042-1

Satorra, A., & Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. *Psychometrika*, *66*(4), 507–514. https://doi.org/10.1007/BF02296192

Seidel, T., Schnitzler, K., Kosel, C., Stürmer, K., & Holzberger, D. (2020). Student characteristics in the eyes of teachers: Differences between novice and expert teachers in judgment accuracy, observed behavioral cues, and gaze. *Educational Psychology Review*, *33*(1), 69–89. https://doi.org/10.1007/s10648-020-09532-2

Shinoda, H., Yamamoto, T., & Imai-Matsumura, K. (2021). Teachers' visual processing of children's off-task behaviors in class: A comparison between teachers and student teachers. *PLoS One*, *16*(11), e0259410. https://doi.org/10.1371/journal.pone.0259410

Stipek, D., & Miles, S. (2008). Effects of aggression on achievement: Does conflict with the teacher make it worse? *Child Development*, *79*(6), 1721–1735. https://doi.org/10.1111/j.1467-8624.2008.01221.x

Stuhlman, M. W., & Pianta, R. C. (2001). Teacher's narratives about their relationship with children: Associations with behavior in classrooms. *School Psychology Review*, *31*(2), 148–163. https://doi.org/10.1080/02796015.2002.12086148

Tobii Connect. (2023). Eye tracker accuracy and precision. https://connect.tobii.com/s/article/eye-tracker-accuracy-and-precision?language=en_US

Turner, J. C., Midgley, C., Meyer, D. K., Gheen, M., Anderman, E. M., Kang, Y., & Patrick, H. (2002). The classroom environment and students' reports of avoidance strategies in mathematics: A multimethod study. *Journal of Educational Psychology*, *94*(1), 88–106. https://doi.org/10.1037/0022-0663.94.1.88

van den Bogert, N., Bruggen, J. V., Kostons, D., & Jochems, W. (2014). First steps into understanding teachers' visual perception of classroom events. *Teaching and Teacher Education*, *37*, 208–216. https://doi.org/10.1016/j.tate.2013.09.001

van Es, E. A., Hand, V., Agarwal, P., & Sandoval, C. (2022). Multidimensional noticing for equity: Theorizing mathematics teachers' systems of noticing to disrupt inequities. *Journal for Research in Mathematics Education*, *53*(2), 114–132. https://doi.org/10.5951/jresematheduc-2019-0018

Williams, R. L. (2000). A note on robust variance estimation for cluster-correlated data. *Biometrics*, *56*(2), 645–646. https://doi.org/10.1111/j.0006-341X.2000.00645.x

Yamamoto, T., & Imai-Matsumura, K. (2013). Teachers' gaze and awareness of students' behaviour: Using an eye tracker. *Comprehensive Psychology*, *2*(6), 01.IT.2.6. https://doi.org/10.2466/01.IT.2.6

Zhang, X., Nurmi, J.-E., Kiuru, N., Lerkkanen, M.-K., & Aunola, K. (2011). A teacher-report measure of children's task-avoidant behavior: A validation study of the Behavioral Strategy Rating Scale. *Learning and Individual Differences*, *21*(6), 690–698. https://doi.org/10.1016/j.lindif.2011.09.007