JYU DISSERTATIONS 731

Saswati Chaudhuri

Teachers' Visual Focus of Attention and Related Factors in Grade 1 Classrooms

Teacher Stress, Students' Academic Skills and Teacher–Student Relationships

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF EDUCATION AND PSYCHOLOGY

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ABSTRACT

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Teachers' visual focus of attention and related factors in Grade 1 classrooms: Teacher stress, students' academic skills and teacher–student relationships
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The aim of the present thesis is to examine teachers' visual focus of attention and its related factors, such as teacher stress, students' basic academic skills and teacher–student relationships in authentic classroom settings in Grade 1. The data referred to herein were part of a larger project focusing on teacher and student stress and interaction in the classroom, conducted in the fall and spring of the 2017–2018 academic year. In sub-study 1, teachers' visual focus of attention in the form of teachers' eye-tracking video data from the fall (N = 53) and spring (N = 52) were investigated in association with teachers' work-related stress domains of emotional exhaustion, cynicism and inadequacy. In sub-study 2, teachers' visual focus of attention in the form of eye-tracking video data from the spring (N = 46) was examined in association with the classroom average of students' basic academic skills in literacy and math and teacher ratings of individual support for each student in academic skills. In sub-study 3, teachers' visual focus of attention in the form of eye-tracking video data from the fall (N = 48) and spring (N = 47) were investigated in association with teacher ratings of the quality of the teacher–student relationship. Additionally, the moderating effect of students' gender and task-avoidant behaviour on the association between teachers' visual focus of attention and quality of teacher–student relationship was examined. The results showed, first, that there was a positive association between teachers' perceived inadequacy and their visual focus of attention during the lesson both in the fall and spring. Second, teachers' visual focus of attention was negatively correlated with students' basic academic skills and positively correlated with teachers' individual support for students in literacy and math. Third, positive associations were found between the teacher–student relationship (domains of closeness and conflict) and the teachers' visual focus of attention in the fall and spring. Additionally, only students' task-avoidant behaviour moderated this association in the spring. Overall, the findings suggest that teachers' visual focus of attention varies in association with several factors related to teachers and students in the classroom. It can be implied that mobile eye-tracking technology can be used in teacher training to improve teacher's awareness of their behaviour towards students.

Keywords: eye-tracking, visual focus of attention, teacher stress, academic skills, teacher–student relationship, first grade

TIIVISTELMÄ

Chaudhuri, Saswati
Opettajan visuaalisen huomion kiinnittyminen ja siihen yhteydessä olevat tekijät ensimmäisellä luokalla: opettajan stressi, oppilaiden akateemiset perustaidot ja opettaja-oppilassuhde
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Tämän väitöstutkimuksen tavoitteena on tarkastella 1. luokan opettajien visuaalista huomion kiinnittymistä autenttisissa opetustilanteissa silmänliikekameran tallenteiden avulla ja tähän yhteydessä olevia tekijöitä, kuten opettajan stressiä, oppilaiden akateemisia perustaitoja sekä opettaja-oppilassuhteita. Tutkimusaineisto on osa laajempaa tutkimushanketta, joka keskittyy opettajan ja oppilaiden stressiin ja vuorovaikutukseen luokassa. Väitöstutkimus koostuu kolmesta osatutkimuksesta, joissa on käytetty lukuvuonna 2017–2018 kerättyä aineistoa ensimmäisen luokan syksyltä ja keväältä. Osatutkimuksessa 1 tarkasteltiin opettajien huomion kiinnittymistä syksyllä (N = 53) ja keväällä (N = 52) ja sen yhteyttä opettajien työhön liittyvän stressin osa-alueisiin emotionaalinen uupumus, kyynisyys ja riittämättömyyden tunne. Osatutkimuksessa 2 tarkasteltiin opettajien (N = 46) huomion kiinnittymistä ja sen yhteyttä luokan oppilaiden keskimääräiseen lukutaidon ja matematiikan taidon tasoon sekä opettajien antamaan oppilaskohtaiseen yksilölliseen tukeen näissä taidoissa. Osatutkimuksessa 3 tarkasteltiin opettajien huomion kiinnittymistä syksyllä (N = 48) ja keväällä (N = 47) ja sen yhteyttä opettaja-oppilassuhteisiin (läheisyys ja ristiriidat). Lisäksi tutkittiin oppilaan sukupuolen ja tehtäviä välttelevän käyttäytymisen yhteyttä opettajien huomion kiinnittymiseen ja opettaja-oppilassuhteeseen. Tulokset osoittivat ensinnäkin, että opettajan huomion kiinnittymisen ja riittämättömyyden tunteen välillä oli positiivinen yhteys. Toiseksi havaittiin, että opettajan huomion kiinnittyminen korreloi negatiivisesti luokan oppilaiden akateemisten perustaitojen tason kanssa, mutta positiivisesti opettajan oppilaille antaman yksilöllisen tuen kanssa. Opettajat kiinnittivät huomiota useammin oppilaisiin, joiden kohdalla he raportoivat antavansa enemmän yksilöllistä tukea akateemisissa perustaidoissa ja jos oppilaan akateemiset perustaidot olivat heikot. Kolmanneksi havaittiin positiivinen yhteys opettajan huomion kiinnittymisen ja opettaja-oppilassuhteen laadun välillä. Lisäksi oppilaiden tehtäviä välttelevä käyttäytyminen moderoi opettaja-oppilassuhteen laadun ja opettajien huomion kiinnittymisen välistä yhteyttä keväällä. Kaiken kaikkiaan tulokset viittaavat siihen, että opettajien huomion kiinnittyminen vaihtelee useiden opettajiin ja oppilaisiin liittyvien tekijöiden suhteen. Opettajien olisi hyvä olla tietoisia, mihin he kiinnittävät huomiota opetuksen aikana ja mistä syistä. Tätä voitaisiin tukea silmänliiketeknologian avulla jo opettajankoulutuksessa.

Avainsanat: silmänliiketutkimus, visuaalinen huomion kiinnittyminen, opettajan stressi, opettaja-oppilassuhde, akateemiset taidot, ensimmäinen luokka

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Jyväskylä December 2023
Saswati Chaudhuri

LIST OF PUBLICATIONS

This doctoral thesis is based on the following articles which are referred to as sub-studies 1, 2 and 3 in this doctoral research. Copies of the published articles I, II and III can be found as appendices to this report. They have been reprinted with the permission of the publishers.

Article 1 Chaudhuri, S., Muhonen, H., Pakarinen, E., & Lerkkanen, M.-K. (2022). Teacher 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

Article 2 Chaudhuri, S., Muhonen, H., Pakarinen, E., & Lerkkanen, M-K. (2022). 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

Article 3 Chaudhuri, S., Pakarinen, E., Muhonen, H., & Lerkkanen, M-K. (2023). Association between the teacher–student relationship and teacher visual focus of attention in Grade 1: Student task avoidance and gender as moderators. [Manuscript in review].

The author of this dissertation has served as the first author of all three research articles and was responsible for preparing, coding and analysing the eye-tracking video recordings referred to in this dissertation. The first author conducted the necessary statistical analysis in consultation with the co-authors based on their respective areas of expertise. The co-authors provided advice on the research design of the sub-studies and finalising the results and offered written feedback on the writing of the manuscripts. The data used in the three publications were collected as part of the Teacher and Student Stress and Interaction in the Classroom (TESSI) study.

FIGURE

TABLE

CONTENTS

1 INTRODUCTION

Classrooms are information-dense, complex environments where multiple events occur simultaneously (Blömberg et al., 2011). Teachers are required to notice relevant information within the complex classroom environment and make quick decisions regarding students' learning and behaviour irrespective of unforeseen demands (Jarodzka et al., 2021). Thus, teachers need to visually notice classroom events to ensure effective classroom management and instruction. However, there are several factors that may be related to how teachers allocate their visual focus of attention in the classroom. For example, Dessus et al. (2016) showed that all students in the classroom get visual attention from the teacher, but the amount of it varies based on the teachers' perception of student needs. Thus, building on previous literature, the aim of the present thesis is to examine how different factors related to teachers and students guide teachers' visual focus of attention in first-grade classrooms.

Most previous studies employing remote eye-tracking technology concerning teachers' noticing and visual focus of attention in the classroom are based on the expert–novice paradigm (Gegenfurtner et al., 2020; Keller et al., 2021; Van den Bogert et al., 2014; Wolff et al., 2016). Previously, eye-tracking has been used in controlled environments, such as in laboratory settings involving mobile eye-tracking where teachers watched classroom videos (Codreanu et al., 2021; McIntyre et al., 2021; van den Bogert et al., 2014) or taught in authentic settings (Dessus et al., 2016; Goldberg et al., 2020; Haataja et al., 2019; Huang et al., 2021; McIntyre & Foulsham, 2018) in the high school classroom environment. This thesis adds to the limited literature on eye-tracking studies in elementary classrooms by describing research conducted on mobile eye-tracking in authentic classroom settings where teachers taught during routine school days. The use of mobile eye-tracking with teachers in authentic classroom settings gave them the opportunity to research their own actions in real time (Jarodzka et al., 2021).

In elementary school, the way teachers behave in the classroom contributes to students' academic development in school (Pianta & Stuhlman, 2004). The beginning of an academic year, especially in Grade 1, can be demanding for teachers in terms of getting to know students in the classroom. In the fall, teachers

typically spend time with students to observe their academic skill levels and behaviours, whereas towards the end of Grade 1 in the spring, teachers typically have improved awareness of student skills and behaviour. In this regard, the present study adds to the scarce literature investigating the possible variations in teachers' visual focus of attention at two time points of an academic year during Grade 1.

The distribution of teachers' visual focus of attention in an authentic classroom setting could be influenced by both teachers and students' characteristics. For instance, previous research has shown that the teaching profession is demanding and that many teachers have reportedly experienced high stress (Aloe et al., 2014; Herman et al., 2020). Moreover, teachers reporting high work-related stress have been found to show lower-quality emotional support, classroom organisation and instructional support during teaching (Soininen et al., 2023). Since teachers' experiences of stress can be personal and internal, stress could have an influence on their classroom behaviour towards students in terms of their visual focus of attention as well. Therefore, in sub-study 1, which is discussed in the present thesis, how teacher stress may associate with teachers' classroom behaviour in terms of visual focus of attention in authentic classroom settings was investigated.

Previous research has also shown that students' characteristics, such as behaviour and academic performance, evoke teachers' instructional support in the classroom (Huber & Seidel, 2018; Nurmi et al., 2012; Silinskas et al., 2015) to improve their literacy (Connor et al., 2004) and math skills (Curby et al., 2009). In early school years, particularly in Grade 1, emphasis is placed on the students' academic skill development in literacy and math (Lerkkanen et al., 2016). However, it is possible that some students may need more individual support from the teacher than others for this development. Moreover, previous research has shown that teachers give a longer visual focus of attention to students who need more adaptive pedagogical support (Seidel et al., 2020). However, little is known about the associations between teachers' visual focus of attention, students' basic academic skills and individual support for students. To address this issue, sub-study 2, which is referenced in this thesis, investigated the extent to which teachers' visual focus of attention was associated with students' basic academic skills and teachers' individual support for students' literacy and math skills.

Moreover, researchers have argued that teachers look longer at students who show interactive behaviour such as talkativeness (Goldberg et al., 2021) and off-task behaviour such as not following the teachers' instructions (Shinoda et al., 2021). Furthermore, previous research related to teacher–student relationships has shown that teachers perceive increased closeness towards students who initiate interactions with the teacher (Pianta, 1999; Pianta & Stuhlman, 2004). Additionally, teachers experience increased conflict with students who show problem behaviours in elementary school (Doumen et al., 2008). However, little is known about whether there is a relationship between teachers' perception of teacher–student relationship and their visual focus of attention towards students.

Therefore, sub-study 3 investigated how teachers' perception of closeness and conflict with students is associated with their visual focus of attention in the classroom at the beginning and ending of Grade 1. In addition, this particular study examined whether students' gender and task-avoidant behaviour moderated this association.

In sum, the present thesis provides novel additions to the limited literature concerning teacher noticing in terms of the visual focus of attention in authentic classroom settings of elementary schools, particularly Grade 1 classrooms. In the sub-studies, the associations between teachers' visual focus of attention and teacher- and student-related factors were investigated in depth with the help of quantitative methods and a case study approach. This thesis has three main aims: first, to study the association between teachers' work-related stress and their visual focus of attention; second, to explicate the association between teachers' visual focus of attention and students' basic academic skills as well as how teacher-reported individual support improves students' academic skills; and third, to examine the association between teacher-reported quality of teacher–student relationships and teachers' visual focus of attention and the moderating effect of students' gender and task-avoidant behaviour on this association.

2 THEORETICAL BACKGROUND

2.1 Teachers' visual focus of attention

Teachers' professional vision has been defined as the teachers' noticing of classroom events and their knowledge-based reasoning about the observed classroom events (Seidel & Stürmer, 2014). The teachers' noticing component can be defined as the ability to observe and detect relevant classroom events. According to van Es and Sherin (2021), teachers' noticing is not only a passive action of observing students but a way to facilitate teachers' shaping of classroom interactions to access more information for in-depth interpretation of student thinking during math lessons. In the present thesis, teachers' visual focus of attention has been considered a part of the noticing component of their professional vision (see Figure 1; Seidel et al., 2021). Additionally, their knowledge-based reasoning involves their description and explanation of observed classroom events and the prediction of the next steps to be taken in their classroom management practices based on retrospections gained when viewing their teaching by means of video recordings (Seidel & Stürmer, 2014). As a part of teachers' noticing, their visual focus of attention on students has been found to indicate their sense-making of classroom activities, awareness of student characteristics, classroom management and instructional practices (van Es et al., 2022). Therefore, in the present thesis, teachers' visual focus of attention is defined as the duration of teachers' gaze on relevant targets, such as students, during a lesson in Grade 1 (Van den Bogert et al., 2014). Furthermore, the way teachers focus their visual attention on students and its association with teacher- and student-related factors in an information-rich elementary classroom environment is a central issue that will be discussed in depth in this thesis.

Previously, teachers' visual focus of attention in the classroom has been studied in laboratory and authentic classroom settings. In laboratory settings, teachers typically watch videos of classroom teaching situations to observe and detect relevant classroom events related to students' learning and behaviour (Codreanu et al., 2021; van Es et al., 2022). In these settings, the teachers' noticing

was studied using individual teachers' verbal accounts of perception, interpretation and decision-making related to the noticed classroom events based on video simulations of classroom teaching (e.g., Codreanu et al., 2021). However, some studies have combined video-based teacher reflections with eye-tracking where the teachers' visual gaze was measured using screen-based eye trackers that were placed below the screen where the video was played (e.g., Van den Bogert et al., 2014; Wolff et al., 2016).

Teachers' focus of their visual attention in authentic classroom settings has been studied using mobile eye-tracking glasses that record teachers' eye movements and durations of visual gaze during teaching in a real-world scenario (e.g., Haataja et al., 2021; Maatta et al., 2021; McIntyre et al., 2020). In authentic classroom settings, the classroom environment is complex as teachers need to manage multiple events that occur simultaneously and require immediate attention from the teacher (Van den Bogert et al., 2014). Therefore, the investigation of teachers' visual focus of attention in authentic classroom settings adds to the understanding of the important issues that draw teachers' attention in the classroom.

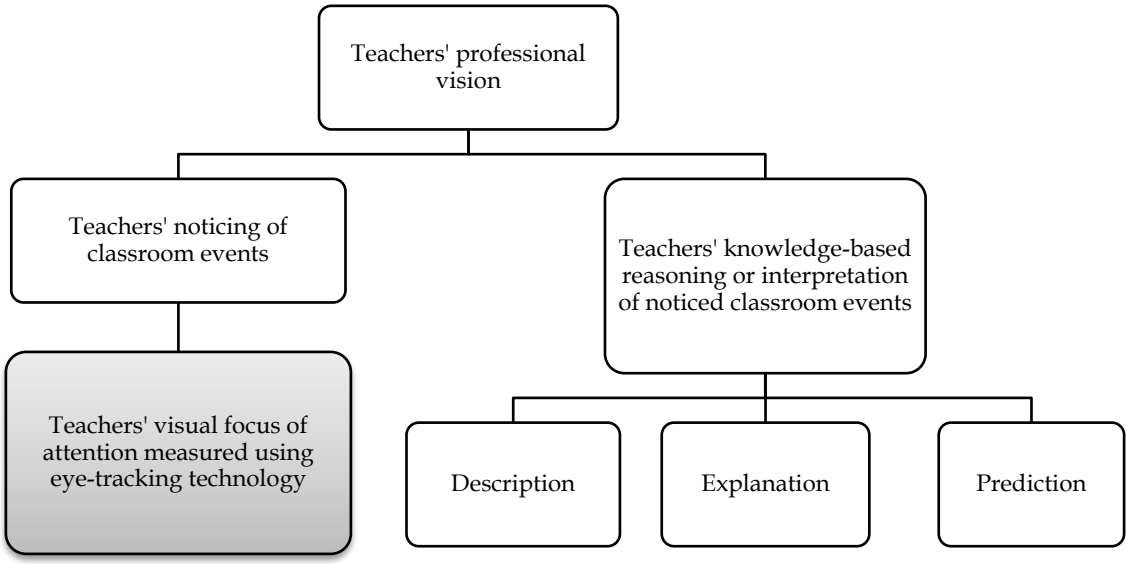


Figure 1. Teachers' professional vision

Traditionally, studies investigating teachers' noticing (Codreanu et al., 2021; Seidel et al., 2021; Van den Bogert et al., 2014; Wolff et al., 2016) have used the expert–novice paradigm. In other words, these studies have shown that there is a difference in the way teachers identified relevant information from classroom events based on their level of work experience. The results have shown that expert teachers who have more teaching experience in the classroom focused their visual attention on relevant information in the classroom faster than novice teachers (Van den Bogert et al., 2014; Wolff et al., 2016) and interpreted it

appropriately (Wolff et al., 2016, 2017). Additionally, Seidel and colleagues (2021) showed that expert teachers accurately judged student profiles to determine who was overestimating, uninterested and underestimating. Moreover, expert teachers gave longer visual focus of attention to students who were struggling, uninterested and needed adaptive pedagogical support. However, Codreanu et al. (2021) showed that pre-service or relatively novice teachers were able to focus their attention efficiently on the relevant classroom information and dominant difficulties of individual students while solving a math problem. The authors conducted their eye-tracking study using simulated classroom interactions instead of authentic classroom settings. In another study conducted by Bastian et al. (2021), it was shown that there was an increase in math teachers' professional noticing between master's degree students and pre-service teachers, contrary to the widely held belief that increased professional noticing is a result of increased visual expertise from more years of teaching experience. However, the authors urged cautious interpretations of their results as they used scripted classroom videos and not authentic classroom settings in their eye-tracking study.

Furthermore, the way teachers visually perceive information from the classroom environment was shown in a theoretical model called Classroom Management Scripts by Wolff et al. (2021). The authors argued that even though there are generalizable differences between expert and novice teachers' noticing of classroom events, yet they support the idea that novice teachers use prior knowledge of teaching and learning albeit differently. This theoretical model showed that teachers apply their visual focus of attention to notice and draw connections between classroom events and the actors (such as students) present in them. First, novice teachers typically follow a bottom-up and image-driven approach, meaning that they perceive information mainly from their surroundings. Second, expert teachers typically follow a top-down and knowledge-driven approach, meaning that they combine the observed information with previous knowledge of teaching and learning.

However, the top-down and bottom-up cognitive processing approaches may not be limited to teachers' level of expertise based on their work experience alone. It is possible that teachers employ their prior knowledge of classroom management, student awareness and pedagogy during teaching regardless of their level of expertise based on their work experience. Based on the classroom management scripts theoretical model, the scope of this thesis mainly addresses the top-down factors, such as the way in which teachers' self-perceived stress, students' academic skills, teachers' individual support for students and the quality of teacher–student relationships are reflected in the teachers' visual focus of attention in the classroom. In the present thesis, teachers' visual focus of attention was studied using mobile eye-tracking methodology in authentic classroom settings. This methodology has provided the opportunity for researchers to investigate teachers' gaze during real-world teaching situations (Dessus et al., 2016). For example, mobile eye-tracking studies have shown that teachers' classroom behaviour in the form of their visual attention plays a significant role in investigating their approaches to classroom management and

teaching practices (Cortina et al., 2015; Dessus et al., 2016; McIntyre et al., 2017, 2019). Another mobile eye-tracking study has shown that teachers' scaffolding intention during math instruction guided their visual focus of attention towards students and learning materials during teaching in a secondary classroom (Haataja et al., 2019). Also, Haataja et al. (2021) showed that the eye gaze behaviour of both teachers and students is associated with teachers' interpersonal behaviour in Finnish classrooms. However, there is scant literature available on the ways in which teacher- and student-related factors guide teachers' visual focus of attention during teaching in elementary school.

Albeit scarce, there are some recent studies that have shown that classroom-related factors such as students' seating arrangements and physical features of the students guide the teachers' visual focus of attention during teaching. For instance, Smidekova et al. (2020) showed that the classroom factor of student seating influences teachers' visual focus of attention. The authors showed that students seated in the first and middle sections of the Grade 5 and 6 classrooms received more teacher visual attention compared with the students sitting outside this zone. Furthermore, Kosel et al. (2023) noted that teachers' visual attention on students was positively related to the number of student hand raisings in a Grade 8 classroom. The authors explained that teachers look more at students when they raise their hands during a lesson to participate in the classroom discussion.

Moreover, Schnitzler et al. (2020) showed that teachers observe student-related factors to accurately judge students' cognitive and motivational characteristics. Additionally, students' learning-related behaviour in terms of interaction with the teacher has been found to draw longer visual attention from teachers (Goldberg et al., 2021). Moreover, teachers often gaze at students' faces to identify their behaviour characteristics such as their expression and engagement in terms of anxiety, boredom, concentration and confusion during the lesson (Kaakinen, 2021).

Furthermore, a study has shown that teachers' visual gaze can vary based on cultural values. In particular, teachers from the United Kingdom (an individualistic culture) showed increased efficiency in attentional gaze during information seeking, whereas teachers from Hong Kong (a collectivistic culture) showed increased efficiency in communicative gaze during information-giving while teaching in authentic classroom settings (McIntyre et al., 2017).

Although it has been established from these studies that classroom-related factors guide teachers' visual focus of attention, the association between specific teacher- and student-related factors with teachers' visual focus of attention remains relatively unexplored. Therefore, this thesis addresses the gap in the literature concerning teachers' visual focus of attention by providing an in-depth investigation of it in relation to specific teacher- and student related factors, such as teachers' stress, students' academic skill levels, individual support rendered to students based on academic skills, and teacher-reported quality of teacher–student relationships in association with students' task-avoidant behaviours and gender in Grade 1 classrooms.

2.2 Factors associated with teachers' visual focus of attention

2.2.1 Teacher-perceived stress

The teaching profession can be stressful for teachers when they face daily challenges that arise in the classroom environment. Teacher stress can be defined as teachers' experiences of negative emotions, such as anxiety, frustration and tension, being triggered by their perception of threat in managing the demands they face in their work (Kyriacou, 2001, 2011). In elementary schools, teachers have reported moderate to high levels of stress when the demands of the classroom environment are beyond the capacity of their resources to cope with them (Herman et al., 2018, 2020). In particular, teachers have reported demands arising from challenging student behaviours, differentiated instruction and disruptive classrooms as stressful (Friedman-Krauss et al., 2013; Kyriacou, 2001).

According to Schaufeli and Enzmann (1998), when stress lasts for a long period of time, it can lead to burnout, which is prolonged occupational stress arising from increased demands at work. Subsequently, teacher-perceived stress has been indicated by the domains of burnout, such as emotional exhaustion, cynicism and a sense of inadequacy (Salmela-Aro et al., 2010). The first domain, emotional exhaustion, is an emotional component of stress that can be defined as fatigue due to overwhelming workloads (Salmela-Aro et al., 2011). The second domain, cynicism, is the cognitive component that refers to reduced interest and feelings of indifference towards one's job and the people at the workplace (Salmela-Aro et al., 2011). The third domain, sense of inadequacy, is the behavioural component of stress that is defined as a reduced efficacy in professional competence and accomplishment at work (Salmela-Aro et al., 2010). Previous research has shown that teachers' feelings of inadequacy are reflected in their classroom behaviour towards students. In particular, teachers with lower levels of self-efficacy are increasingly prone to stress and exhaustion, thereby influencing their quality of classroom instruction and teacher–student interactions (Jeon et al., 2017; Virtanen et al., 2019). Moreover, an increase in teachers' stress has been found to adversely contribute to the quality of classroom management and instructional practices (Penttinen et al., 2020).

A qualitative study by Muhonen et al. (2022) investigating the professional vision of Grade 1 teachers experiencing varied levels of stress found that teachers' knowledge-based reasoning mainly comprised descriptions related to teacher information, classroom management and student behaviour. Additionally, the authors showed that moderately stressed teachers used self-reflection the most, whereas highly stressed teachers used it the least. For this reason, it is possible that teachers' perceived stress could reflect on the way they distribute their visual gaze in terms of the visual focus of attention towards the students in the classroom during teaching. To gain a greater understanding of this issue, the first sub-study investigated how teachers' stress reflected on their visual focus of attention during teaching in the fall and spring of Grade 1.

2.2.2 Students' basic academic skills and teachers' individual support for students

In Finland, in Grade 1, the emphasis of learning is on students' basic academic skills of literacy and arithmetic (Lerkkanen et al., 2016). In this regard, teachers need to focus individually on students to ensure their development of basic academic skills. Classroom observation studies have shown that teachers provide more individual and adaptive instructional support to students facing challenges with reading skills in Grade 1 (Connor et al., 2009; Ruotsalainen et al., 2020). Furthermore, research has shown that students in Finland performing poorly in reading and math at the beginning of Grade 1 receive increased individual support from teachers at the end of Grade 1 (Nurmi et al., 2012). Accordingly, it can be postulated that students' academic skill levels evoke responses from the teacher during classroom instruction (Nurmi, 2012). In addition, Kiuru et al. (2015) showed that the students showing the poorest academic skills in reading and math received the most instructional support from the teacher in Grades 1 and 2 in Finland. In this regard, teachers' classroom behaviour towards individual students in the form of their visual focus of attention could vary based on students' academic performance and the amount of individual support from the teacher.

In the present thesis, teachers' individual support for students is defined as their perception of the amount of individual support provided to students in literacy and math in comparison with other students in the same classroom. In order to provide individual support to students for their academic development, teachers need to monitor individual students regularly and show judgement accuracy of students' cognitive and motivational characteristics during the lesson (Kosel et al., 2021; Schnitzler et al., 2020). It was seen from an eye-tracking study that teachers showing increased judgement accuracy of student characteristics had shorter average fixation duration and increased fixation counts on students, indicating better information processing in relation to students (Schnitzler et al., 2020). Furthermore, Goldberg et al. (2023) have argued that teachers need to monitor students' moment-to-moment attention-related behaviour during a lesson in order to adapt their classroom instruction to support students' academic skills development. It is evident that student characteristics, particularly their academic skill levels, evoke responses from the teacher in the form of providing individual support to students. However, there is little research showing the association between students' basic academic skill levels, teachers' individual support for students and teachers' visual focus of attention towards students.

2.2.3 Quality of teacher–student relationships

In the early school years, the teacher–student relationship contributes to students' school adaptation, learning motivation and academic and social developments (Pakarinen et al., 2021; Pianta, 1999; Pianta & Stuhlman, 2004). Previous research has shown that teachers' classroom instruction is more effective when teachers build warm and caring relationships with students (Hamre & Pianta, 2001). In

addition, teacher–student relationships play an important role in students' skill acquisition, which is necessary for their success in school (Pianta & Stuhlman, 2004). Furthermore, students who have a closer relationship with the teacher can communicate well with the teacher during classroom instruction (Birch & Ladd, 1997). In the present thesis, the quality of the teacher–student relationship is classified as teachers' perceptions of closeness and conflict towards students in the classroom (Hamre & Pianta, 2001; Pianta, 1999). Teacher–student closeness can be defined as teacher-perceived affection, openness and warmth towards the students, whereas teacher–student conflict has been defined as teachers' perceived negativity towards the students (Birch & Ladd, 1997; Jerome et al., 2009; Pianta, 1999).

The teachers' perception of closeness and conflict in the teacher–student relationship has been found to reflect on the way teachers interact with students in the classroom (Koenen et al., 2022). Previous research has shown that at the junior high school level, when teachers perceive more closeness in the teacher–student relationship, they give more autonomy to students, reduce control, offer more choices and provide positive feedback to students (Roth et al., 2011). On the other hand, in elementary school, when teachers perceive more conflict in the teacher–student relationship, they increase control related to classroom activities, reduce choices and give more negative feedback to students (Hamre & Pianta, 2001; Roorda et al., 2011; Stuhlman & Pianta, 2001).

It is possible that the way teachers perceive closeness and conflict could reflect on teachers' classroom behaviour in terms of their visual focus of attention. For instance, teachers establish eye contact with students to enforce desired behaviours and build relationships (Hietanen et al., 2008; Ledbury et al., 2004). Moreover, the way teachers establish eye contact with students has been found to reflect the quality of the teacher–student interaction (Haataja et al., 2021). The authors argued that teachers initiated eye contact with students when they gave instructions, whereas students initiated eye contact more when teachers showed an affinity towards them. Additionally, McIntyre et al. (2020) showed that there is an association between teachers' gaze towards students and the way students perceive their interpersonal behaviour. In particular, the authors observed that when teachers used a more attentional gaze (teachers' information-seeking eye contact with students), students perceived more dominance from the teacher. However, when teachers increased their communicative gaze (teachers' information-giving eye contact), students perceived more communion or friendliness from the teacher during lecturing. However, currently, there are no studies investigating the association between teachers' perception of the quality of the teacher–student relationship and teachers' visual focus of attention.

2.2.3.1 Students' gender and task-avoidant behaviour as moderating factors

The students' gender and task-avoidant behaviour have been considered as moderating factors only in sub-study 3. First, the students' gender has been found to influence the teachers' perception of the quality of teacher–student

relationship at the elementary school level. For instance, previous research has shown that teachers typically reported greater closeness and less conflict with girls than boys, and girls typically received more positive attention from teachers than boys did due to more perceived closeness (Hamre & Pianta, 2001; Jerome et al., 2009; Kesner, 2000; Silver et al., 2005). Additionally, previous research has shown that girls showing social withdrawal typically receive less attention than boys from teachers (McClowry et al., 2013). Therefore, based on previous literature, it is known that a student's gender could reflect on the teachers' perception of closeness and conflict towards the student, and thereafter the amount of attention they receive from the teacher. Furthermore, this thesis addresses the unexplored moderating effect of students' gender on the association between the quality of teacher–student relationship and teachers' visual focus of attention. Specifically, it considers whether the association between the teacher–student relationship and teachers' visual focus of attention could differ between boys and girls in Grade 1 classrooms.

Teachers need to observe individual students' learning behaviour often to see if they are achieving their learning goals, in order to adjust their teaching strategies to ensure improved student outcomes. While performing academic tasks during a lesson, students apply different strategies to complete the task. Turner et al. (2002) showed that some students apply task-focused strategies while performing academic tasks denoted by engaging behaviour and showing persistence and resilience in challenging situations, whereas other students apply task-avoidant behaviour which is indicated by showing resistance, withdrawal and avoidance from challenging situations when presented with difficult tasks. Furthermore, it is possible that students' different learning behaviours could reflect on the visual focus of attention from the teacher. For instance, previous research has found that students showing more interactive behaviour, such as asking questions, receive longer visual attention from the teacher (Goldberg et al., 2021). Therefore, in the present thesis, the moderating role of teacher-reported students' task-avoidant behaviour on the association between teacher-perceived quality of teacher–student relationship and teachers' visual focus of attention is examined. In the current thesis, students' task-avoidant behaviour is defined as teachers' reports of students showing maladaptive behaviours such as withdrawal and resistance in response to being presented with challenging academic tasks (Aunola et al., 2004; Pakarinen et al., 2011; Zhang et al., 2011).

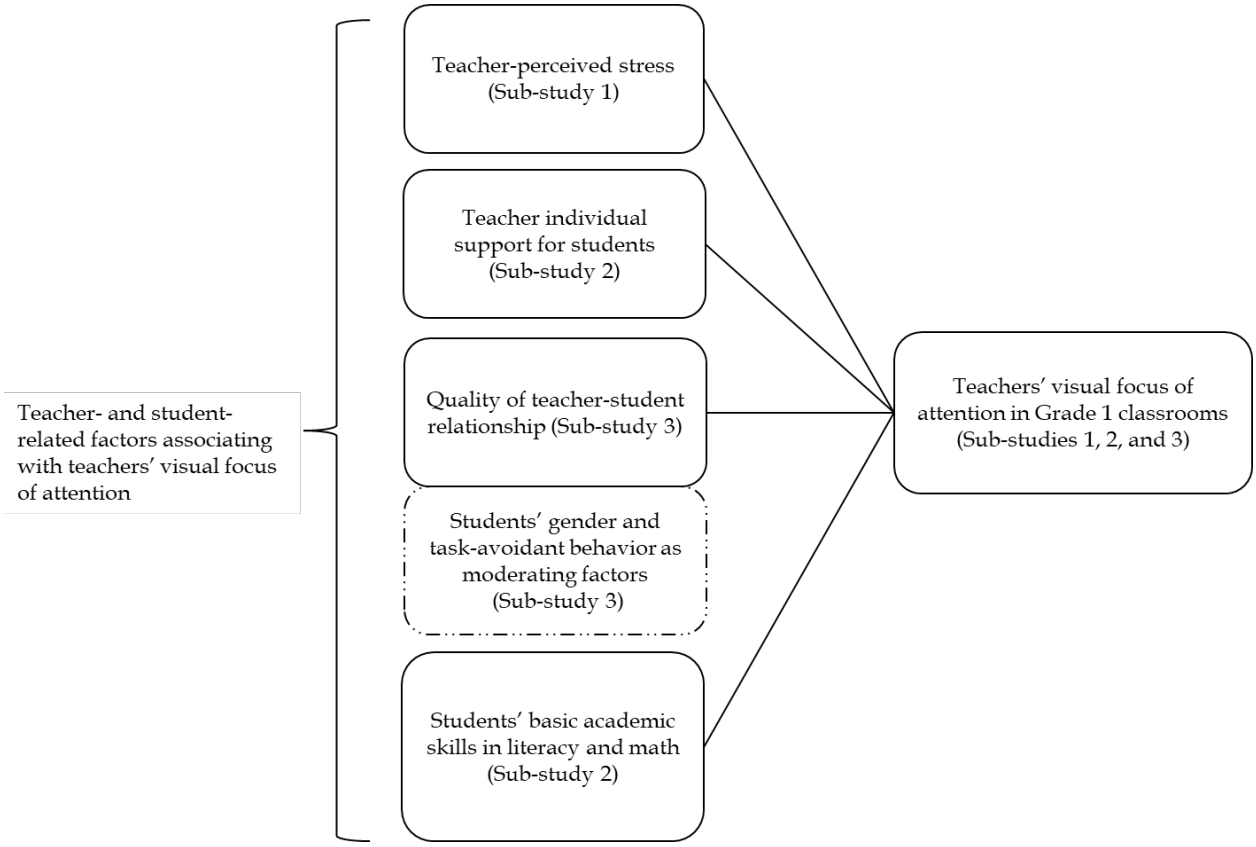


Figure 2. Summary of the teacher and student related factors investigated in association with teacher visual focus of attention.

3 AIM OF THE THESIS

The overall aim of this thesis is to explain the important relationship between teachers' visual focus of attention on students and the various teacher- and student-related factors in Grade 1. The thesis takes a novel approach towards combining teachers' eye-tracking data with other measures from the classroom environment. However, the investigation of the teachers' visual focus of attention described in this thesis was limited to the duration of teachers' visual gaze on the students in the classroom during a lesson. The teacher-related factors relating to teachers' visual focus of attention were considered teacher-perceived stress and teacher-perceived teacher–student relationships. In addition, students' gender and task-avoidant behaviour were considered as moderating factors. Subsequently, the student-related factors of students' basic academic skill levels in literacy and math and individual support for these skills development from the teacher were considered. Therefore, the more specific aims of the present thesis are as follows:

1. To study the association between teacher-reported stress and teachers visual focus of attention. (Sub-study 1)
2. To investigate the association between students' basic academic skills, teacher-reported individual support to students for academic skills and teachers' visual focus of attention. (Sub-study 2)
3. To examine the association between teacher-reported quality of teacher–student relationship and teachers' visual focus of attention and the moderating effect of students' gender and task-avoidant behaviour on this association. (Sub-study 3)

4 METHODS

4.1 Participants and procedure

All participants in the sub-studies were part of a larger project called Teacher and Student Stress and Interaction in the classroom (TESSI; Lerkkanen & Pakarinen, 2016–2022). The TESSI project was approved by the Committee of Ethics at University of Jyväskylä in August 2017 and November 2018. Based on the guidelines established by TENK (Tutkimuseettinen neuvottelukunta; translated as the Finnish National Board on Research Integrity), participation in the study was voluntary, and the participants gave written consent to be part of the study. Parents and/or guardians of the students gave written consent for their child's participation. The participants were free to stop participating in the study at any time. In the TESSI project, 870 students, along with their teachers and parents, were followed through kindergarten (spring 2016), Grade 1 (the academic year 2017–2018), Grade 2 (spring 2019), Grade 3 (spring 2020) and Grade 4 (spring 2021).

In the present thesis, data from teachers (N_{Fall} = 54, N_{Spring} = 53) and students (N_{Fall} = 865, N_{Spring} = 876) from Grade 1 (the academic year 2017–2018) in Central Finland were used. The data consisted of teachers' eye-tracking data in combination with teacher-reported background information, stress, individual support for students and the quality of teacher–student relationships. In addition, student-related characteristics such as gender, basic academic skills in literacy and math and task-avoidant behaviour were used in combination with teachers' eye-tracking data (see Table 1). Teachers' eye-tracking videos were recorded typically during the second lesson in an authentic classroom setting of a routine school day. In addition, students' literacy and math skills were assessed by trained research assistants after the teachers' eye-tracking video recordings. A summary of the samples, study variables, measures and analyses used in the sub-studies are shown in Table 1.

Table 1. Summary of samples, study variables, measures and analyses used in sub-studies 1, 2 and 3.

Sub-study	Sample	Study variables	Measures	Analyses
1. Teachers' focus of attention in Grade 1 classrooms: Exploring teachers experiencing more or less stress using mobile eye-tracking	Fall: 53 Grade 1 teachers (50 females, 3 males) Spring: 52 Grade 1 teachers (50 females, 2 males)	• Teacher-reported stress: emotional exhaustion, cynicism and inadequacy • Teachers' visual focus of attention	• Bergen Burnout Inventory (BBI-9; Salmela-Aro et al., 2010) • Fixation metric: Total fixation duration	Pearson's correlation, Gini coefficient, descriptive statistics
2. Teachers' visual focus of attention in relation to students' basic academic skills and teachers' individual support for students: An eye-tracking study	Spring: 46 Grade 1 teachers (44 females, 2 males), 879 students	• Students' basic academic skill levels in math and literacy • Teacher-reported individual support for academic skills • Teachers' visual focus of attention	• Literacy skills - 'ARMI' test battery (Lerkkanen et al., 2006) translated as 'Literacy assessment material for 1st grade' • Math skills Basic Arithmetic Test (BAT; Aunola & Räsänen, 2007) • Teacher-reported individual support in math and literacy (Silinskas et al., 2015) • Fixation metrics: Total fixation duration, average fixation duration, fixation counts	Pearson's correlation, descriptive statistics, Mann–Whitney *U* test
3. Association between teacher–student relationships and teachers' visual focus of attention in Grade 1: Student task avoidance and gender as moderators	Fall: 48 Grade 1 teachers (45 females, 3 males), 650 students (326 females, 324 males) Spring: 47 Grade 1 teachers (45 female, 2 males), 630 students (318 females, 312 males)	• Quality of teacher–student relationships: Closeness and conflict • Student characteristics as moderators: Gender and task-avoidant behaviour • Teachers' visual focus of attention	• Student–Teacher Relationship Scale (STRS; Pianta, 2001; Finnish translation of STRS, (Pakarinen et al., 2011, 2018) • Behavior Strategy Rating Scale (BSRS; Aunola et al., 2000; Zhang et al., 2011) • Fixation metric: Total fixation duration	Pearson correlation, eta value analysis, moderation analysis using multi-group modelling

4.2 Measures

4.2.1 Teachers' visual focus of attention

Teachers' visual focus of attention was measured with mobile eye-tracking technology, wherein each teacher wore Tobii Pro Glasses 2 (Tobii AB, Danderyd, Sweden) for a duration of 20–25 min starting from the beginning of the second lesson of a routine school day. The authentic classroom setting was ensured first by not controlling the structure and content of the lesson, and second by giving teachers the free choice to conduct the lesson the way they wanted. In the fall, the teachers' eye-tracking video recordings consisted of 22 literacy lessons, 18 math lessons and eight activity-based lessons. In the spring, there were 20 literacy, 23 math and four activity-based lessons. As suggested by the manufacturer, two trained research assistants calibrated the mobile eye-tracking glasses using a 1-point calibration. The next step was to validate and recheck the calibration by asking teachers to look at three points on the wall. Once the calibration was correctly completed and the teachers' eye-gaze met the three points on the wall, the research assistants started the eye-tracking recording. The specifications of the Tobii Pro Glasses 2 (Tobii User Manual, 2018) were as follows: four cameras for corneal reflection and pupil tracking with scene camera resolution of 1,920 × 1,080 pixels at 25 frames per second. The visual angle of the scene camera was 82 degrees horizontal and 52 degrees vertical. The frame dimensions were 179 × 159 × 57 millimetres.

Once the teachers' eye-tracking videos were recorded, each video was further processed using Tobii Pro Lab v.1.128, a software that is used for generating eye-movement data from eye-tracking videos. A step-by-step description of the coding process can be seen in Figure 3. In the Tobii Pro Lab software, there are eye-movement filters that can be selected in order to detect eye movements, including saccades and eye stillness, such as fixations. For processing the eye-tracking videos used in the present studies, the I-VT Attention filter setting was used, since it is the best suited for identifying participants' eye fixations from eye-tracking glasses in authentic settings wherein the physical movements are not restricted (Tobii Connect, 2018). Fixations have been defined as the duration of time when the eye is relatively still and takes input from the environment for information processing (Grub et al., 2020; Holmqvist et al., 2015). In the present thesis, fixation metrics, such as total fixation durations, average fixation durations and fixation counts or number of fixations, were considered as indicators for assessing teachers' visual focus of attention and used for further analysis (see Table 1). According to Holmqvist et al. (2015), total fixation duration is the total duration of time when the eye is relatively still in one position. Fixation durations are typically between 100–300 milliseconds and can be as long as several seconds. Furthermore, fixation counts are the number of times fixations occurred in each area of interest. Previously, fixation durations and counts were used to investigate teachers' information processing in the classroom in several

studies (e.g., Cortina et al., 2015; Van den Bogert et al., 2014; Wolff et al., 2016; Yammamoto & Imai-Matsumura, 2013).

The teachers' visual focus of attention in the classroom was determined based on the areas of interest (AOIs). AOIs were the targets that the teacher looked at during eye-tracking recording, which included students, instructional materials (e.g., teaching and learning materials) and noninstructional materials (e.g., tables, walls, curtains, etc.). Next, trained research assistants mapped fixations identified from eye-tracking video recordings on Tobii Pro Lab v.1.128 software onto the respective AOIs, based on where the teacher looked. For example, when a red circle representing the teachers' eye gaze was seen as being targeted on particular student, then the gaze was manually mapped on the respective snapshot of the student, and it was identified as the teachers' AOI.
Altogether, 20% of the videos from the entire dataset were double coded. The double coding was performed by two researchers with a background in education and classroom teaching. Before conducting the double coding, both coders watched one eye-tracking video together to agree and decide on some specific ambiguous situations. For example, if two students came into the red circle representing teacher's eye gaze then gaze was mapped onto the student that occupies the circle more than the other (see example 1 from Figure 4). Similarly, the coders agreed on 14 more decisions of such situations (see examples in Figure 4). After making the double coding decisions, both coders followed steps 2–5 as can be seen in Figure 3 in order to double code the eye-tracking videos. Next, the intercoder reliability was calculated using fixation counts obtained from two coders. In particular, a double coding agreement percentage was calculated (an example calculation for one eye-tracking video can be seen in Appendix 1). The intercoder reliability provided a double coding agreement average of 91.43% for the fall data and 90.09% for the spring data. After the manual mapping of the teachers' fixations on the teachers' AOIs, teachers' visual focus of attention in terms of total fixation duration, average fixation duration and fixation counts or number of fixations only on students were selected for further analysis. To ensure good-quality data, only eye-tracking recordings with a gaze sample percentage of 70% and above were selected. The gaze sample percentage was defined as the total percentage of the recording duration when one or both eyes were detected by the mobile eye-tracking glasses. Accordingly, three eye-tracking video recordings from the fall of 2017 and the spring of 2018, respectively, were excluded due to a gaze sample percentage of less than 70%. Some possible reasons for the low gaze sample percentage were high amount of blinking, fast paced head movements, unsuitable lighting conditions in the classroom, and eye-make up of teacher.

Figure 3. Summary of the steps taken during coding teacher's eye-tracking video recordings.

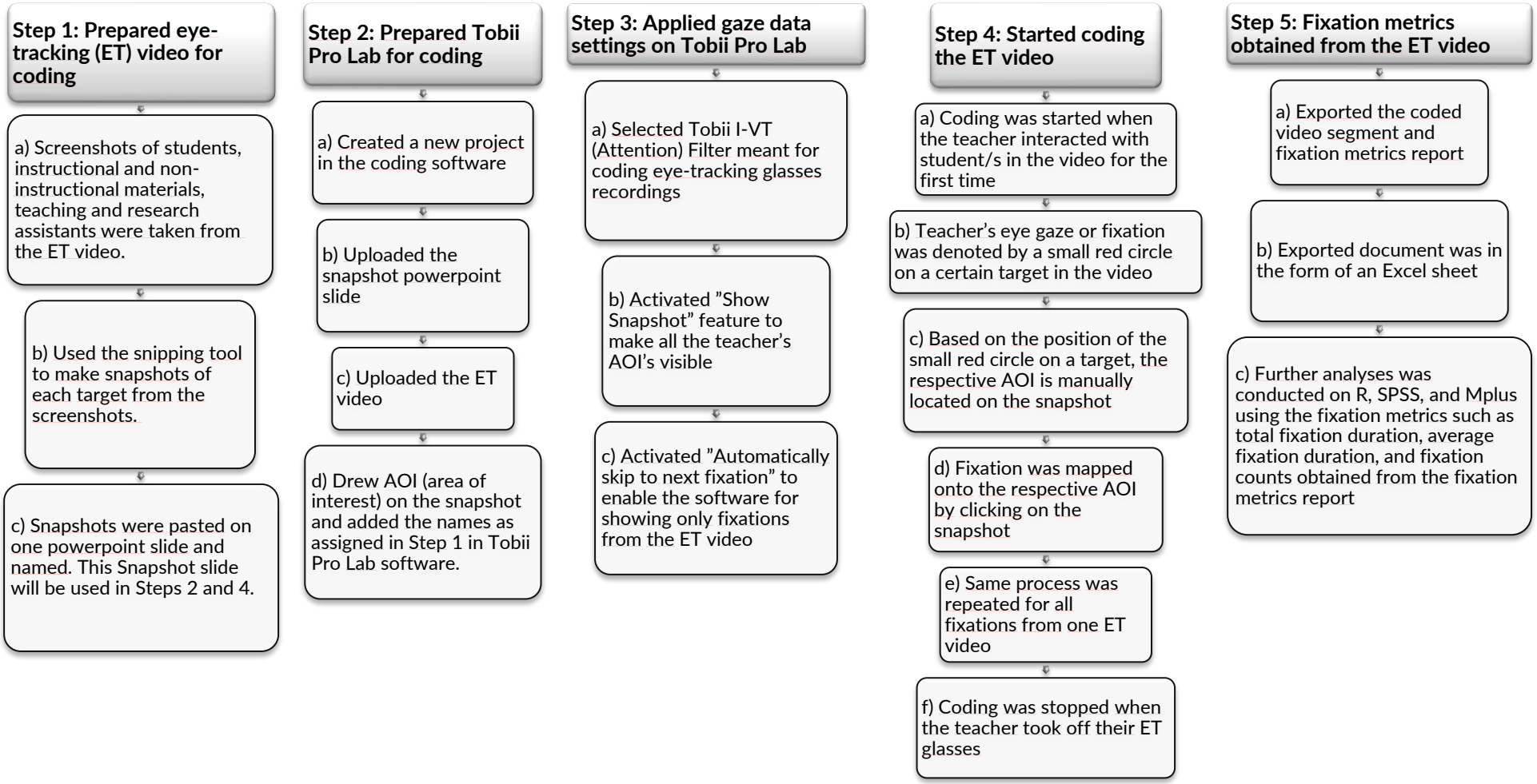
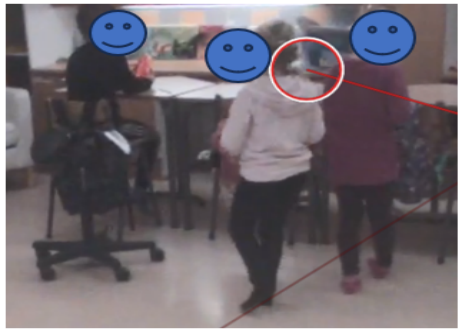


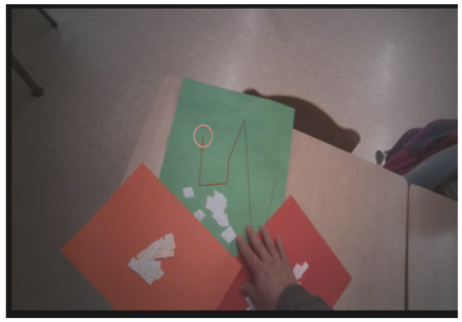
Figure 4. Examples of coding decisions agreed by two coders before the final double coding.



Example 1- When two students come into the same circle while coding then gaze will be mapped on the student covering more space in the circle.

Example 2- Gaze on eye tracking equipment mapped as others.

Example 3- Gaze circle touching the head/body part of the student is mapped as a gaze on the student. Move the cursor from the beginning of the fixation to the end and map it on the student covering majority time of the fixation.



Example 4- Gaze on materials that are not used in the 20 minutes of the eye tracking video teaching time are coded as others.

Example 5- Gaze on electronic items while turning them on/off during teaching time is mapped on teaching materials.

4.2.2 Teacher-reported stress

Teachers' self-perceived stress was measured using a shortened Finnish version of the Bergen Burnout Inventory (BBI-9; Salmela-Aro et al., 2010). There were nine items in this questionnaire from three domains that were rated from 1 (completely disagree) to 6 (completely agree); these were emotional exhaustion (e.g., 'I am snowed under with work'), cynicism (e.g., 'I feel dispirited at work, and I think about leaving my job'), and inadequacy (e.g., 'I frequently question the value of my work') at work. The three domains focused on prolonged work-related stress. Specifically, the emotional exhaustion domain focused on the feeling of fatigue that was caused by increasing workloads. The cynicism domain of the BBI-9 focused on teachers' loss of interest in their work and their feelings of indifference towards work and people at work. Lastly, the domain of inadequacy focused on teachers' reduced efficacy in their professional competency and accomplishments at work. The BBI-9 measure was used in sub-study 1. Cronbach's alpha reliability of the domains in the fall were as follows: exhaustion, .53; cynicism, .65; and inadequacy, .74, and in the spring as follows: exhaustion, .46; cynicism, .70; and inadequacy, .77. In the present sample, low reliability coefficients can be seen in terms of emotional exhaustion in fall and spring. There could be two reasons contributing to the low reliability coefficients. First, this study involved a rather small sample of teachers that could reduce the statistical power of the dataset, and second, there were only three items in BBI-9 measuring teachers' emotional exhaustion.

The three-factor structure of BBI-9 has been tested for factorial validity and showed invariance across all cross-sectional samples in a study across organisations, including educational institutions (Feldt et al., 2013). Furthermore, sources of work-related stress were measured by asking the teachers to answer an open-ended question on the questionnaire: 'What causes you the most stress and exhaustion at work?'. For the case study approach in sub-study 1, teachers' answers were used to gain a deeper understanding of the work-related stress of the two selected teachers.

4.2.3 Students' basic academic skills

The students' basic academic skills in literacy and math were measured. First, literacy assessment material for a Grade 1 test battery (ARMI- Luku-ja kirjoitustaidon arviointimateriaali 1. luokalle; Lerkkanen et al., 2006) was used to assess reading accuracy of students in Grade 1. This reading fluency test in Finnish was comprised of words in an increasingly difficult order ranging from 2- to 16-syllables. The test was administered by trained research assistants. Each student was shown one word at a time and 20 words in total. Students were asked to read each word aloud. The research assistants noted the sum of correct responses that were read aloud by the students. The total score was calculated out of a maximum score of 20. The Cronbach's alpha of students' basic academic skill in literacy was 0.61.

Second, the Basic Arithmetic Test (BAT; Aunola & Räsänen, 2007) was used to measure arithmetic fluency skill in math for each student. This three-minute timed test consisted of 28 items where students were shown arithmetic operation questions in addition (14 items, e.g., 2 + 1 = ? and 3 + 4 + 6 = ?) and subtraction (14 items, e.g., 4 – 1 = ? and 20 – 2 – 4 = ?). Then, students were instructed by trained research assistants to perform the calculations with speed and accuracy. The research assistants recorded the number of correct items and determined the sum score out of a maximum score of 28. Cronbach's alpha of the students' basic academic skill in math was 0.84.

For further analysis in sub-study 2, both the literacy and math test scores were standardised and investigated in relation to teachers' visual focus of attention indicators. For in-depth investigation using two case studies as part of the sub-study 2, only the students' math test scores were considered.

4.2.4 Teachers' individual support for students

The teachers rated the need for individual support from the teacher for each student in reading, writing and math. They rated a total of nine items, out of which six items indicated teachers' support to the student in literacy during a day in reading words, reading comprehension, reading fluency, word level spelling, writing words and writing text. Next, three items indicated the teachers' support to the student in math skills, such as number counting, verbal math problems and basic math problems. The teacher rated each student based on the individual support they gave during literacy and math learning on a routine school day in comparison to other students in the classroom (Silinskas et al., 2015). The ratings were on a 5-point scale (1 = Substantially less than other students, 2 = Somewhat less than other students, 3 = An equal amount as other students, 4 = Somewhat more than other students, and 5 = Substantially more than other students). Cronbach's alphas for items indicating individual support in literacy and math were 0.97 and 0.94, respectively, in sub-study 2.

For further analysis in sub-study 2, scores obtained from items related to teachers' individual support for students in reading and math were standardised and investigated in relation to teachers' visual focus of attention indicators. Furthermore, an in-depth investigation was conducted using two case studies wherein only teachers' individual support for students in math was considered.

4.2.5 Quality of teacher–student relationships

Teachers rated their perceived quality of teacher–student relationships in terms of closeness and conflict using the Student-Teacher Relationship Scale (STRS; Pianta, 2001; for the Finnish translation of STRS, see also Pakarinen et al., 2011, 2018) with each student in the classroom. The questionnaire consisted of 15 items, each of which was rated on a 5-point scale (1 = Definitely does not apply to 5 = Definitely applies). The subscale measuring closeness comprised eight items, such as, 'This child experiences physical closeness or touch expressed by me as uncomfortable', 'I have a close, warm relationship with this child' and 'If this

child is upset, s/he seeks comfort from me'. In addition, the subscale measuring conflict comprised seven items, such as 'This child easily gets angry at me', 'There always seem to be difficulties between this child and me' and 'This child becomes persistently angry or resistant, I should limit her/his behaviour'. In sub-study 3, 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 in the fall and the spring.

For further analyses in sub-study 3, scores related to closeness and conflict in the teacher–student relationships were investigated in association with the teachers' visual focus of attention in terms of the teachers' total fixation durations in the fall and spring. Next, it was investigated whether there was a moderating effect of students' gender and task-avoidant behaviour on this association at fall and spring.

4.2.6 Moderating factors: Students' gender and task-avoidant behaviour

The teachers reported each participating student's gender in the fall and spring in the background information. For further analyses, in sub-study 3, gender differences were estimated by grouping students' gender into boys (N_{Fall} = 323, N_{Spring} = 310) and girls (N_{Fall} = 325, N_{Spring} = 318).

Furthermore, the teacher rated each participating student's task-avoidant behaviour using the Behavior Strategy Rating Scale (BSRS; Aunola et al., 2000; Zhang et al., 2011). This scale comprised five items, each of which was rated on a 5-point rating scale (1 = Never to 5 = Always). Before calculating the sum score, the two positively worded items were reversed. In sub-study 3, Cronbach's alpha for students' task avoidance was .95 in the fall and .96 in the spring. In sub-study 3, for moderation analyses, students' task-avoidant behaviour was grouped as 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%).

4.3 Analyses

4.3.1 Association between study variables

Pearson's correlation analysis. The associations between teachers' visual focus of attention and factors related to teachers and students were estimated using Pearson's correlation analysis in IBM SPSS Statistics 27 (IBM, Armonk, NY, USA) for all three sub-studies. In sub-study 1, a statistical measure of the Gini coefficient (Cortina et al., 2015; Dessus et al., 2016) was calculated using the R programme to show how teachers distributed their visual focus of attention on students, instructional materials and non-instructional materials during a lesson using the teachers' total fixation durations on each target in the classroom. The Gini coefficients range from 01, where 0 refers to equal distribution of visual focus of attention to all targets, to 1 which refers to an unequal distribution of

visual focus of attention wherein only one target receives all the visual focus of attention from the teacher (Cortina et al., 2015).

In sub-study 1, first, the teachers' distribution of visual attention on students was shown using the Gini coefficient during the whole lesson and separately during various activity settings such as management/routines, and transitions, teacher-directed large group instructions, small group/pair work and individual work in the fall and spring semesters. Then, the association between teachers' focus of attention using the Gini coefficient and teachers' stress domains of emotional exhaustion, cynicism and inadequacy were estimated at both time points.

In sub-study 2, associations between teachers' visual focus of attention, students' basic academic skills, and teachers' individual support for academic skills in literacy and math were estimated using the classroom aggregates only for the spring semester.

Finally, in sub-study 3, associations between quality of the teacher–student relationship and teachers' visual focus of attention were estimated for both the fall and spring semesters. Furthermore, the associations between student gender and task-avoidant behaviour and teachers' visual focus of attention were indicated using eta coefficients.

Moderation analyses using multi-group models. In sub-study 3, multi-group models were specified using the Mplus software (Version 8.7; Muthén & Muthén, 1998–2012). These models estimated whether students' task-avoidant behaviour and 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. The data in sub-study 3 were nested since the teachers rated their students in the classroom with regard to their perception of the quality of teacher–student relationships and students' task-avoidant behaviour. Due to the nested nature of the data, the TYPE = COMPLEX option was used since it corrected the distortions in standard errors in estimates caused by the clustering of observations. The model parameters were estimated using full information maximum likelihood (FIML), with robust standard errors maximum likelihood ratio (MLR). To conduct moderation analysis, students' gender was grouped into boys and girls. In addition, students' task-avoidant behaviour was grouped into low, average and high task avoidance. Furthermore, cut-off points were made in order to choose the 20%–25% of lowest and highest ends of students' task-avoidant behaviour.

Next, multi-group modelling tested whether there were significant differences in the path coefficients among the groups based on the Satorra–Bentler scaled chi-square difference test (Satorra & Bentler, 2001). The Satorra-Bentler scaled chi-square difference test compared constrained models with unconstrained models. In the constrained models, all the paths were restricted to be invariant by the groups, whereas in unconstrained models, the paths were one by one allowed to vary by group. Furthermore, the estimated models were evaluated based on their goodness of fit using the following model fit indices: comparative fit index (CFI), root mean square error of approximation (RMSEA),

and standardised root mean square residual (SRMR). Next, the cut-off criteria for fit indices suggested by Hu and Bentler (1999) were used to denote a good model fit by utilising a cut-off value close to .95 for CFI, .06 for RMSEA and .08 for SRMR.

4.3.2 Case study approach

The case study approach was implemented to obtain an in-depth description of the chosen example teachers and how factors from their classroom reflected the variation in their visual focus of attention on students. In educational research, case studies are known to be detailed investigations of small samples focusing on specific aspects of an experience within a classroom (Tight, 2010). Therefore, in our sub-studies, the in-depth analysis of the case studies provided a comprehensive picture of how teacher-related and student-related factors are reflected in teachers' visual focus of attention in real-life situations during teaching. Furthermore, the case study approach was used to investigate whether the results from sub-studies 1 and 2 were reflected in the individual classrooms. This approach provided the opportunity to explore in depth how teachers' classroom behaviour in terms of their visual focus of attention could vary in a specific classroom environment. Although quantitative methods allow the investigation of a phenomenon in a large sample, a granular level of descriptive analysis using a case study approach is needed to understand the unique classroom environments and how teachers act in them.

In sub-study 1, the variations in teachers' visual focus of attention between a more stressed and less stressed teacher were explored using a case study approach. Two teachers were selected for in-depth investigation based on their stress scores, that is, one teacher with more than average stress and one teacher with less than average stress in the larger sample/data pool of teachers. After selecting the teachers, three steps were followed. First, the two individual teachers' stress scores and background information were described in detail. Second, visual representations in the form of bar graphs and line graphs were made to show the teachers' visual focus of attention on students, instructional materials, non-instructional materials, and the teachers' total fixation durations during a math lesson both in the fall and spring. Finally, activity settings consisting of management/routines and transitions, teacher-directed large group activity, individual work and small group/pair work activities were determined from the teachers' eye-tracking video recordings and considered in sub-study 1. The visual representations showed how the teachers' visual focus of attention varied during different activity settings in a lesson.

In sub-study 2, the case study included the selection of two classrooms based on teachers' ratings of individual support for students in math skills. One example classroom with high teacher individual support characterised by a higher-than-average score of teacher individual support for students in math skills was selected. Next, another example classroom with a lower-than-average score of teacher individual support for students in math skills was selected in the case study. After the selection of the two classrooms, three steps of analysis were followed. First, the Mann–Whitney *U* test was used to investigate the differences

in teachers' visual focus of attention from the two selected classrooms based on the eye-tracking parameters during math lessons. Second, the differences were explored in teachers' visual focus of attention between two student groups indicated by their high and low teacher-reported individual support scores in math skills. Finally, both teachers' visual focus of attention in terms of fixation counts (number of fixations) with respect to students' academic skills and teacher-reported individual support scores in math were visually represented.

5 OVERVIEW OF RESULTS

5.1 Study 1: Teachers' focus of attention in first-grade classrooms: Exploring teachers experiencing less and more stress using mobile eye-tracking

The first aim of sub-study 1 was to investigate the association between teachers' visual focus of attention and teacher-perceived stress experienced at work in the form of emotional exhaustion, cynicism and perceived inadequacy in the fall and spring. The participants in sub-study 1 were 53 first grade teachers from 36 schools. To analyse the data, correlational analysis was employed to investigate the association between teachers' visual focus of attention during the entire lesson and different activity settings and teacher-reported stress. The second aim was to explore through an in-depth descriptive case study analysis how a teacher reporting more stress and another teacher reporting less stress focused their visual attention on students during math lessons in the classroom in the fall and spring.

In sub-study 1, teachers' focus of attention was estimated based on their even or uneven distribution of visual attention indicated by the Gini coefficient. The Gini coefficient was calculated using the teachers' total fixation duration on all students in the classroom. Additionally, in the case studies, the teachers' total fixation duration on students was estimated separately during each of the activity settings. Teachers rated their perceived stress based on the domains of exhaustion, cynicism and inadequacy of work-related stress. For an in-depth understanding of each teacher's teaching practices during a lesson, all the teachers' lessons were further divided into segments based on the dominant activity settings (see Table 2) determined from the eye-tracking video recordings.

Table 2. Activity settings observed in the eye-tracking recordings.

Activity setting	Description
Management/routines/transitions	Non-academic nature of activities wherein the teacher managed the classroom based on students' behaviour and facilitated classroom routines and transitions between activities.
Teacher-directed large group activity	Academic nature of activities wherein the teacher gave academic/content-related instruction to large groups of students using instructional materials.
Individual work	Academic nature of activities wherein all the students of the class work on a task individually. Teachers typically walk around the class and help students individually, or they could work with one student for the entire duration of the activity.
Small group/pair work	Academic nature of activities wherein students work in small groups or pairs where they are assigned to work. The teacher could work with individual or several groups of students.

The results showed first that teachers reported more emotional exhaustion in the fall and increased inadequacy in the spring. In addition, in the fall, teachers gave more individual attention to students during individual work activity settings (see Table 2), whereas in the spring, more individual attention was given during small group/pair work activity settings. The teacher-reported emotional exhaustion, cynicism and inadequacy positively correlated with visual focus of attention during management/routines and transitions (see Table 2) in the fall. In addition, teacher-perceived inadequacy was marginally positively correlated with teachers' visual focus of attention during the entire lesson in the spring. Furthermore, teacher perceived inadequacy was positively marginally correlated with the teachers' visual focus of attention during teacher-directed large group activity (see Table 2).

The case study of one more stressed teacher (see Table 3) showed that student behaviour problems and a fixed-term working contract were their causes of stress in fall. In addition, the teacher reported that no students needed special education support in their classrooms. However, in the spring, the more stressed teacher reported similar causes of stress as in the fall and additionally mentioned the adversity of lacking classroom resources in terms of the unavailability of special needs educators. In addition, in the spring, the more stressed teacher reported that nearly half of the students needed support in terms of learning and socio-emotional learning problems. In terms of the teacher's visual focus of attention, it was seen that the more stressed teacher focused their attention most of the time on students during management/routines and transitions at fall. Moreover, in the spring, the more stressed teacher focused longer on students during teacher-directed large group activity and distributed visual focus of attention rather evenly amongst students.

The case study of one less stressed teacher (see Table 3) showed that changes related to new assessment practices based on the new curriculum and

changes in working patterns were reported as their causes of stress in the fall. In addition, the teacher reported challenges in the development of students' reading skills and reinforcing reading fluency with some students as their main causes of stress in the spring. However, the less stressed teacher was supported by a special needs educator to provide the required guidance to students needing specialised support in the classroom during teaching. In the case of this less stressed teacher, it was observed that during a math lesson in the fall, more visual attention was given to students during the teacher-directed large group activity setting and more visual attention was given to instructional materials during the individual work activity setting. Additionally, in math lessons during spring, the less stressed teacher focused most of their visual attention on students during small group/pair work activity settings. In addition, the teacher focused their attention rather evenly on all students during the spring math lesson.

To conclude, sub-study 1 was the first of its kind to investigate the association between teacher stress and teacher visual focus of attention in Grade 1 classrooms. Overall, the results suggest that it is important to support teachers' well-being, as it could be reflected in their classroom behaviour through their visual focus of attention on students. In addition, teachers could benefit from focused training and mentoring related to classroom management routines, with a particular focus on managing challenging student behaviours at both pre- and in-service programmes.

Table 3. Summary of the case studies of two teachers from sub-study 1.

		More stressed teacher	Less stressed teacher
Fall	**Subject of the lesson in eye-tracking recording**	Math	Math
	Classroom information: Class size Students needing special support **Classroom support:** School counsellor Special needs educator	 22 0 Yes No	 24 4 Yes Yes
	Stressors	a) Student behaviour problems b) Fixed-term work contract	a) New assessment practices from new curriculum b) Change in working patterns
	Visual focus of attention during the lesson	Longer visual focus of attention on students only during management/routines/transitions activities	Longer visual focus of attention on students during teacher-directed large group activity and instructional materials during individual work activity
Spring	**Subject of the lesson in eye-tracking recording**	Math	Math
	Classroom information: Class size Students needing special support **Classroom support:** School counsellor Special needs educator	 21 12 Yes No	 24 5 Yes Yes
	Stressors	a) Similar as in the fall b) Adversity due to lack of classroom resources to support students, such as, special needs educator	a) Challenges in developing students' reading skills b) Reinforcing reading fluency with some students
	Visual focus of attention during the lesson	a) Longer visual focus of attention on students during teacher-directed large group activity b) More even distribution of visual attention on students	a) Longer visual focus of attention on students during small group/pair work activity b) More even distribution of visual attention on students

5.2 Study 2: Teachers' visual focus of attention in relation to students' basic academic skills and teachers' individual support for students: An eye-tracking study

The overall aim of sub-study 2 was to examine the relationship between teachers' visual focus of attention and students' basic academic skill levels. In addition, the association between teachers' visual focus of attention and teacher-reported individual support for students was investigated. Furthermore, an in-depth investigation of teachers' visual focus of attention was done with two classrooms, one characterised by high teacher-reported individual support for students and another characterised by low teacher-reported individual support for students. The participants in this sub-study were 46 Grade 1 teachers and 879 students from seven municipalities in Central Finland.

In sub-study 2, the teachers' visual focus of attention was indicated by the total fixation duration, average fixation duration and fixation counts obtained after coding the mobile eye-tracking videos. Additionally, students' basic academic skill levels were indicated by literacy and math test scores; teacher-reported individual support for students in math and literacy was indicated by the teachers' ratings. The analysis was approached in two ways. First, correlation analysis was employed to investigate the relationship between teachers' visual focus of attention, students' basic academic skill levels in math and literacy and teacher-reported individual support for students in academic skills. Second, a case study approach was employed to investigate two classrooms in depth. In the case studies, the Mann–Whitney *U* test was employed to study the differences in the teachers' visual focus of attention, students' academic skill levels and individual support students both between and within the two classrooms.

The results showed first that teachers' visual focus of attention in terms of fixation counts negatively correlated with students' basic academic skill levels in literacy and math and positively correlated with teachers' individual support for students in basic academic skills. Second, the case study of two teachers' visual focus of attention in high and low individual support classrooms revealed that there may be variations in teachers' visual focus of attention based on their reports of individual support for students and students' basic academic skill levels.

In the case study of the high individual support in math for students (Teacher 1), the teacher's average fixation duration varied significantly between groups of students categorised as needing high and low individual support in math (see Table 4). In this classroom, students who were reported as needing high individual support from the teacher received less visual focus of attention in terms of average fixation duration from the teacher in comparison to students who were rated as needing less support. Furthermore, students' math skills varied between the students who were rated as needing high teacher individual support and those students rated as needing low teacher individual support. In addition, teacher-reported individual support varied significantly between high

and low teacher-reported individual support groups of students. In terms of the teacher's fixation counts in this classroom, three students with higher basic academic skills in math received less visual attention from the teacher, and four students with lower basic academic skills received more visual attention from the teacher and students. Moreover, there were inconsistencies in the amounts of teacher's visual focus of attention that were seen in the classroom characterised by high teacher individual support. Specifically, some students, despite having lower teacher-reported individual support and higher basic academic skills in math, received frequent visual focus of attention from the teacher. Similarly, some students with lower basic academic skills in math and higher teacher-reported individual support received less visual focus of attention than the other students.

Next, within the classroom characterised by low individual support for students in math skills by the teacher (Teacher 2), the results showed that the teacher's visual focus of attention did not vary between students who were reported as needing high and low individual support in math skills (see Table 4). However, students' basic academic skills in math differed significantly between students who were reported as needing high and low individual support. In particular, students reported as needing high teacher-reported individual support had low scores in math skills and vice versa. In addition, as expected, teacher individual support significantly varied between students reported as needing high and low teacher-reported individual support in this classroom. In terms of the teacher's visual focus of attention, some students scoring high in math were reported as requiring low teacher individual support, and these students received less visual focus of attention from the teacher. Furthermore, there were inconsistencies in the teacher's visual focus of attention based on the number of fixations on students in this classroom. This teacher gave less visual focus of attention to students who were reported as needing low teacher individual support despite having lower basic academic skill levels in math. In addition, the teacher gave increased visual focus of attention to some students having lower math scores and low teacher-reported individual support for students. Similarly, the teacher gave increased visual focus of attention to some students who scored high in math and were reported as needing lower individual support than others.

To conclude, it seems that teachers' visual focus of attention can vary based on students' basic academic skill levels and teacher individual support for students in academic skills. Therefore, it would be important to maintain a manageable ratio of students with higher teacher individual support needs so that the teacher can give them the required visual focus of attention. Furthermore, in the future, investigation of teachers' means of differentiating instructions in relation to the present results could give insights into the amount of individual support in academic skills the teacher provides to individuals or groups of students in the classroom.

Table 4. Summary of case studies of two teachers from sub-study 2.

	Teacher 1	**Teacher 2**
Basis of classroom selection	Higher-than-average teacher individual support for students	Lower-than-average teacher individual support for students
Class size	23	24
Differences between two classrooms	• Students' math skill levels were higher than the average of all classrooms. • Teacher's average fixation duration per student was higher.	• Students' math skill levels were lower than the average of all classrooms. • Teacher's average fixation duration per student was lower.
Differences within each classroom	• Teacher gave less visual focus of attention to students with high teacher-reported individual support. • Students with high teacher-reported individual support had poorer math skills.	• Teacher's visual focus of attention did not vary between students with high and low teacher-reported individual support. • Students with high teacher-reported individual support in math had poorer math skills.
Exceptions noticed	• Two students with low teacher individual support scores and high math skills were fixated on more than other students. • Four students with low math skills and high teacher individual support received a smaller number of fixations from the teacher. • One student with low math skills and low teacher-reported individual support received fewer fixations from the teacher.	• Five students received lower fixation counts from the teacher despite having lower math skills. • Two students had higher math scores and lower individual support scores but received more fixations from the teacher. • Four students had lower math scores and low teacher-reported individual support, but the teacher fixated more on these students than those with high teacher-reported individual support.

5.3 Study 3: Association between the teacher–student relationship and teacher visual focus of attention in Grade 1: Student task avoidance and gender as moderators

In sub-study 3, the overall aim was to investigate the association between teachers' visual focus of attention and the quality of teacher–student relationship (closeness and conflict) in the fall and spring of Grade 1. Furthermore, the moderating effect of students' gender and task-avoidant behaviour on the association between teachers' visual focus of attention and the quality of teacher–student relationship was investigated. The participants of this study were from Grade 1 classrooms in Central Finland that included 48 teachers and 650 students in the fall and 47 teachers and 630 students in the spring. In this study, teachers' visual focus of attention was indicated by the teachers' total fixation duration on individual students in the classroom. Additionally, teachers reported the quality of the teacher–student relationships with individual students and students' task-avoidant behaviour using questionnaires. First, correlation analysis was conducted to investigate the associations between teachers' visual focus of attention and quality of the teacher–student relationship (closeness and conflict) in the fall and spring of Grade 1. Second, the moderation effect of students' gender and task avoidance on the association between teachers' visual focus of attention and quality of teacher–student relationship was investigated using a multi-group approach.

The results showed that there was a relationship between the teachers' visual focus of attention and the teachers' perception of the quality of teacher–student relationships in the fall and spring of Grade 1. Specifically, teacher–student closeness was positively associated with teachers' total fixation duration in the fall and spring of Grade 1. This indicated that with more teacher–student closeness the teacher reported with a particular student, teachers gave more visual focus of attention to the student. In addition, the more the teacher experienced conflict with the particular student in the spring, the more visual focus of attention they gave to the student.

Second, the results showed that gender did not moderate the association between teacher–student relationships and teachers' visual focus of attention either in the fall and spring of Grade 1. Furthermore, students' task-avoidant behaviour did not moderate the association between the teacher–student relationships and teacher visual focus of attention in the fall. However, in the spring, the results showed that students' task-avoidant behaviour moderated the association between the teacher–student relationships and teacher visual focus of attention. It was found that in the spring, teacher–student closeness was positively associated with teachers' total fixation duration for students with low and average task-avoidant behaviour, but not for students with high task-avoidant behaviour. Furthermore, teacher–student 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.

Additionally, the results showed that students' task-avoidant behaviour correlated with the teachers' visual focus of attention in terms of total fixation duration and the teachers' perception of the quality of teacher–student relationships. In particular, students' task-avoidant behaviour correlated positively with teachers' total fixation duration in both the fall and spring. This indicated that the more a student showed task-avoidant behaviour, the longer the teacher focused their visual attention on the student.

To conclude, the results showed that teachers' visual focus of attention was associated with teachers' overall perception of closeness and conflict in teacher–student relationships with students. Furthermore, this association was moderated by students' task-avoidant behaviour in the classroom. Overall, the results suggest that it is important to discuss students' achievement-related behaviour and its influence on teachers' classroom behaviour in pre- and in-service teacher training programmes.

6 GENERAL DISCUSSION

The investigation of teachers' visual focus of attention in the classroom using eye-tracking in combination with other teacher- and student-related factors showed that contextual factors in the classroom environment reflected on teachers' classroom behaviour towards students. For instance, previous research has shown that teachers look longer at students who show increased interactive or disruptive behaviour (Goldberg et al., 2021) and need adaptive pedagogical support during lessons (Seidel et al., 2020). In addition, mobile eye-tracking technology makes it possible to investigate a teacher's visual focus of attention on selective targets in the classroom that the teacher prioritises for information processing in authentic classroom settings. Along these lines, Haataja et al. (2019) showed using mobile eye-tracking that teachers' scaffolding intentions reflected their visual focus of attention during a math lesson. In particular, the teachers focused longer on the students' gestures during cognitive scaffolding when the students typically explained abstract ideas. Moreover, through mobile eye-tracking studies, it has been found that teachers' visual gaze coupled with their verbal discourse shows when teachers make eye contact with students to convey friendliness or authority towards them during teaching situations (Haataja et al., 2021; McIntyre et al., 2020).

The overall aim of the present thesis is to clearly illustrate how teachers' visual focus of attention on students is linked to various teacher-and student-related factors in authentic classroom settings in Grade 1. The results of our research showed that, first, teachers' stress in terms of sense of inadequacy was positively associated with teachers' distribution of visual attention (sub-study 1). Second, the teachers' visual focus of attention during management/routines and transitions in the classroom was associated with the teachers' overall work-related stress. Furthermore, the results showed that teachers focused their visual attention longer on students with low basic academic skills in math and literacy in Grade 1. Additionally, teachers gave a longer visual focus of attention to those students whom the teacher reported to be providing more individual support in academic skills (sub-study 2). Next, the results showed that in the fall, teachers' duration of visual focus of attention was associated with teacher-reported

closeness in terms of the quality of teacher–student relationships (sub-study 3). However, in the spring, teachers' visual focus of attention to students was associated with both teacher-reported closeness and conflict in the quality of teacher–student relationships. Furthermore, in the spring, the relationship between teacher–student closeness as well as conflict and the teachers' visual focus of attention was moderated by the students' task-avoidant behaviour.

6.1 Association between teacher stress and teachers' visual focus of attention

The first aim of the present thesis is to examine the association between teacher stress and distribution of teachers' visual focus of attention during teaching. The findings presented here (sub-study 1) indicated that first, there was a positive association between teachers' sense of inadequacy at work and their distribution of visual focus of attention on students during the entire lesson. In other words, teachers' reduced efficacy in their professional competence was associated with less individualised distribution of focus of attention amongst students in the fall and spring. This could be because teachers may not yet be aware of each student's needs in the classroom at the beginning of the school year in Grade 1. In addition, as noted in previous research, it could be that teachers' reduced efficacy in professional competence in managing student behaviour could make teachers prone to stress, feelings of detachment and exhaustion (Aloe et al., 2014; Salmela-Aro et al., 2011).

Second, teachers' stress in the form of emotional exhaustion, cynicism and sense of inadequacy was found to be positively associated with their distribution of visual focus of attention on students during management/routines and transitions activity settings in the fall when the teacher typically managed the classroom and student behaviour and engaged in social conversations with students. This finding could align with previous research showing that classroom management related to challenging student behaviour has been found to be associated with increasing teachers' work-related stress (Friedman-Krauss et al., 2013; Herman et al., 2018). Moreover, to manage challenging student behaviour, teachers need to prioritise monitoring and giving immediate visual attention to certain students in the classroom during the fall semester (Van den Bogert et al., 2014).

Third, there was a positive association between teachers' sense of inadequacy and their distribution of visual focus of attention on students during teacher-directed large group activities in the fall. This finding suggests that it could be easier for the teacher to spread their visual focus of attention rather evenly on students in the fall, especially during teacher-directed large group activity. Moreover, the purpose of teacher-directed large group activity settings is to direct all students to follow specific academic content-related instruction. As found in previous research, it could be that teachers' sense of inadequacy during

teaching could arise from their reduced control over distressful situations and from the adversity caused by a lack of resources needed to support students, which can be overwhelming for the teachers, thereby affecting teachers' classroom behaviour towards individual students (Lindqvist et al., 2017).

Further in-depth analysis of a more and less stressed teacher using the case study approach showed that individual teachers' stressors from their work can vary. First, the more stressed teacher reported that managing students' behaviour in their classroom was a cause of stress. Additionally, the analysis of eye-tracking video recording showed that the more stressed teacher focused visual attention longer on students during classroom management-related activity settings. In the spring, the more stressed teacher reported having more students needing individual support in their learning and behaviour and lack of support from a special needs instructor as their causes of stress. The closer analysis of the more stressed teacher's eye-tracking video recording from spring showed that they focused longer in terms of duration of visual attention on students and distributed their visual attention more evenly during teacher-directed large-group activity. This aspect of the case study might support the earlier finding from this study that teachers' sense of inadequacy is associated with their overall distribution of visual focus of attention in the spring. This appears to align with previous research arguing that teachers experience feelings of insufficiency, increased workload and stress while attending to students' varied learning-related needs (Pozas et al., 2023). Nevertheless, previous research has shown that even though differentiating instruction can be stressful, teachers implement differentiated instruction to support student learning despite their varying levels of expertise in terms of their professional vision (Roose et al., 2022).

Second, the less stressed teacher's case study showed that they reported changes in work patterns and challenges associated with assessment practices suggested in the new curriculum as their causes of stress in the fall. Moreover, the analysis of less stressed teachers' eye-tracking video recordings showed that they gave longer visual focus of attention to materials than students during individual work activity in the fall. The purpose of individual work activity settings is for students to independently complete the academic tasks assigned by the teacher. During this activity setting, the teachers' action may typically include, but is not limited to, monitoring students' work and providing required support and feedback about the academic task to individual students. However, there was no association found between the teacher's stress and their distribution of visual focus of attention on students during individual work activity setting. This result is supported by previous research showing that low teaching-related stress is linked to a higher quality of classroom organisation and emotional support towards students (Penttinen et al., 2020). Furthermore, in the spring, the less stressed teacher reported challenges with developing reading-related skills with some students as their cause of stress. The less stressed teacher's eye-tracking video recording in the spring showed that they focused longer visual attention on students during small group/pair work activity settings wherein the teacher typically monitored either individual or small groups of students while

they completed the assigned academic task. However, there were no associations between this teacher's stress and distribution of their visual focus of attention during small group/pair work activity setting. The results from the case study of the low stressed teacher supports previous research that showed that high-quality instructional support from the teacher is linked to less antisocial and more prosocial student behaviour (Soininen et al., 2023). In summary, the variations in teachers' stress may reflect on teachers' visual focus of attention; however, there is no fixed pattern as each classroom is different, requiring varied approaches to classroom instruction.

6.2 Teachers' visual focus of attention in relation to students' basic academic skills and teachers' individual support for students

The second aim of the present thesis is to examine teachers' visual focus of attention in relation to students' basic academic skills and teacher-reported individual support to students for improving their academic skills. The study results indicate that teachers' visual focus of attention is associated with students' basic academic skills in literacy and math and teacher-reported individual support for students in basic academic skills (sub-study 2). Specifically, teachers' fixation counts were found to be associated positively with their individual support for students in literacy and math and negatively with students' academic skills in literacy and math. These results indicate that during lessons, teachers look more frequently at students with low academic skills in literacy and math and high teacher-reported individual support for academic skills. This is in line with previous research showing that students having low basic academic skills in Grade 1 receive more individual support from the teacher (Nurmi et al., 2012). In addition, eye-tracking studies have shown that an increase in the number of fixations and average duration of fixations point to improved awareness, information processing and judgement accuracy of student assessments (Gegenfurtner et al., 2011; Schnitzler et al., 2020). Furthermore, previous research has shown that teachers look longer at individual students to interpret students' learning strategies and respond based on the individual students' understanding (Jacobs et al., 2010). Therefore, it is possible that teachers process information from students and differentiate classroom instruction based on the basic academic skill levels of students, especially in the spring, after observing them during the academic year. Previous research related to teachers' professional vision has shown that teachers employ differentiated instructions irrespective of their level of visual expertise (Roose et al., 2022). Additionally, teachers have been found to focus their visual attention longer on students who struggle with academic tasks during a lesson (Seidel et al., 2020). In summary, it is possible that teachers' increased visual attention on particular students in terms of fixation counts could be based on their prior knowledge of students' learning-related

skills and behaviours (Wolff et al., 2020). Previously, studies have investigated how teachers notice and address students' content-related thinking and confusion during teaching (Copur-Gencturk & Tolar, 2022; Van Es & Sherin, 2008). Building on this premise, this thesis contributes to the literature on teachers' noticing of students based on students' academic skill levels and teacher-reported individual support for students during teaching situations in elementary school classrooms.

In-depth investigation of two selected classrooms, one characterised by high teacher-reported individual support for students in math skills, and one characterised by low teacher-reported individual support for students in math skills, showed that there could be variations in teachers' visual focus of attention in terms of their fixation counts. In the classroom characterised by high teacher-reported individual support, the teacher reported a greater number of students to whom they provided high individual support compared with the classroom characterised by low teacher-reported individual support. The results showed that the two selected classrooms showed significant differences in teachers' visual focus of attention in terms of average fixation duration, students' math skills and teachers' individual support in math. This result can be supported by previous research showing that teachers distribute their visual attention rather unevenly during teaching due to variations in students' academic skill levels and teacher-reported individual support (Dessus et al., 2016).

Since teachers' eye movements were recorded in an authentic classroom setting, it is possible that other factors from the classroom environment could have influenced their visual focus of attention. Similarly, students' academic skill levels and teachers' individual support for students may not be the only reasons why the teacher would look at an individual student. Moreover, there were some noticeable differences between the two case study classrooms. The amount of the teachers' average fixation duration on students varied between the two classrooms. Furthermore, in the classroom characterised by high teacher individual support for students in math, some students that teacher reported as needing more individual support compared with others received less visual focus of attention from the teacher in comparison with the students that the teacher reported as needing less teacher individual support. This is supported by previous research showing that students displaying increased interactive learning behaviour can attract more teachers' visual focus of attention compared with students who are less interactive (Goldberg et al., 2021). Furthermore, a recent study has shown that teachers look longer at students who raise their hands often during classroom discussions (Kosel et al., 2023). It could be that students requiring less teacher individual support in math show increased participatory and interactive behaviour towards the teacher in the classroom, thereby receiving increased teacher visual focus of attention. However, in the case study classroom characterised by low teacher individual support, there were no significant differences in the way teachers noticed high and low teacher individual support students. It seemed that the teacher focused their visual attention more on some students despite their low teacher individual support in

math. As shown in previous research, it could be that the teacher needed to give increased visual focus of attention to these students to attend to their mathematical strategies used while doing their math task to further interpret their progress in academic skill development (Jacobs et al., 2010). In summary, during a lesson, the teachers' visual focus of attention on individual students could vary based on the students' academic skills and individual support from the teacher. However, it is possible that the amount of individual support from the teacher and visual focus of attention could vary not only based on students' academic skills but also on the specific requirements of the student during the lesson.

6.3 Association between the quality of the teacher–student relationships and teachers' visual focus of attention: Students' gender and task-avoidant behaviour as moderating factors

The third aim of the present thesis is to investigate the association between the teacher-reported quality of teacher–student relationships with students and teachers' visual focus of attention in the classroom. In addition, how this relationship is moderated by student-related factors such as task-avoidant behaviour and gender is explained. The study results showed that, first, the teachers' perception of closeness with students was positively associated with their visual focus of attention in terms of total fixation duration in the fall in Grade 1. This aligns with previous research by McIntyre et al. (2020) showing that teachers establish eye contact with students to communicate warmth and communion. Furthermore, studies by Hietanen et al. (2008) and Ledbury et al. (2004) have shown that teachers establish eye contact with students to facilitate suitable student behaviour and build warm relationships. The results also showed that teachers' perception of conflict with students was positively associated with teachers' visual focus of attention in the spring. This indicates that the more teachers perceived conflict in their relationship with a particular student, the longer they gave their visual focus of attention to them in the spring. In the spring, teachers are well acquainted with typical student behaviours in the classroom resulting from frequent interactions over the academic year. Therefore, it is possible that a teachers' perception of conflict with students arises from the way students behave towards teachers and their classmates. For instance, previous research has shown that students' problem behaviours in the classroom contribute to increased conflict in the teacher–student relationship (Doumen et al., 2008). Additionally, previous eye-tracking research has found that teachers give a longer visual focus of attention to students showing increased disruptive behaviour during teaching (Goldberg et al., 2021). Furthermore, Haataja et al. (2021) showed that a teacher could give a longer visual focus of attention to a student while giving them feedback in relation to their learning-related behaviour. It is important to consider that teacher- and student-related factors

guiding teachers' visual focus of attention could vary based on the time of academic year. For example, in the early years of school, especially at the beginning of the academic year, increased teacher visual focus of attention to students typically helps in building warm relationships with them, thereby contributing to better school adjustment for students.

Next, the results showed that there was no moderation effect by students' gender on the association between the quality of the teacher–student relationship and teachers' visual focus of attention either in fall or spring of Grade 1. According to previous research, teachers give close attention to students' behavioural and cognitive skills when assessing their academic and learning ability (Schnitzler et al., 2020). Furthermore, the results indicated that students' task-avoidant behaviour moderated the association between the quality of the teacher–student relationship and teachers' visual focus of attention in the spring of Grade 1. Results from the moderation analysis showed that, first, in the low and average task-avoidant behaviour groups, teacher-reported closeness was positively associated with teachers' visual focus of attention. This result may be explained by the fact that students in the low and average task-avoidant behaviour groups typically showed high interest and focus on the academic tasks during the lessons. This aligns with previous research that found teachers perceive closeness towards particular students who show interest academics, and they tend to encourage this learning-related behaviour (Pakarinen et al., 2011). In addition, another study found that teachers give positive feedback to the student by establishing eye contact (Haataja et al., 2021). Thus, according to previous research, it could be that teachers may give a longer visual focus of attention towards the students to encourage their desired learning behaviour and give positive feedback to the students.

In addition, the study showed that in low and high task-avoidant behaviour groups, teacher-reported conflict was positively associated with teachers' visual focus of attention. Students' low or passive task-avoidant behaviour can be characterised by reduced involvement in the learning task, less interaction with the teacher and social withdrawal (Pakarinen et al., 2014). Additionally, students' high task-avoidant behaviour can be characterised by disruptive behaviour, low motivation and low focus on the academic task (Olson et al., 2005). These maladaptive achievement behaviours can be distressful for the teacher and increase their perception of conflict with these particular students. Therefore, it may be that teachers focus their visual attention longer on particular students towards whom they perceive increased conflict to give them increased pedagogical support (Seidel et al., 2020), manage disruptive student behaviour (Van den Bogert et al., 2014), establish authority through eye contact (McIntyre et al., 2020) and provide differentiated instructional support (Roose et al., 2022) to these students. In sum, the results support prior literature on teachers' interpersonal relationships with students as a factor that guides their visual focus of attention on students during teaching. This points out why the moderating factors related to teachers and students in the complex classroom environment

need to be considered when examining teachers' visual focus of attention in authentic classroom settings.

6.4 Implications of the study

The present thesis contributes to the existing literature on teacher noticing with an emphasis on investigating teachers' visual focus of attention in authentic classroom settings. Furthermore, it contributes to the field of teachers' professional vision studies by showing that teacher- and student-related factors are an important part of teachers' professional vision during classroom teaching. In accordance with the recommendation from Van den Bogert et al. (2014) to combine teachers' eye-tracking data with other measures, this thesis is among the first to combine teachers' visual focus of attention from authentic classroom settings with other teacher- and student-related factors from the classroom.

The related factors examined alongside the teachers' visual focus of attention could be aligned with the visual perception component of classroom management script theoretical model (Wolff et al., 2020). The visual perception component in this theoretical model shows that teachers' cognitive processes involve top-down (prior knowledge-driven and focused information search) and bottom-up (image-driven and scattered information search) approaches (Wolff et al., 2020). It is important to note that the mentioned cognitive approaches were not studied in detail in the research described here. However, in the present thesis, factors such as teacher stress, individual support for students, students' gender, academic skills in literacy and math, student task-avoidant behaviour and the quality of teacher–student relationships were considered top-down factors influencing teachers' visual focus of attention. More importantly, the results showed that teachers' visual focus of attention varied based on teacher- and student-related factors in the classroom.

Furthermore, there are two noteworthy aspects of the datasets investigated in the described studies. First, the amount of data in terms of teachers' eye-tracking video recordings was relatively large in comparison with the data used in previous eye-tracking studies concerning teachers in the classroom setting (e.g., Haataja et al., 2021; Goldberg et al., 2021; McIntyre et al., 2020; Seidel et al., 2020). Second, teachers' eye-tracking videos were recorded in the fall and spring academic semesters in the academic year 2017–2018. The present thesis is one of the first to examine teachers' visual focus of attention in both the fall and spring academic semesters, as can be seen in sub-studies 1 and 3.

One practical implication of the results discussed in thesis is that teacher stress reflects on teachers' visual focus of attention in an authentic classroom setting. Previous research has shown that teachers' work-related stress influences teacher–student interactions, classroom management and instructional practices (Chan et al., 2023; Penttinen et al., 2020). Therefore, it is important for teachers to be aware of their visual focus of attention patterns and classroom behaviour towards students, especially during their pre-service training by using mobile

eye-tracking. In this scenario, mobile eye-tracking technology can be used as a tool wherein teachers can locate the targets that they prioritise during classroom teaching. Watching their eye-tracking video recordings can enrich teachers' self-reflection exercises related to their own teaching practices. For example, previous research has shown that self-reflection exercises and discussions based on challenging classroom teaching situations can help teachers be aware of their potentially distressful classroom situations and reduce their sense of inadequacy at work (Lindqvist et al., 2017). Furthermore, this could help teachers approach a challenging situation with individual students more objectively.

With the help of eye-tracking, teachers can watch their own eye-tracking videos during teacher professional development exercises. In particular, teachers can practice knowledge-based reasoning about the observed classroom situations from the eye-tracking videos by describing the identified teaching and learning issues, explaining and reasoning about a classroom situation and predicting future events or decisions made by applying their own pedagogical knowledge (Seidel & Stürmer, 2014). In addition, using eye-tracking, teachers can be more aware of whether they are able to provide visual focus of attention to students who need instructional support. Wang (2022) has argued that implementing eye-tracking as an objective measure of teachers' visual focus of attention can provide insights to teachers about their perceptions of differences between learners. It is important for teachers to notice when they need to use alternative teaching strategies to support individual students based on their academic progress.

This thesis further argues that teachers' perception of the quality of teacher–student relationships reflects on their visual focus of attention. For instance, teachers looked longer at students towards whom they perceived closeness. Furthermore, the teachers gave a longer visual focus of attention to students towards whom they perceived conflict. Therefore, teachers need to be aware of issues related to individual students that could evoke unfavourable reactions. It would benefit teachers to reflect on their own reactions towards individual students based on individual students' characteristics (Seidel et al., 2011).

6.5 Ethical considerations

The studies described in the present thesis were conducted in accordance with the ethical guidelines of the Finnish Advisory Board of Research Integrity (TENK, 2019). Three important criteria were followed. First, the autonomy of research participants was respected. Second, caution was taken to avoid any harm to the participants. Finally, data protection and privacy were ensured (TENK, 2019). The data discussed in the present thesis were taken from a larger project called TESSI. This project was approved by the Committee of Ethics at the University of Jyväskylä in August 2017 and November 2018. Based on the guidelines established by TENK, participation in the study was voluntary. All participants (teachers and children's guardians) signed a written consent form to participate in the study and were informed that they could withdraw their participation at

any point in the study. Guardians gave written consent for their children to participate. The participants had the freedom to stop participating in the study at any time. Participants were informed of the study's purpose, background, data protection, data processing, storage, archiving of personal data and research results presentation. The data of the participants were anonymised by assigning codes to the identifying information, such as names of participants, schools and municipalities. Only the anonymised data were further used for analysis in the sub-studies. The eye-tracking videos were handled according to the TENK guidelines. In accordance with ethical guidelines (TENK, 2019), special attention was given to the sensitive treatment of children, as they were only six to eight years old during the data collection. After the data collection, they were anonymised by removing all participant names, school names, municipality names and other identifying information. Finally, anonymity of the participants was guaranteed while reporting the results. Students who did not have consent from their parents to participate in the study were removed from the dataset after the eye-tracking video was coded. The University of Jyväskylä's Ethics Committee Guidelines were strictly followed for data management and storage. The results from the present thesis (sub-studies 1 and 2) have been published in peer reviewed journals following the open access and open science protocols. After publishing the results in leading journals in the field of educational psychology, the parallel versions of the articles will be published in open publication archives, such as the archives of the library of the University of Jyväskylä (JYX) and ResearchGate.

6.6 Limitations and future directions

There are some limitations to the research methodology implemented in the studies that are the basis of the present thesis. First, recording video data in authentic classroom settings using mobile eye-tracking glasses is challenging. For instance, the video quality of the eye-tracking video recordings that were recorded using the Tobii Pro Glasses 2 was not always very good due to the free head movements. In addition, the sound quality in the eye-tracking video recordings was not of the highest quality. Although authentic classroom settings assure high ecological validity, the physical contextual factors in the classroom, such as lighting conditions, position of teacher and seating of students, are controlled. Second, there was no control over the topic of the lesson and classroom instruction delivered by the teacher. Third, the eye-tracking video recordings were 20–25 min long. In that duration, a teacher's classroom management and instructional practices at different stages of the lesson may not be fully visible. Fourth, the case study approach used in sub-studies 1 and 2 was based on teachers teaching math lessons. This limits the generalisation of the results. Finally, teachers' visual focus of attention was analysed only based on their eye movements; however, the duration of their visual gaze on students in the classroom and verbal communication was not considered.

In future research, first, a multimodal approach to collecting more data related to teachers, students and teaching practices, along with eye-tracking, could be beneficial. For instance, qualitative interviews, physiological measures and observational measures could be implemented to deepen the understanding of the reasons behind the variations shown in teachers' visual focus of attention in the classroom. Second, other student-related factors such as temperament, motivation and self-regulation could yield deeper insights into the student-related factors that may contribute to variation in teacher visual focus of attention during teaching. Additionally, teachers' self-reflections on student-related factors coupled with their own eye-tracking video recordings from teaching situations could provide a deeper insight into their visual perceptions during pre- and in-service teacher training programmes. Third, the influence of teachers' perceptions of students' social and learning-related behaviour and prior knowledge of teaching and learning on teachers' visual focus of attention in the classroom needs to be investigated in depth. In this regard, teachers' retrospections on their own teaching practices can be combined with eye-tracking data. Fourth, in future research, consideration of teachers' verbal communication with students during eye-tracking could provide a better understanding of the quality of teacher–student interactions during teaching. Fifth, a longitudinal approach to studying teachers' visual focus of attention could show how teachers' expertise in noticing student-related factors develops over time in the presence of several contextual classroom factors. Finally, investigation of joint attention using mobile eye-tracking with both teachers and students during a lesson could show how teachers provide instructional support to individuals or groups of students and interact with these students and vice-versa in the classroom.

7 CONCLUSION

In the present thesis, the association between teachers' visual focus of attention and related factors in authentic classroom settings in Finnish Grade 1 classrooms were investigated. The results from the sub-studies results indicate that, first, the more stressed the teacher is, the less individual focus of attention the teacher gives to students during classroom management activity settings. Second, the results indicate that teachers look more at students to whom they give more individual support than others in the classroom. In addition, the studies found that teachers give more visual focus of attention to those students who score low in basic academic skills of literacy and math. Finally, the teacher–student relationship was found to be positively associated with the amount of teachers' visual focus of attention towards students. In addition, students' task-avoidant behaviour moderated the link between teacher-perceived quality of teacher–student relationships and teachers' visual focus of attention on students in the classroom at the end of Grade 1.

These results add to the existing literature of teacher noticing in terms of teachers' visual focus of attention on students based on specific teacher- and student-related factors in the classroom. Additionally, these results show that investigating teachers' visual focus of attention alone may not be informative unless it is investigated in combination with other measures from authentic classroom settings. Furthermore, the findings discussed in this thesis indicate that both more data and a fine-grained approach consisting of case studies is needed to gain a comprehensive and in-depth understanding of teachers' visual focus of attention and its related factors in the classroom. While managing the daily challenges arising from unpredictable classroom situations, teachers typically notice students' academic skills and behaviour in order to decide relevant adaptive pedagogical support to improve student learning. Furthermore, teachers' own perceptions of stress, individual support provided to students and quality of the teacher–student relationships guide the way they give their visual focus of attention to students in the classroom. Consequently, an important implication of this study is the need to encourage teachers to reflect on their teaching practices during pre- and in-service training sessions for the development of teachers' noticing as a part of their professional vision.

YHTEENVETO

Tämän väitöstutkimuksen tavoitteena on tarkastella 1. luokan opettajien visuaalista huomion kiinnittymistä autenttisissa opetustilanteissa silmänliikekameran tallenteiden avulla ja tähän yhteydessä olevia tekijöitä, kuten opettajan stressiä, oppilaiden akateemisia perustaitoja sekä opettaja-oppilassuhteita. Tutkimusaineisto on osa laajempaa tutkimushanketta, joka keskittyy opettajan ja oppilaiden stressiin ja vuorovaikutukseen luokassa (Lerkkanen & Pakarinen, 2016–2022). Väitöstutkimus koostuu kolmesta osatutkimuksesta, joissa on käytetty lukuvuonna 2017-2018 kerättyä aineistoa ensimmäisen luokan syksyltä ja keväältä. Väitöstutkimus koostuu kolmesta osatutkimuksesta. Osatutkimuksessa 1 tarkasteltiin opettajien huomion kiinnittymistä syksyllä (N = 53) ja keväällä (N = 52) ja sen yhteyttä opettajien työhön liittyvän stressin osa-alueisiin emotionaalinen uupumus, kyynisyys ja riittämättömyyden tunne. Osatutkimuksessa 2 tarkasteltiin opettajien (N = 46) huomion kiinnittymistä ja sen yhteyttä luokan oppilaiden keskimääräiseen lukutaidon ja matematiikan taidon tasoon sekä opettajien antamaan oppilaskohtaiseen yksilölliseen tukeen näissä taidoissa. Osatutkimuksessa 3 tarkasteltiin opettajien huomion kiinnittymistä syksyllä (N = 48) ja keväällä (N = 47) ja sen yhteyttä opettaja-oppilassuhteisiin (läheisyys ja ristiriidat). Lisäksi tutkittiin oppilaan sukupuolen ja tehtäviä välttelevän käyttäytymisen yhteyttä opettajien huomion kiinnittymiseen ja opettaja-oppilassuhteeseen.

Opettajien huomion kiinnittymistä mitattiin Tobii Pro Glasses 2 -lasien silmänliikekameran tallenteiden avulla. Opettajien silmänliikekameran tallenteet koodattiin Tobii Pro Analyzer -ohjelmistolla v. 1.130 koodauskriteerien perusteella. Analyzer-ohjelmiston I-VT-asetusta käytettiin suodattamaan opettajan visuaalisen huomion fiksaatiot (kesto ja lukumäärä) määriteltyihin kohteisiin kuten oppilaisiin, opetusmateriaaliin ja muuhun kuin opetusmateriaaliin. Tämän jälkeen opettajien visuaalisen huomion kiinnittymisen indikaattorina käytettiin ainoastaan opettajan kiinnittymistä oppilaisiin. Lisäksi arvioitiin opettajien stressiä (emotionaalinen uupumus, kyynisyys ja riittämättömyyden tunne), oppilaiden lukutaitoa ja matemaattisia taitoja, opettajan kokemaa opettaja-oppilassuhteen laatua (läheisyys ja ristiriidat) ja oppilaan tehtävää välttelevää käytöstä. Aineisto analysoinnissa käytettiin SPSS-ohjelmaa (Pearsonin korrelaatioanalyysi ja Mann Whitneyn U-testi) sekä M-Plus-ohjelmaa (monitasomallinnus). Lisäksi osatutkimuksissa 1 ja 2 käytettiin tapaustutkimuslähestymistapaa tarkasteltaessa, miten tulokset heijastuivat opettajan huomion kiinnittymisen kahdessa eri luokkahuoneessa.

Ensimmäisen osatutkimuksen tulokset osoittivat, että opettajien visuaalisen huomion kiinnittymisen jakautuminen oli yhteydessä opettajan kokemaan työhön liittyvään stressiin. Ensimmäisen luokan syksyllä opettajan emotionaalinen uupumus, kyynisyys ja riittämättömyyden tunne liittyivät opettajan huomion jakautumiseen luokassa, joka taas liittyi erityisesti koko luokan hallintaan, rutiineihin ja siirtymiin. Tulos osoitti, että mitä stressaantuneempi opettaja oli, sitä vähemmän yksilöllistä huomiota opettaja antoi oppilaille. Lisäksi opettajien huomion kiinnittymisen jakautuminen oppitunnin aikana liittyi opettajan riittä-

mättömyyden tunteeseen. Lisäksi tapaustutkimus osoitti, että stressaantunut opettaja kiinnitti syksyllä enemmän huomiota luokanhallintaan kuin yksittäisiin oppilaisiin, kun taas vähemmän stressaantunut opettaja kiinnitti syksyllä enemmän huomiota oppilaiden oppimateriaaleihin ja keväällä pari- ja ryhmätyöskentelyyn.

Toisen osatutkimuksen tulokset osoittivat, että opettajan huomion kiinnittyminen korreloi negatiivisesti luokan oppilaiden akateemisten perustaitojen tason kanssa, mutta positiivisesti opettajan oppilaille antaman yksilöllisen tuen kanssa. Opettajat kiinnittivät huomiota useammin oppilaisiin, joiden kohdalla he raportoivat antavansa enemmän yksilöllistä tukea akateemisissa perustaidoissa ja jos oppilaan akateemiset perustaidot olivat heikot. Lisäksi tapaustutkimus osoitti, että luokassa, jolle oli ominaista korkea opettajan yksilöllinen tuki, opettaja kiinnitti pidempikestoisen oppilaskohtaisen huomion kuin opettaja luokassa, jolle oli ominaista alhainen opettajan yksilöllinen tuki oppilaille. Lisäksi tapaustutkimus osoitti, että opettajan huomion kiinnittyminen vaihteli oppilaiden matematiikan taitotason ja siihen liittyvän opettajan raportoiman yksilöllisen tuen perusteella.

Kolmannessa osatutkimuksessa havaittiin positiivinen yhteys opettajan huomion kiinnittymisen ja opettaja-oppilassuhteen laadun välillä. Lisäksi oppilaiden tehtäviä välttelevä käyttäytyminen moderoi opettaja-oppilassuhteen laadun ja opettajien huomion kiinnittymisen välistä yhteyttä keväällä. Opettaja-oppilassuhteen läheisyys ennusti opettajan huomion kiinnittymistä matalan ja keskimääräisen tehtävää välttelevän käyttäytymisen ryhmissä, kun taas opettaja-oppilassuhteen ristiriidat ennustivat opettajan huomion kiinnittymistä matalan ja korkean tehtäviä välttelevän käyttäytymisen ryhmissä. Tämä tutkimus osoitti, että oppilaan käyttäytyminen ohjaa opettaja-oppilassuhteen tunnetta läheisyydestä ja ristiriidoista sekä oppilaalle osoitetun visuaalisen huomion kiinnittymisen määrää.

Tässä tutkimuksessa oli joitakin rajoituksia. Ensinnäkin kaikki kolme tutkimusta tehtiin aidoissa luokkahuoneissa, jolloin erot luokkahuoneen fyysisissä ominaisuuksissa, kuten opettajan sijainti, oppilaan ja opettajan välinen etäisyys, luokkahuoneen pohjaratkaisut ja oppituntien erilaiset aiheet, ovat voineet vaikuttaa tämän tutkimuksen tuloksiin. Vaikka silmänliikenauhoitusten kerääminen autenttisessa luokkahuoneympäristössä antoi aineistolle korkean validiteetin, se kuitenkin vähensi opettajan liikkeiden ja luokkahuoneen fyysisten olosuhteiden kontrollia. Tämä vaikutti osaltaan siihen, että joidenkin opettajien katseiden prosenttiosuudet silmänliiketallenteissa laskivat, minkä vuoksi heidät oli tarpeen jättää tutkimusaineiston ulkopuolelle. Toiseksi vaikka osatutkimuksissa 1 ja 2 käytetty tapaustutkimusmenetelmä mahdollisti kahden yksittäisen opettajan ja kahden eri luokan yksityiskohtaisemman tarkastelun, niistä saatuja tuloksia ei voida yleistää.

Tämä väitöstutkimus on yksi ensimmäisistä, joka yhdistää opettajien visuaalisen huomion kiinnittymisen muihin opettajiin ja oppilaisiin liittyviin tekijöihin. Lisäksi tämä tutkimus on ensimmäinen, jossa tutkitaan opettajan visuaalista huomion kiinnittymistä kahdessa ajankohdassa lukuvuoden aikana ensim-

mäisellä luokalla. Kaiken kaikkiaan tulokset viittaavat siihen, että opettajien huomion kiinnittyminen vaihtelee useiden opettajiin ja oppilaisiin liittyvien tekijöiden suhteen. Opettajien olisi hyvä olla tietoisia, mihin he kiinnittävät huomiota opetuksen aikana ja mistä syistä. Silmänliiketeknologian avulla voidaan kannustaa opettajia pohtimaan omia opetuskäytäntöjään.

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Appendix- 1

Example to calculate the double coding agreement percentage after coding teacher ID 36011's ET video.

Applying the double coding agreement percent formula to Fixation Counts (FC) of teacher 36011 on student c5 (AOI: 36011_f_c5)

Coder 1 = x Coder 2 = y Considering FC of c5: x = 41 y = 36 If z is the disagreement between the coders, then, z = x-y Therefore, 41-36 = 5	Double coding agreement percentage formula: z/x + y * 100 = disagreement % in FC Therefore, 5/41 + 36 * 100 = 6.49%100-disagreement %= Double coding agreement % 100 - 6.49 = 93.51% agreement

Similarly, each AOI´s FC will be used to calculate agreement percent and the average of all agreement percent of all AOI´s will determine the overall agreement in coding for teacher ID 36011.

For example, teacher ID 36011

	Fixation Counts (FC)		Agreement %
	Coder 1	Coder 2	
Fixation count|36011_f_c1	17	17	100
Fixation count|36011_f_c3	39	33	91.67
Fixation count|36011_f_c5	41	36	93.51
Fixation count|36011_f_c6	34	29	92.1
Fixation count|36011_f_c7	80	82	98.8
Fixation count|36011_f_c9	102	110	99.08
Fixation count|36011_f_c11	82	80	98.77
Fixation count|36011_f_c13	83	82	99.4
Fixation count|36011_f_c15	31	26	91.23
Fixation count|36011_m_c2	30	28	96.56
Fixation count|36011_m_c4	26	28	96.3
Fixation count|36011_m_c8	50	56	94.34
Fixation count|36011_m_c10	68	72	97.15
Fixation count|36011_m_c12	84	82	98.8
Fixation count|36011_m_c14	38	35	95.66
Fixation count|36011_m_c16	20	19	97.44
Fixation count|36011_m1	333	278	91
Fixation count|36011_m2	129	139	96.27

Fixation count | 36011_m3	41	5	21.74
Fixation count | 36011_m4	78	76	98.71
Fixation count | 36011_sm1	620	665	96.5
Fixation count | 36011_others	495	560	93.84
Fixation count | 36011_ra	28	28	100
Average agreement %			97

ORIGINAL PAPERS

I

TEACHERS' FOCUS OF ATTENTION IN FIRST-GRADE CLASSROOMS: EXPLORING TEACHERS EXPERIENCING LESS AND MORE STRESS USING MOBILE EYE-TRACKING

by

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Teachers' Focus of Attention in First-grade Classrooms: Exploring Teachers Experiencing Less and More Stress Using Mobile Eye-tracking

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ABSTRACT

This study investigated teachers' focus of attention and stress in first-grade classrooms. Teachers' (n = 53) focus of attention was recorded in fall and spring with a mobile eye-tracking device, and the teachers reported stress via questionnaires. Correlation analysis was used to examine association between teacher stress (exhaustion, cynicism, and inadequacy) and focus of attention. Then, one teacher reporting more stress and one reporting less stress were selected for a case study to examine variations in their focus of attention. The results showed positive associations between teachers' perceived inadequacy and overall focus of attention (whole eye-tracking recording) both in fall and spring. Teachers' focus of attention during specific activity settings of management/routines and transitions correlated positively with all three stress domains in fall. In addition, a positive association was also found between teacher inadequacy and focus of attention during teacher-directed large group activity setting.

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Mobile eye tracking; focus of attention; teacher stress; inadequacy; first-grade classroom

1. Introduction

The teaching profession has been acknowledged as very demanding and stressful. Research has shown that teachers experience higher stress, compared to many other professions (e.g., Aloe, Shisler, et al., 2014; Herman et al., 2020). Teachers must deal with many challenges and demands that can affect their well-being and influence their ability to create a supportive learning environment for their students. For each lesson, teachers must identify relevant information and classroom details to produce effective management routines and practices beneficial to their students' learning (e.g., van den Bogert et al., 2014). This demanding moment-to-moment process requires teachers' focussed attention in changing situations (Pennings et al., 2018) where several unpredictable events may take place simultaneously, each one requiring an immediate response (van den Bogert et al., 2014). Recent research has shown that during teaching interactions, the teacher's eye contact with students forms an essential part of learning (McIntyre & Mainhard, 2020). However, teachers' focus of attention could differ, depending, for example, on their work experience (McIntyre et al., 2017). Teachers have also been found to distribute their attention unevenly amongst their students, instructional materials and other details in the classroom (e.g., Dessus et al., 2016; Haataja et al., 2019). Although it is well recognised that teaching is a demanding profession, no studies have been conducted on how teacher stress may affect their focus of attention in authentic classroom situations. Therefore,

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this study aims to explore the extent to which teacher stress is associated with their focus of attention in authentic classroom settings. A case study design was utilised to explore in more detail the variations in focus of attention of two teachers reporting more and less stress. The purpose of the case studies is to provide concrete examples about the associations of teacher stress and focus of attention.

1.1. Teachers' Focus of Attention in the Classroom

Teachers' focus of attention can be defined as teachers' gaze on relevant targets during a lesson and their ability to process information present in the classroom environment (van den Bogert et al., 2014). In educational research, several terms are used interchangeably to address eye tracking in the classroom: focus of attention (van den Bogert et al., 2014), teacher visual attention (Cortina et al., 2015), gaze behaviour (McIntyre et al., 2017; McIntyre et al., 2019; McIntyre & Mainhard, 2020), teacher gaze (McIntyre et al., 2019), eye movements (Henderson, 2011, p. 4), and teacher vision and attentional distribution (Wolff et al., 2016). In the present study, the term focus of attention is used to investigate the distribution of teachers' gazes on students as well as on instructional materials and non-instructional materials during a lesson. Using mobile eye-tracking devices, eye movements objectively provide insights into moment-to-moment changes in teacher attention in the classroom where students' learning needs are supposed to be met (McIntyre & Mainhard, 2020; Tatler et al., 2014).

Teachers' classroom behaviour and focus of attention affect each other, as teachers target their gaze and monitor relevant tasks and situations (Tatler et al., 2014). For example, students' classroom behaviour may affect the teacher's focus of attention, because disruptive students who are not concentrating during a lesson can frequently attract teacher's focus of attention (Yamamoto & Imai-Matsumura, 2012). Additionally, research has suggested that experienced teachers tend to focus more attention on the reactions of students around the disruptive students, whereas novice teachers narrow their focus of attention on the disruptive students (Wolff et al., 2016). Previous research has confirmed that during lessons, teachers focus more attention on students with whom they are engaging in elaborating their responses and providing individual feedback (Cortina et al., 2015). In addition, in a case study of a Finnish teacher, Haataja et al. (2019) revealed that based on scaffolding intentions during a math lesson, the teacher focussed more attention on the students' faces during affective scaffolding in problem-solving. However, most studies using mobile eye tracking to date have been conducted in secondary schools (e.g., Cortina et al., 2015; Haataja et al., 2019; McIntyre et al., 2017, 2019; McIntyre & Mainhard, 2020; Yamamoto & Imai-Matsumura, 2012); thus, our understanding of teachers' focus of attention amongst younger children is limited, such as in first-grade classrooms. There has been a long tradition of eye-tracking studies related to teachers and teaching in controlled laboratory settings, for example, studies on teachers' focus of attention have used remote eye tracking on pre-recorded classroom videos (van den Bogert et al., 2014; Wolff et al., 2016; Yamamoto & Imai-Matsumura, 2012). However, new research has encouraged investigation of educational practices in authentic classroom settings (Jarodzka et al., 2020), for example, by using mobile eye tracking (Cortina et al., 2015; Haataja et al., 2019; McIntyre et al., 2017, 2019; McIntyre & Mainhard, 2020).

Fixation data obtained in the form of time duration is a frequently used measure in eye-tracking research (e.g., Cortina et al., 2015; Haataja et al., 2019; Yamamoto & Imai-Matsumura, 2012). Fixations are defined as the duration in which the eye is relatively steady, providing the ability to process visual information from the surroundings (van den Bogert et al., 2014). Researchers have confirmed that fixations are clustered at informative regions of the scene (Henderson 2011, p. 5). In the context of a classroom, a teacher's fixations on informative areas might change according to their students' needs. For example, Haataja et al. (2019) noticed longer fixation durations on students' faces and hands during behaviour management segments of a lesson due to teacher–student conversations. According to Holmqvist et al. (2015), fixations depict the focus of attention on an

object when an individual processes information, although the durations of fixations alone may not accurately represent a teacher's cognitive processing of classroom events. Therefore, an eye-tracking methodology should be coupled with supporting data that provide background information for the recorded eye movements to justify the fixations (van den Bogert et al., 2014). Consequently, in the present study, we examined possible variations in teachers' focus of attention on students, instructional materials and non-instructional materials in authentic classrooms in relation to teachers' self-ratings of stress.

1.2. Teachers' Stress

Teachers' work-related stress can be defined as their experiences of negative emotions, such as anxiety, frustration and tension, resulting from their work (Kyriacou, 2001). Teaching is a highly stressful profession (Kyriacou, 2001), and elementary school teachers have reported moderate to high levels of stress at work (Herman et al., 2018). Work-related stress can arise from situations in the workplace that adversely affect an individual physiologically, socially and psychosocially (Friedman-Krauss et al., 2014). Previous research has stated that teachers experience stress when the demands of the classroom environment are beyond their perceived capacity of resources to cope (Herman et al., 2020). Teachers may face challenges in the classroom while catering to their students' needs for behavioural and instructional support. Specifically, teachers have reported high levels of stress from perceptions of challenging student behaviours (Friedman-Krauss et al., 2013), disruptive classrooms and differentiated instructions (Kyriacou, 2001). Previous research confirmed that when classroom management self-efficacy decreases, emotional exhaustion increases among teachers (Aloe, Amo, et al., 2014).

Teachers' perceived stress and burnout can be examined through domains of emotional exhaustion, cynicism and feelings of inadequacy (Salmela-Aro et al., 2010). Emotional exhaustion (emotional component) focusses on the fatigue caused by increased workloads, while cynicism (cognitive component) refers to a loss of interest and feelings of indifference towards work and the people at work (Salmela-Aro, Pietarinen, & Pyhältö, 2011). The feelings of inadequacy (behavioural component) is a consequence of exhaustion or cynicism and refers to reduced efficacy in professional competence and accomplishments at work (Maslach & Leiter, 2016; Salmela-Aro et al., 2011). In addition, teachers' reduced feelings of professional competence, achievements and accomplishments in the job could be reflected in their classroom behaviour towards different students (Salmela-Aro et al., 2010). Therefore, teachers' perceived inadequacies related to their work could reveal variations in their focus of attention during a lesson. In addition, experiencing higher levels of stress in the teaching profession has been associated with lower self-efficacy and increasing reprimands, whereas teachers who experience lower stress and who have higher coping mechanisms have reported higher self-efficacy and increased student pro-social behaviour (Herman et al., 2020). Furthermore, teachers with lower levels of efficacy beliefs are prone to stress, exhaustion and anxiety (Jeon et al., 2017), thereby affecting their instruction and the quality of their teacher–student interactions in the classroom (Virtanen et al., 2019). However, little is known about how teacher stress may be reflected in their focus of attention in the classroom.

1.3. The Aim of the Study

Studying teachers' focus of attention, especially in authentic classroom settings, is a relatively new field amongst educational classroom studies. The first aim of the present study is to explore the extent to which teacher perceived stress is associated with their focus of attention in authentic classroom settings. The second aim is to explore in more detail the variations in focus of attention between two teachers reporting more and less stress. The present study will add to the existing research by combining the measures of teachers' self-reported stress and mobile eye-tracking

data to study teachers' focus of attention on students, instructional materials and non-instructional materials within first-grade classrooms of the academic school year.

The research questions are:

1. To what extent is teacher-reported stress associated with their focus of attention in first-grade classrooms?
2. How does a teacher with more than average stress and a teacher with less than average stress distribute their focus of attention in the classroom?

The present study was conducted in Finland where 9 years of elementary school begins at age 7. The placement of students in school is only based on the school's proximity to their residence. All teachers are highly qualified with master's degrees in education, and the same teacher typically teaches the same class for several years in elementary school. Most of the schools are public schools, and they follow the national core curriculum designed by the Finnish National Board of Education.

2. Methods

2.1. Participants and Procedure

The participants of the present study were 53 Finnish Grade 1 teachers (50 females, 3 males; M_{age} = 44.6, SD = 8.92) from 36 schools. The schools were located in five municipalities in Central Finland and included both urban and rural areas. The teachers reported their work experience in years (M_{exp} = 16.07, SD = 9.43, Min_{exp} = 0.5, Max_{exp} = 39) and class size (M_{cs} = 19.3, SD = 4.34, Min_{cs} = 7, Max_{cs} = 25). Teachers' education showed that 90.6% were qualified as class teachers, 7.5% had double qualifications for teaching (most typically as class teachers and kindergarten teachers), and 1.9% were qualified as special education teachers. The reported study is part of a larger project focusing on the role of teacher and student stress on teacher–child interactions (Lerkkanen & Pakarinen, 2016–2022). Before commencement of the study in 2016, approval from the ethics committee of the university was received.

In fall 2017, teachers were invited by phone or email to participate in the larger study during the 2017–2018 academic year. Participation in the study was voluntary, and teachers and children's parents provided written consent for their participation prior to data collection. Questionnaires regarding teachers' self-reported stress and background information were sent to the teachers and returned via postal mail. Questionnaires concerning the family's background information were also sent to the children's parents via postal mail. The parents' responses indicated that 2.5% had a comprehensive school degree (9 years of education), 32.8% had completed high school or had a vocational school degree (12 years of education), 7.9% had completed college-level training (14 years of education), 26.2% had completed polytechnic school or had a bachelor's degree, 26.7% had completed a master's degree, and 3.9% had completed a doctoral degree.

Tobii Pro Glasses 2 were used to record eye-tracking videos for all lessons in this study. Using the Tobii Pro Glasses 2 mobile eye-tracking glasses, eye-tracking data were collected from all 53 teachers during their normal school day. Each teacher had two lessons recorded, one in the fall and one in the spring, respectively. Two research assistants were trained to collect the data; they also helped the teachers with wearing the glasses and conducted a 3-point calibration before each lesson started. In order to maintain the data quality, each teacher was asked to look at three marked points on the wall at the beginning of the video recording. The research assistants then confirmed that the teacher's gaze met the three points correctly. The eye-tracking video recordings ranged from 20 to 25 min. During the course of the recordings, the research assistants noted the course of the lesson, the seating plan in the classroom and the materials used. The Tobii Pro Glasses 2 (see Tobii Pro Glasses 2 Product Description Manual, 2018) used in the present study have four cameras for corneal reflection and pupil tracking. The resolution of the scene camera was 1920 × 1080 pixels at 25

frames per second. The scene camera visual angle was 82 degrees horizontal and 52 degrees vertical. The frame dimensions were 179 × 159 × 57 mm. For further investigation, two teachers were selected—one with more than average stress and one with less than average stress—based on their self-ratings on their questionnaires (see Table 3).

2.2. Measures

Teachers' Stress. A Finnish short version of the Bergen Burnout Inventory (BBI-9; Salmela-Aro et al., 2010) was used to measure teachers' self-perceived stress using a questionnaire. The inventory had nine items from three domains with ratings from 1 (completely disagree) to 6 (completely agree); namely, exhaustion (e.g., 'I am snowed under with work'), cynicism (e.g., 'I feel dispirited at work and I think about leaving my job'), and inadequacy (e.g., 'I frequently question the value of my work') at work. These domains focussed on work-related stress and burnout. The exhaustion domain focussed on the fatigue caused by increased workloads. The cynicism domain referred to a loss of interest and feelings of indifference towards work and the people at work. The inadequacy domain identified reduced efficacy in professional competence and accomplishments at work. Cronbach's alpha reliability of the domains in fall were as follows: exhaustion .53, cynicism .65 and inadequacy .74, and in spring as follows: exhaustion .46, cynicism .70 and inadequacy .77. The 3-factor structure of BBI-9 has been tested for factorial validity and showed invariance across all cross-sectional samples in a study across organisations including educational institutions (Feldt et al., 2013). Moreover, sources of work-related stress were measured by asking the teachers to answer an open-ended question on the questionnaire: 'What causes you the most stress and exhaustion at work?'. Teachers' answers were used to gain deeper understanding on the work-related stress of the two teachers.

Teachers' Focus of Attention. As a first step, separate targets in the classroom were identified as teachers' areas of interest (AOI), using Tobii Pro Analyser software v. 1.128. An AOI was defined as parts of a stimulus that would explain gaze behaviour. A stimulus could be an action or an object that instigates gaze behaviour. In the present study, an authentic classroom scenario was the stimulus where students and instructional materials were the teachers' targets during the lesson. Holmqvist et al. (2015) suggested that manual coding was best suited when total dwell time on a target is required to answer the research question. Therefore, manual mapping feature was used for mapping gaze behaviour in eye-tracking recordings using a coding criteria.

Eye-tracking video recordings with 70% and above gaze sample percentages were selected for the study to ensure that one or both eyes were detected during 70% of the recording's duration. Therefore, in fall and spring, 3 out of 53 videos at both time points were not coded due to gaze sample percentages of less than 70%, poor quality of the recording and defects in the eye-tracking recording project file. Codes specific to students, instructional material, teaching assistants, research assistants and non-instructional material were used to define the AOI in the eye-tracking videos by taking screenshots of the video recordings. The coder started gaze mapping from the teacher's first look at a student AOI in the classroom and ended coding when the teacher took off the mobile eye-tracking glasses. Two coders who coded the eye-tracking videos were pursuing studies in teacher education and had experience with collecting eye-tracking recordings in authentic classroom settings. Inter-coder reliability was checked by double coding 20% of the videos from the whole data set for the fall and spring separately. Double coding agreement for the fall ranged from 89% to 93% with an average of 91.43%, and for the spring from 84.80% to 94.03% with an average of 90.09%. The total fixation durations on each student, instructional materials and non-instructional materials were obtained after coding the eye-tracking recordings to investigate teacher focus of attention. Previous studies have suggested that fixation is a relatively steady eye gaze when the eye takes in and processes visual information from the surroundings, allowing viewers to process a scene cognitively in a coherent way (Henderson, 2011, p. 2-3; Holmqvist et al., 2015).

The teachers operated during the normal school day in authentic classroom settings, and subjects or activity settings were not fixed beforehand. In fall, the subjects taught in the eye-tracking recordings of lessons were 41.18% literacy, 35.29% math, 7.84% science and 15.69% art. Additionally, in spring, the subjects taught in the eye-tracking recordings of lessons were 52% math, 40% literacy, 6% art and 2% other, e.g., Independence Day quiz, Friendship's Day activity.

Activity settings were coded in the lesson to analyse the eye-tracking data descriptively. The eye-tracking videos were divided into segments based on the dominant activity in which the teacher and the majority of the students were engaged. An activity was coded as a separate activity segment if it lasted a minimum of 30 s. Activities lasting less than 30 s were considered a part of the larger ongoing activity. Activity settings were broadly classified into academic content-based activities and non-academic activities. Non-academic activities were grouped as management, routines or transitions when the teacher managed student behaviours, and facilitated routines and transitions between play times. Academic activities were grouped as teacher-directed large group activities, individual work, and small group or pair work.

2.3. Analyses

The first research question aimed to investigate the extent of the association between teacher stress and focus of attention. A statistical measure of distribution called the Gini coefficient was calculated with the R program to explain the distribution of teachers' focus of attention in the classroom on students, instructional materials and non-instructional materials, using the total fixation duration on each target during the whole video recording and each activity setting (see also Cortina et al., 2015; Dessus et al., 2016). The Gini coefficient ranges from 0 to 1, where 0 refers to an equally distributed focus of attention on all targets and 1 refers to an unequal distribution, in which case only one target receives all the focus of attention (Cortina et al., 2015). Using IBM SPSS Statistics 26, correlation analyses were conducted to examine the relation between perceived stress and the Gini coefficient (focus of attention) in the whole eye-tracking video recording and within activity settings in all lessons.

The next aim was to explore variations in teachers' focus of attention between a more-stressed and a less-stressed teacher, using a case study design. The teachers' stress scores were used to select two teachers, i.e., one with more than average stress and one with less than average stress, for an in-depth investigation. First, the teachers' stress scores and background information were described. Second, to visually represent the teachers' focus of attention on students, instructional materials and non-instructional materials, total fixation durations during a math lesson from both teachers were used at both time points in the fall and spring to avoid the possible effect of different subjects. Finally, activity settings during the lesson from the eye-tracking video recordings were considered.

3. Results

3.1. Teacher Focus of Attention in Relation to Teacher Stress

The first research question examined the extent to which teacher stress is associated with a teacher's focus of attention. As can be seen in Table 1, teachers reporting exhaustion in fall and sense of inadequacy in spring gave more individual focus of attention to students during individual work activity setting in fall and small group/pair work activity setting in spring. The results showed a positive correlation between inadequacy and focus of attention (using the Gini coefficient) in the whole recording ($r_{fall} = 0.33$, $p < 0.05$) in fall (see Table 2). In addition, teacher's sense of inadequacy also marginally correlated with focus of attention in the whole recording ($r_{spring} = 0.27$, $p < .1$) in spring (see Table 2). This indicates that teachers' reduced efficacy in their professional competence is associated with less individualised distribution of focus of attention amongst students in fall and spring.

Table 1. Descriptive information of teacher stress domains and focus of attention in different activity settings.

	Teachers (n = 53) Fall Mean (SD)	Teachers (n = 52) Spring Mean (SD)
Teacher Stress[a] Exhaustion	3.75 (0.95)	2.99 (0.91)
Cynicism	2.03 (0.93)	2.09 (1.00)
Inadequacy	1.92 (0.95)	2.11 (1.05)
Focus of attention[b] (n_{fall}=50,n_{spring}=49)	0.51 (0.10)	0.51 (0.10)
Management/Routines and Transitions[c] (n_{fall}=46, n_{spring}=47)	0.39(0.10)	0.44(0.13)
Teacher directed large group activity[c] (n_{fall}=48, n_{spring}=45)	0.38(0.11)	0.39(0.13)
Individual work[c] (n_{fall}=30, n_{spring}=24)	0.51(0.16)	0.49(0.17)
Small group/pair work[c] (n_{fall}=12, n_{spring}=15)	0.47(0.20)	0.59(0.15)

[a]Teacher stress scale was 1 (completely disagree) to 6 (completely agree).
[b]Gini coefficient from full eye-tracking video recordings.
[c]Gini coefficient from activity settings in lessons.

Table 2. Correlations between teachers' stress domains and focus of attention in activity settings.

			Exhaustion[c]		Cynicism[c]		Inadequacy[c]	
	N_{Fall}	N_{Spring}	Fall (N^c = 53)	Spring (N^c = 52)	Fall (N^c = 53)	Spring (N^c = 52)	Fall (N^c = 53)	Spring (N^c = 52)
1. Focus of attention[a]	50	49	.079	−.048	.165	.177	.330*	.258[†]
2. Management/Routines and Transitions[b]	46	47	.344*	−.138	.306*	.065	.333*	.131
3. Teacher directed large group activity[b]	48	45	.096	−.205	.217	−.075	.268[†]	−.106
4. Individual work[b]	30	24	−.001	−.149	−.028	−.085	−.038	−.280
5. Small group/Pair work[b]	12	15	.308 .375[d]	−.334 −.438[d]	−.119 .128[d]	−.344 −.329[d]	.205 .387[d]	−.297 −.256[d]

Note. ** $p < .001$* $p < .05$, [†] $p < .1$.
[a]Gini coefficient for the full lesson.
[b]Gini coefficient for activity setting.
[c]stress domains.
[d]Spearman's correlation coefficient.

Each lesson was further divided into segments based on the dominant activity setting in which the teacher and students were engaged. Correlational analysis between domains of stress and focus of attention during particular activity settings revealed that exhaustion ($r_{fall} = 0.34$, $p < 0.05$), cynicism ($r_{fall} = 0.30$, $p < 0.05$) and inadequacy ($r_{fall} = 0.33$, $p < 0.05$) positively correlated with focus of attention during management/routines and transitions activity setting in the fall. In addition, teacher inadequacy correlated marginally significantly ($r_{fall} = 0.26$, $p < .1$) with focus of attention during teacher-directed large group activity setting in fall.

3.2 Closer Investigation of More- and Less-stressed Teachers' Focus of Attention

3.2.1. Backgrounds of the Two Teachers

The second research question examined variations in the focus of attention between two teachers—one with more than average stress and another with less than average stress. Teacher 1 (Te1), who reported more than average stress in both fall and spring (see Table 3), was new to the workplace during the time of data collection. Her class size ranged between 21 and 22 students in fall and spring. The causes of reported stress were students with behaviour problems and a fixed-term service contract at the workplace. Additionally, in fall, Te1 reported that no students in the classroom required special needs support. In spring, the causes of stress reported by Te1 were similar as in fall with one additional challenge, which was an adversity of resources for the upcoming academic year, in particular, a special needs instructor. It was reported that in the spring, seven students needed support with learning and five students with socio-emotional behaviour problems. However, there was no special education needs teacher available in the classroom.

Table 3. Descriptive background information and stress scores of Teacher 1 and Teacher 2.

	Teacher 1 (Te1)	sTeacher 2 (Te2)
Background information		
Gender	Female	Female
Age (years)	38	43
Education: MA degree in education	class teacher	class teacher
Work experience (years)	10	12
Class size: Fall semester	22	24
Class size: Spring semester	21	24
Students needing special support: Fall semester	0	4
Students needing special support: Spring semester	12	5
Classroom support available:		
School Counsellor	X	X
Special Education Needs Teacher		X
Teacher Stress[a]		
Exhaustion: fall	4.00	1.67
Exhaustion: spring	5.00	1.33
Cynicism: fall	3.00	1.00
Cynicism: spring	3.67	1.00
Inadequacy: fall	2.33	1.00
Inadequacy: spring	4.33	1.00
Focus of attention: fall[b]	0.36	0.57
Focus of attention: spring[b]	0.43	0.40

[a]Teacher stress scale was 1 (completely disagree) to 6 (completely agree).
[b]Gini coefficient.

Teacher 2 (Te2), who reported less than average stress (see Table 3) in fall and spring, had been in the current workplace for 7 years. Her class size was consistent at 24 students in both fall and spring. In fall, changes in assessment practices with the new curriculum and changes in working patterns were reported as her main causes of stress. Additionally, in fall, three students were reported as needing support in learning and one student with socio-emotional behaviour problems. However, in spring, Te2 reported three students with learning problems and two students requiring support with new language acquisition. In spring, Te2 reported challenges with developing reading skills and reinforcing reading fluency with some students as the main cause of stress. Additionally, she had support from the school counsellor and a special needs teacher in the fall and spring to support students with special needs.

3.2.2. Teachers' Focus of Attention in Fall and Spring

Teacher1 (Te1). During the whole lesson in fall, Te1 gave 52% of her overall focus of attention to students, 33% to instructional materials and 15% to non-instructional materials. Figure 1 describes the overall variations in focus of attention during the entire eye-tracking recording. Peaks in students' time series are during management/routine/transitions or non-academic activities, whereas peaks in instructional materials time series are during teacher-directed large group or academic activities. On average, Te1 focussed her attention on each student ($M_{\text{fixation duration}} = 1.17$s, SD = 2.09s, $\text{Min}_{\text{fixation duration}} = 0$s, $\text{Max}_{\text{fixation duration}} = 18.78$s) and teaching material ($M_{\text{fixation duration}} = 2.56$s, SD = 3.84s, $\text{Min}_{\text{fixation duration}} = 0$s, $\text{Max}_{\text{fixation duration}} = 19.66$s) during the 24-minute math lesson in fall. Te1 distributed her focus of attention relatively evenly as indicated by the Gini coefficient (0.36), which is lower than the average of the whole sample in fall (see Table 1).

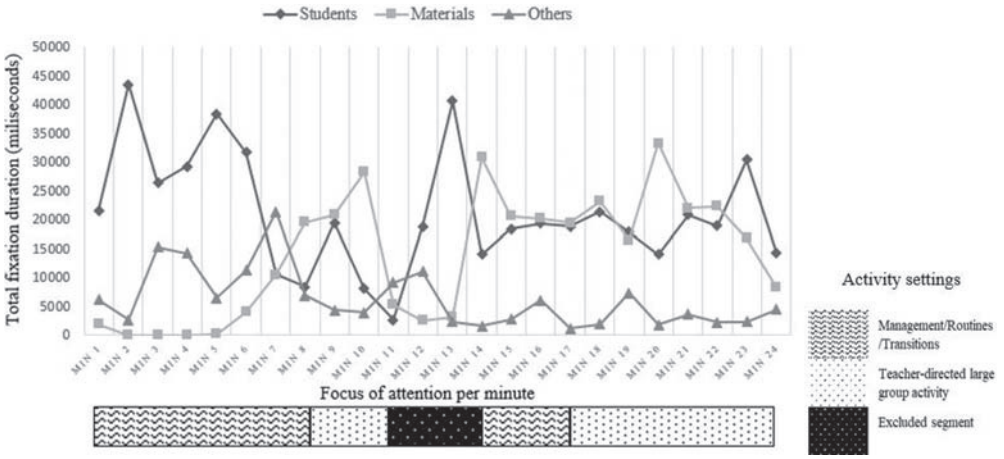

Figure 1. Variations in focus of attention of Teacher 1 (more-stressed teacher) in fall lesson.

The first graph explains the variations in the focus of attention as the lesson progressed. The second graph describes how much time was focussed (in percentages) on students, instructional materials and non-instructional materials during the individual activity settings. Both lessons in fall and spring were first divided into segments, based on the course of activity settings during each lesson (example, see Figure 1), and followed by analyses of focus of attention according to the activity settings (example, see Figure 2). While identifying the activity settings, it was noticed that Te1 used a teacher-directed large group activity for 11 min, where she focussed 30% of her time on students at segment 08:00–10:30 and 46% of her time on students at segment 16:00–24:30 to deliver math-related content (see Figure 2). During management, routines and transitions, 63% of her time was focussed on students at segment 01:00–08:00, and 52% of her time was focussed on students at segment 10:30–16:00 (see Figure 2). Therefore, the focus of attention was more on students during the non-academic activity settings. However, during the teacher-directed large group activity, the focus of attention was more on instructional materials (see Figure 2).

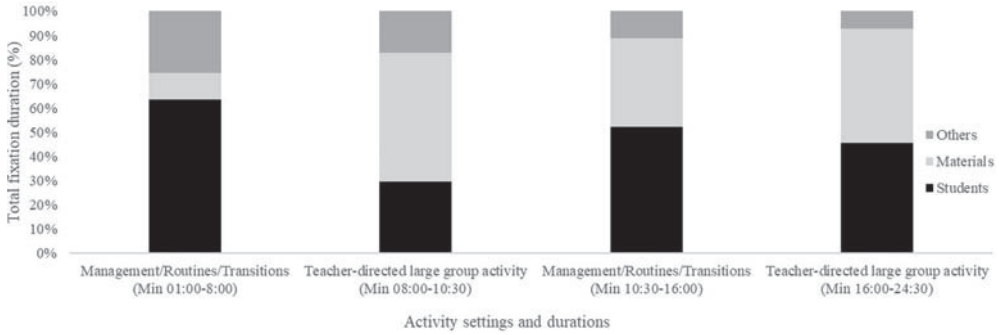

Figure 2. Distribution of Teacher 1's focus of attention in fall amongst activity settings.

In spring, Te1 gave 56% of her overall focus of attention from the lesson to students, 25% to instructional materials and 19% to non-instructional materials. Figure 3 describes variations in Te1's focus of attention in the spring lesson. Peaks are seen in the time series plot of total fixation duration on students and materials during the teacher-directed large group or academic activity.

However, the highest peak in the time series plot of total fixation duration on students was seen during the last management/routines/transitions or non-academic activity (see Figure 3). Overall, Te1 emphasised her focus of attention on students in most parts of the lesson, as depicted by the peaks in the time series plot (see Figure 3).

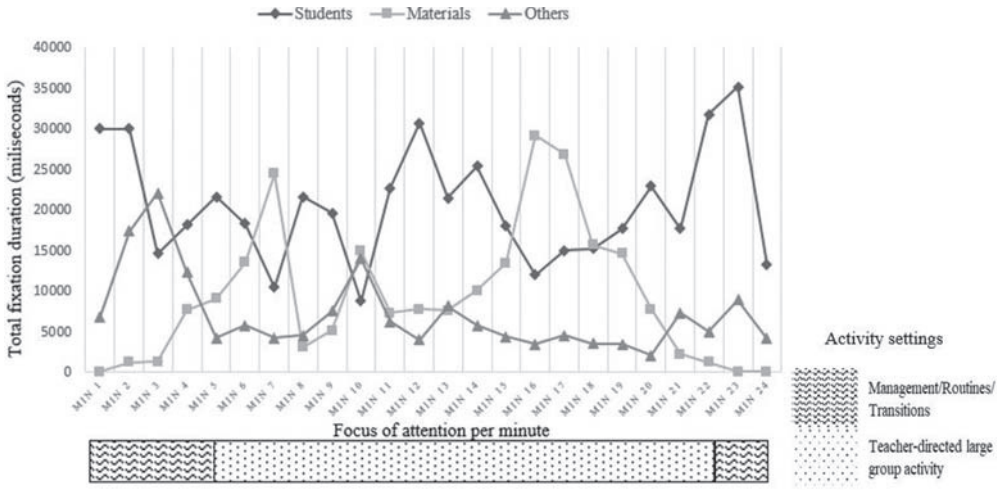

Figure 3. Variations in focus of attntion of Teacher 1 (more-stressed teacher) in spring lesson.

In spring, Te1 focussed attention on each student ($M_{\text{fixation duration}} = 1.07$s, SD = 1.90s, $\text{Min}_{\text{fixation duration}} = 0$s, $\text{Max}_{\text{fixation duration}} = 20.34$s) and each teaching material ($M_{\text{fixation duration}} = 2$s, SD = 4.34s, $\text{Min}_{\text{fixation duration}} = 0$s, $\text{Max}_{\text{fixation duration}} = 28.71$s) during a 24-minute math lesson. As can be seen in Figure 4, 16 min were used for a teacher-directed large group activity, where 73% of Te1's time was focussed on students at segment 05:30–22:30. Management/routines/transition activities used 7 min 30 s, where 58% of Te1's time was focussed on students at segment 0:00–05:30, and 80% of her time was focussed on students at segment 22:30–24:39 in the math lesson in spring. Te1 gave a more focus of attention to the students as a whole group during the teacher-directed large group activity. Te1 distributed her focus of attention relatively evenly amongst students as indicated by the Gini coefficient, which is lower (0.43) than the average of the whole sample in spring (see Table 1).

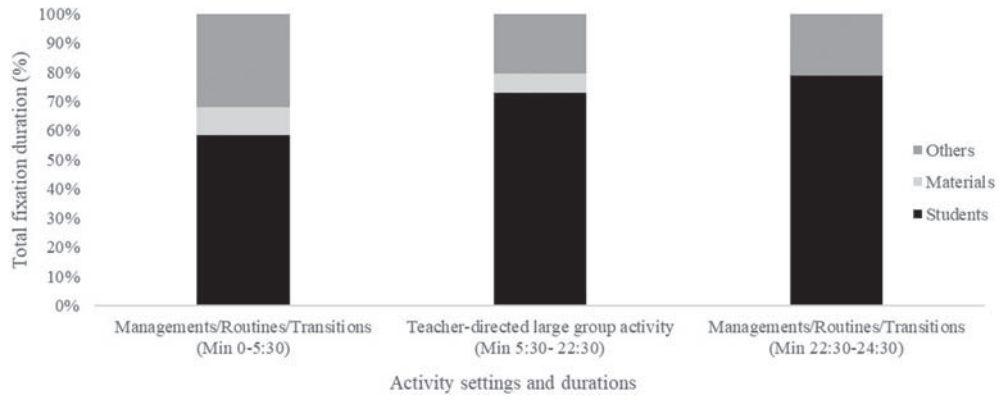

Figure 4. Distribution of Teacher 1's focus of attention in spring amongst activity settings.

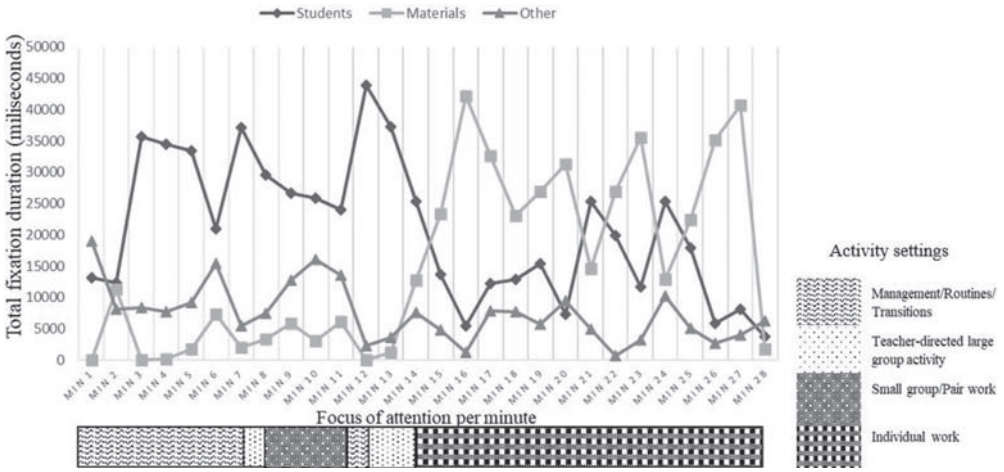

Figure 5. Variations in focus of attention of Teacher 2 (less-stressed teacher) in fall lesson.

Teacher2 (Te2). During the lesson in fall, Te2 gave 48% of her overall focus of attention to students, 35% to instructional materials and 17% to non-instructional materials from a duration total of 28 min. Figure 5 describes the overall variations in focus of attention of Te2 during the entire eye-tracking recording. Peaks are seen in Te2's total fixation duration on students from the beginning to the middle of the lesson and on materials from the middle to the end of the lesson. On average, Te2 focussed attention on each student ($M_{\text{fixation duration}} = 0.90$s, SD = 1.73s, $\text{Min}_{\text{fixation duration}} = 0$s, $\text{Max}_{\text{fixation duration}} = 20.54$s) and each teaching material ($M_{\text{fixation duration}} = 0.50$s, SD = 2.05s, $\text{Min}_{\text{fixation duration}} = 0$s, Maxfixation duration = 10.92s) within the 28-minute math lesson. Pair work and individual work activities were implemented during the lesson. Te2 may have provided individual support to students as indicated by the Gini coefficient (0.57; see Table 3).

Figure 6 shows two management/routines/transitions segments, 0:00–07:30 and 11:30–12:00, where Te2 gave 66% and 95% of her focus of attention, respectively, to students. Teacher-directed large group activities were during segments 07:30–08:00 and 12:00–14:00, where Te2 gave 73% and 71% of her focus of attention, respectively, to students. Te2 gave 57% of her focus of attention to students during a small group/pair work activity at segment 08:00–11:30. An individual work activity during the 14:00–28:00 segment showed that Te2 gave only 29% of her focus of attention to students in this activity setting. During this math lesson, the individual work activity setting was the longest duration. The duration of Te2's focus of attention on instructional materials during the individual work activity setting was 6 min and 15 s.

In the spring lesson, Te2 gave 64% of her overall focus of attention to students, 23% to instructional materials and 13% to non-instructional materials from the total duration of 21 min. Figure 7 shows Te2's overall variations in her focus of attention in the spring lesson. Most peaks in total fixation durations are seen on students in most parts of the lesson, and only three peaks are seen on materials during the academic activity settings of teacher-directed large group and small group/pair work activities. In spring, Te2 focussed her attention, on average, on each student ($M_{\text{fixation duration}} = 0.97$s, SD = 1.86s, $\text{Min}_{\text{fixation duration}} = 0$s, $\text{Max}_{\text{fixation duration}} = 28.16$s) and each teaching material ($M_{\text{fixation duration}} = 1.17$s, SD = 3.38s, $\text{Min}_{\text{fixation duration}} = 0$s, $\text{Max}_{\text{fixation duration}} =$ 28.22s) during the 21-minute lesson.

Figure 8 shows that Te2 implemented management/routines/transitions where 58% of her focus of attention was on students at segment 0:00–4:00, and 26% was on students at segment 18:00–19:00. During a teacher-directed large group activity at 04:00–08:30, Te2 focussed 81% of her

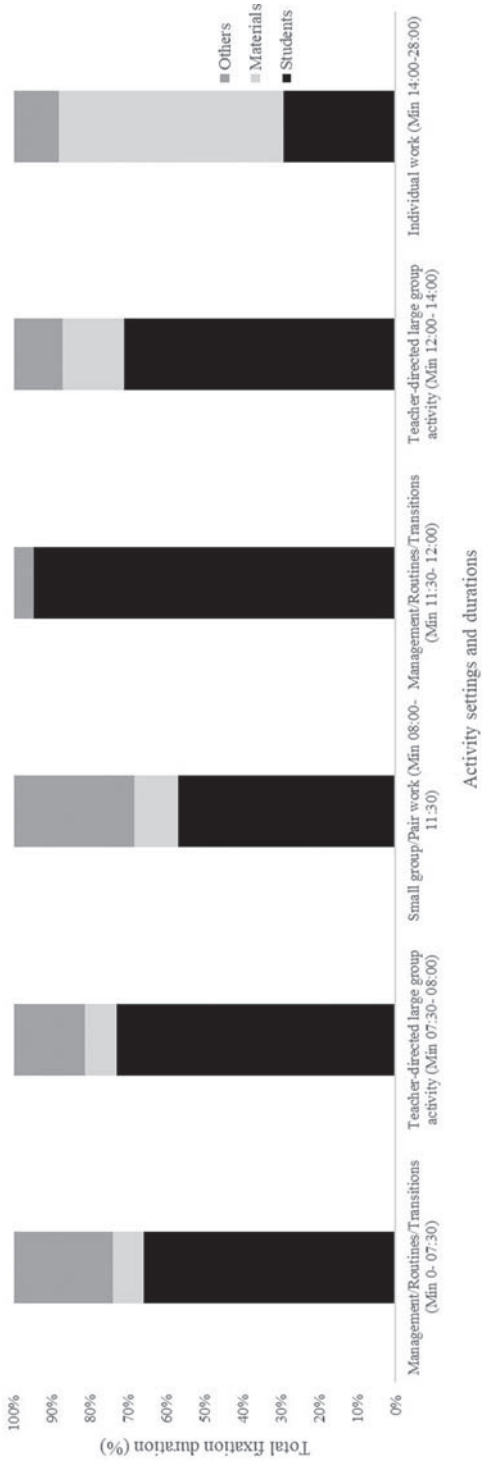

Figure 6. Distributions in focus of attention of Teacher 2 in fall amongst activity settings.

attention on students, and at segment 10:00–18:00, 58% of Te2's attention was focussed on students. During the small group/pair work segments, Te2 focussed 93% of her attention on students from 08:30–10:00 and 57% on students in segment 19:00–21:00. However, Te2 distributed her focus of

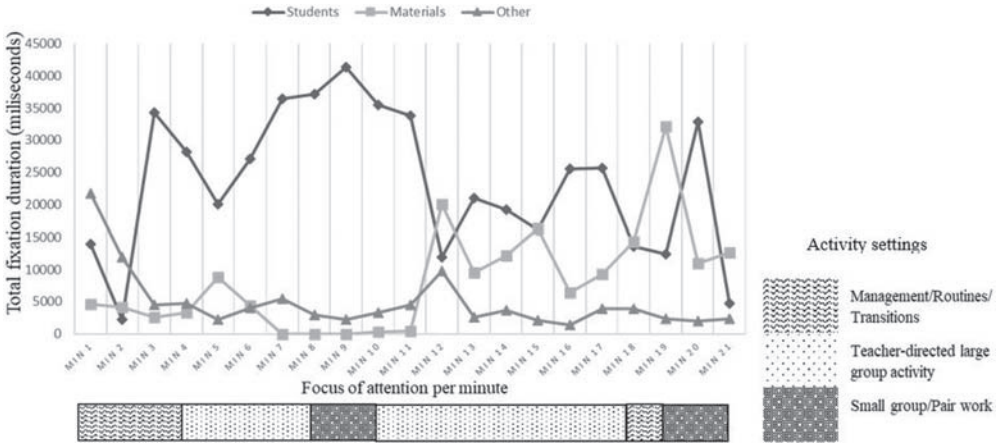

Figure 7. Variations in focus of attention of Teacher 2 (less stressed teacher) in spring lesson.

attention relatively evenly amongst all students as shown by the Gini coefficient (0.40), which is lower than the average of the whole sample in spring (see Table 1). Te2 incorporated a teacher-directed large group activity of a high duration, where instructional materials were used to deliver math content. However, pair work was used two times in the spring lesson, where the duration of Te2's focus of attention on students was longer.

4. Discussion

The present study had two aims: first, to explore the extent to which teacher stress is associated with their focus of attention in classroom settings and, second, to analyse in-depth the variations in the focus of attention between two teachers reporting more and less stress. The results showed, firstly, a positive association between teacher inadequacy at work and the overall distribution of focus of attention in the fall and a marginally significant positive correlation in spring. Furthermore, positive association was found between all domains of teacher stress and focus of attention during management/routines and transitions activity settings in fall. Thirdly, there was a marginally significant positive correlation between teachers' inadequacy and teacher focus of attention during teacher-directed large group activity in fall. Furthermore, the case studies served as examples that confirmed these findings and demonstrated the distribution of teachers' focus of attention.

First, we investigated the association between perceived teacher stress and focus of attention in the lesson using eye-tracking recording. Firstly, the results indicated that in the beginning of the first grade, teachers' sense of inadequacy was positively associated with their distribution of focus of attention. This is in line with previous research stating that reduced efficacy in professional competence in managing student behaviour could make teachers prone to be detached from students, stressed and exhausted (Aloe, Amo, et al., 2014; Salmela-Aro et al., 2011). Secondly, teacher stress was associated with teacher focus of attention during management/routines and transition activity settings in the fall. This finding supports prior research, which has shown that challenging student behaviour, and therefore higher need for classroom management, is associated with more teacher stress (Friedman-Krauss et al., 2013; Herman et al., 2018). The finding also suggests that teachers need to prioritise their immediate responses and attention (van den Bogert et al., 2014) to all students in the fall semester. Thirdly, teachers' sense of inadequacy was associated with focus of attention during teacher-directed large group activity settings in the fall. This finding could suggest that teachers may have stronger sense of inadequacy with little knowledge about the academic and behaviour needs of each student and may scan the whole classroom regularly

rather than provide individualised support. Teacher sense of inadequacy may also arise from the teacher's reduced control over distressful situations, limited means of action and uncertainty in the classroom, which could be emotionally overwhelming and, in turn, reflected in the teacher's behaviour and actions to manage classroom situations (Lindqvist et al., 2017).

The second research question involved a case study design to investigate in more detail the variation in focus of attention of two teachers one with more and another with less stress. In the fall, Te1 (more stress) reported that student behaviour problems were a cause of stress and her eye-tracking recording showed that she focused her attention longer on students during classroom management activity settings. This supports our finding with the whole sample that teacher focus of attention during classroom management activity setting associated with teacher stress at fall. In the spring, Te1 reported more students identified as needing support with learning and behaviour, and lack of resources from special needs teacher as a cause of her stress. Previous research confirmed that differentiating instructions and managing disruptive student behaviour contribute to more teacher's stress (Herman et al., 2018; Kyriacou, 2001). According to her eye-tracking recording in spring, Te1 now spent majority of time within teacher-directed large group activity providing more attention to students and spread her attention more evenly suggesting Te1's improved awareness of student needs during the school year. This supports our finding with the whole sample as well that teachers' sense of inadequacy associated with teacher overall focus of attention during the eye-tracking recordings in the spring. It is also noteworthy that despite the high students' needs, Te1 invested longer time in large group teaching.

Te2 (less stress) reported challenges in assessment practices with new curriculum and change in work patterns as her causes of stress in fall and her eye-tracking recording in fall showed that Te2 implemented longer individual work activity setting when she focused longer on materials. Individual support during academic tasks usually occurs during individual work activity settings and however, we did not find any associations between individual work and stress in fall. This could indicate that providing individual support might not be stressful during individual work activity setting. Te2 reported challenges with developing reading skills and reinforcing reading fluency with some students as her cause of stress in spring and her eye-tracking video in spring showed that she focused longer on students during small group/pair work activity settings. In small group/pair work activity settings, teacher assisted students in pairs and groups during academic tasks. However, we found no associations between small group/pair work and teacher perceived stress in fall and spring. During the school year, students could learn to work and interact in small groups and pairs requiring less monitoring that could make these activities less stressful for the teacher. These results and teacher cases provide some examples of how teacher focus of attention might vary between a more and less stressed teacher. However, to confirm these patterns they should be examined further in larger data sets.

4.1. Practical Implications

The present study has some practical implications. This study adds to the existing literature of teacher visual attention by establishing a link between teachers' feelings of stress at work and their focus of attention in the classroom. Teacher stress could be reflected in even/uneven distribution of visual attention during lesson, and thereby shape student classroom experiences. As teaching has been found as a stressful job (Aloe, Shisler, et al., 2014; Herman et al., 2020), it is important for teachers to be aware of how their occupational wellbeing could be reflected in their focus of attention in the classroom. The present study was among the first ones conducted in authentic classroom settings investigating teacher's visual attention with mobile eye-tracking in a dynamic and information-rich setting. Student teachers could benefit from the use of eye tracking during their teaching practice to become more aware of their focus of attention patterns in the classroom. In addition, reflecting on the video recording of their own teaching could open their eyes to their own classroom behaviour and actions. Eye-tracking can also be a powerful tool for teachers'

professional development at in-service trainings by providing them with objective information on their non-verbal interactions in the classroom towards different students during a lesson. According to Lindqvist et al. (2017), contemplative discussions about anticipatory distressful classroom situations in addition to viewing eye-tracking recordings could facilitate resolving sense of inadequacy at work and empower teachers to reflect on their classroom practices. Being more task focussed than emotion focussed during distressful classroom situations could help teachers overcome their sense of inadequacy at work and to focus their attention more on individual students.

4.2. Methodological Limitations and Future Directions

Collecting and analysing eye-tracking data is well recognised as time-consuming and expensive, which makes it challenging to conduct these studies. Although this study was amongst the first to investigate teachers' focus of attention in authentic classroom settings, it is not without its limitations. First, using a small sample size and a case study approach limits the possibilities to generalise the findings. Instead, case studies should be read entirely as a narrative (Flyvbjerg, 2006) and the essence of a case study lies in detailed investigation of a small sample focusing on specific aspects of an experience within a classroom (Tight, 2010). Therefore, the in-depth analysis of the case studies may provide a deeper and unbiased picture of how stress is reflected in focus of attention in real-life situations in current study. Additionally, the focus of attention of a larger data set of teachers could be used to confirm the trends found from the case studies. Second, since the present study was conducted in authentic classroom settings, differences in classroom characteristics could somewhat influence the results of this study. For example, arrangement of students and classroom layouts, personal characteristics of the teachers, different topics of the lesson, different positioning of the teacher with respect to students, and differences in teaching methods might also affect teacher focus of attention. Further research could focus on in-depth examinations of teachers' focus of attention on students during various activity settings with respect to other moderating factors, such as student academic achievement and motivation as well as special education needs. Third, the study captured only 20 min of eye-tracking recordings from every lesson, which may not be adequate to generalise about teaching quality and effectiveness of teaching. Fourth, authentic classroom settings provided higher ecological validity; yet, it could lead to little or no control over teachers' movements and light conditions during eye-tracking recording, which sometimes leads to lower gaze sample percentages. Therefore, the eye-tracking recordings with lower gaze sample percentages were not used in the study. Finally, since the case studies demonstrated teacher focus of attention only during math lessons, further research could consider investigating teacher focus of attention in more details in other subjects. Further investigation of teacher focus of attention in different subject areas could give deeper insights for improving teacher's instructional practices. In future research, the eye-tracking recordings should be complemented with teachers' qualitative interviews that can shed light on the emotional experiences of teachers and reasons for their actions during the recordings. Relatedly, future studies could consider a wider variety of stress measures and interviews in getting deeper understanding on the relations between teacher stress and focus of attention.

4.3. Conclusions

This exploratory study opened a new area of research concerning the associations between teachers' stress and their focus of attention in classrooms with Grade 1 students. Previous studies on teacher focus of attention have been conducted in secondary school classrooms (e.g., Cortina et al., 2015; Haataja et al., 2019) but these studies have not investigated the association between stress and teacher focus of attention at primary school with young children. Mobile eye-tracking methodology was used to investigate teachers' focus of attention providing insights about teachers' visual information processing during lessons in authentic classroom

settings. The findings suggest that teachers' perceived stress could be reflected in the variations of their focus of attention. In addition, examining teachers' focus of attention during various activity settings showed diverse associations with different domains of stress, and similar type of trends were demonstrated within the two teacher case studies. The case studies supported the findings that teacher stress was associated with teachers' focus of attention during classroom management activity settings in fall. This could suggest that student behaviour management can be stressful for the teacher, especially in the beginning of Grade 1 when students are learning how to study and behave in school classroom. Further investigation of these trends and possibilities is needed for developing an in-depth understanding of relationship between teacher stress and focus of attention in the classroom.

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II

TEACHERS' VISUAL FOCUS OF ATTENTION IN RELATION TO STUDENTS' BASIC ACADEMIC SKILLS AND TEACHERS' INDIVIDUAL SUPPORT FOR STUDENTS: AN EYE-TRACKING STUDY

by

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& Marja-Kristiina Lerkkanen, 2022

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Teachers' visual focus of attention in relation to students' basic academic skills and teachers' individual support for students: An eye-tracking study

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ABSTRACT

This study investigated how teachers' visual focus of attention is associated with students' basic academic skills and teachers' individual support for students in basic academic skills in authentic classroom settings. Teachers' ($N = 46$) visual focus of attention in the classroom was measured with mobile eye-tracking, and students' ($N = 879$) literacy and math skills were tested in Grade 1. The results revealed that teachers' visual focus of attention in terms of fixation counts correlated with students' basic academic skills and teachers' individual support for students in literacy and math. Two case studies showed that teachers' visual focus of attention varied among students with different teacher-reported individual support. It might indicate that the number of students with high teacher individual support in the classroom could influence how evenly teachers are able to distribute their attention. The practical implications of our findings suggest that it is essential to ensure the appropriate distribution of students who require greater individual support so these students can receive more of the teachers' visual focus of attention in the classrooms.

1. Introduction

The classroom is a complex environment that requires teachers to provide individual focus of attention to influence students' learning and ensure effective instruction (Blomberg et al., 2011). A teacher's selective visual focus of attention is known to be a prerequisite for the teacher's noticing of relevant classroom events and thereby, interpreting the classroom events based on their professional knowledge of teaching and learning (Sherin & van Es, 2005). It can be very challenging for teachers to focus immediate visual attention on all students who require individual academic support (van den Bogert et al., 2014). In the early school years, particularly Grade 1, the emphasis of learning is on students' basic academic skills in literacy and math (Lerkkanen et al., 2016). Therefore, teachers must identify students who need more individual support to develop their basic academic skills. This phenomenon is often connected to the term "evocative effect," which refers to an adult's response arising from children's characteristics, such as behavior or academic performance (Nurmi et al., 2012). Previous research has found that students' academic performance evokes teachers' instructional support in the classroom (Huber & Seidel, 2018; Nurmi et al., 2012; Silinskas et al., 2015) to improve their literacy (Connor et al., 2004) and math skills (Curby et al., 2009). However, less is known about the extent to which teachers' visual focus of attention affects the variation of teacher's individual support for students in relation to the development of their basic academic skills. In addition, there is a lack of studies that have utilized eye-tracking methodology to investigate the links between teachers' visual focus of attention and students' basic academic skills and teacher individual support for students in elementary school classrooms. This study used an exploratory approach to investigate, first, whether students' basic academic skills and teachers' individual support for students were associated with teachers' visual focus of attention in Grade 1 classrooms. Second, a case study design was used to explore in-depth the variations in teachers' visual focus of attention in two example classrooms: one classroom scoring higher than average and another classroom scoring lower than average in the teacher's individual support for students in math.

1.1. Teachers' visual focus of attention

There are multiple unpredictable events happening simultaneously in the classroom that require teachers to notice and be selective with their visual focus of attention (Sherin & van Es, 2005). Accordingly, the

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concept of *teacher's professional vision*, first introduced by Goodwin (1994), was further developed to provide a deeper insight into teacher's professional competence that included their ability to *notice* relevant classroom events and provide *knowledge-based reasoning* for the noticed information in the classroom (Seidel et al., 2011; Seidel & Stürmer, 2014). Eye-tracking technology has been used in this regard to study teachers' noticing in terms of moment-to-moment changes in teachers' visual focus of attention on students and in relation to teachers' pedagogical actions (Jarodzka et al., 2020; McIntyre & Mainhard, 2020; Tatler et al., 2014). Recent studies have involved mobile eye-tracking for in-depth investigation of teacher's noticing through their selective focus of visual attention toward classroom events while watching teaching videos (Codreanu et al., 2021; McIntyre et al., 2021; van den Bogert et al., 2014) or while teaching in an authentic classroom setting (Dessus et al., 2016; Goldberg et al., 2021; Haataja et al., 2019; Huang et al., 2021; McIntyre & Foulsham, 2018). Drawing from the existing literature, this study examined the aspect of teachers' noticing through their selective visual focus of attention towards students. The teachers' visual focus of attention is defined as the teacher's gaze on relevant targets (such as students) for processing information present in an authentic classroom setting (van den Bogert et al., 2014), and this can be measured by using eye-tracking indicators of fixation-based metrics, such as total fixation duration, average fixation duration, and fixation counts. In previous studies, fixation has been defined as the duration in eye tracking when the eye is relatively still and provides the ability to process information from the targets in the classroom environment (e.g., Goldberg et al., 2021; McIntyre & Mainhard, 2020; McIntyre et al., 2017; Stahnke & Blömeke, 2021; van den Bogert et al., 2014; Wolff et al., 2016).

The theoretical Classroom Management Script model developed by Wolff et al. (2020) showed that teachers' expertise can influence perception, interpretation, and response to events connected to students in the classroom. Recent eye-tracking studies have shown that expert teachers show improved noticing of classroom events through faster recognition of relevant information (Gegenfurtner et al., 2020; Keller et al., 2021; van den Bogert et al., 2014), improved monitoring of students, and better judgment accuracy regarding student assessment in the classroom when compared with novice teachers (Kosel et al., 2021). The Classroom Management Script model suggested that teachers' visual focus of attention is complex and could follow both top-down and bottom-up processes simultaneously when they concentrate on student-related issues to provide individual attention. For instance, top-down processes could involve teachers' prior knowledge related to students' academic skills and perceived individual support for students, whereas bottom-up processes could involve the students' actual behaviors and other physical characteristics of students guiding the teachers' gaze in the classroom (Wolff et al., 2020). The present study focused on investigating teachers' top-down processes involving students' academic skills and teacher-perceived individual student support, which could influence teachers' visual focus of attention during lessons.

Teachers' visual focus of attention can vary based on students' academic skills and actual behaviors in the classroom. For example, teachers gazed more on secondary school students who needed adaptive pedagogical action (Seidel et al., 2020) and gazed longer when providing guidance to students who struggled, showed less interest, and did not concentrate during academic activities (Dessus et al., 2016; McIntyre et al., 2017; Seidel et al., 2020; Yamamoto & Imai-Matsumura, 2013). Teachers also focused more visual attention on individual students while providing feedback on their answers during classroom interactions (Cortina et al., 2015). Additionally, teachers seemed to focus more visual attention on students who showed disruptive behavior (Wolff et al., 2016; Yamamoto & Imai-Matsumura, 2013) and interactive behavior, such as asking the teacher questions or explaining their answers to the teacher (Goldberg et al., 2021). Therefore, teachers need to engage with students to improve learning and influence a group or individual students through monitoring, interaction, and support whenever required in the classroom (Seidel & Stürmer, 2014; van Es & Sherin, 2008). Recent eye-tracking studies have acknowledged that immediate attention and decisions related to individual student's achievement and understanding have been considered a challenging task for secondary school teachers (Cortina et al., 2015; Dessus et al., 2016; Goldberg et al., 2021; Haataja et al., 2019; Seidel et al., 2020; Wolff et al., 2016; Yamamoto & Imai-Matsumura, 2013) and higher education teachers (Prieto et al., 2017); however, there are limited studies concerning how teachers' visual focus of attention is related to students' basic academic skill levels and teachers' individual support for students in literacy and math at the beginning of elementary school.

1.2. Students' basic academic skills and teachers' individual support for students

Literacy and math are basic academic skills that students must acquire during their early school years. Students who struggle with developing basic academic skills in these years are more likely to struggle with academics in the future (Aunola et al., 2004). Therefore, teachers should support students' individual learning of basic literacy and math skills during their first school year (Lerkkanen et al., 2016). It has been found that students' academic performances evoke teachers' responses, such as individualized support and adaptive instructions (Nurmi et al., 2012; Pakarinen et al., 2011). Previous observational studies have shown that teachers provide more individual support to students who struggle with reading skills (Ruotsalainen et al., 2020) and adapt instruction based on the students' literacy skill level (Connor et al., 2009). In addition, students' low performance in reading and math in the fall of Grade 1 has been associated with increased teacher support in the spring of Grade 1 (Nurmi et al., 2012; Silinskas et al., 2015). In the present study, teachers' individual support for students was defined as teachers' perception of the amount of support they provide in literacy and math to a student compared with other students in the class.

Previous eye-tracking studies have shown that cues such as student academic skills and behavior influence teachers' visual focus of attention. For example, teachers showing greater judgment accuracy of student's cognitive and motivational characteristics used combinations of students' diagnostic cues (Schnitzler et al., 2020) and monitored individual students regularly (Kosel et al., 2021). In addition, teachers who showed greater judgment accuracy in assessing students had increased fixation counts and shorter average fixation duration on students (Schnitzler et al., 2020), possibly indicating improved information processing. Even though students' basic academic skills and teachers' individual support for students have been studied, there is little research on how teachers' visual focus of attention might be related to students' literacy and math skills and the amount of individual student support offered by the teacher in these subject areas. In particular, little is known concerning whether variations in students' basic academic skills and teachers' perceptions of individual student support are related to teachers' visual focus of attention in the classroom.

1.3. Aim of the study

The aim of this study was to investigate teachers' visual focus of attention in relation to students' basic academic skills and teachers' individual support for students in literacy and math in authentic classroom settings using mobile eye-tracking technology. In the classroom context, there is a need to investigate whether teachers provide selective focus of attention to students by noticing student cues, such as their basic academic skills, and how this is related to teachers' individual support for students. To gain a deeper understanding, we used case studies to examine the variations in teachers' visual focus of attention in two example classrooms: one classroom scoring higher than average and another classroom scoring lower than average in teachers' individual support for students in math.

The research questions for this study are as follows:

1. To what extent is teachers' visual focus of attention associated with students' basic academic skills (literacy and math) and teachers' individual support for students in these skills?
2. How are students' math skills and teachers' individual support for students in math skills reflected in teachers' visual focus of attention in classrooms characterized by high and low teacher individual support for students?

The present study was conducted in Finland, where students begin their nine years of elementary school at seven years of age. The students are placed in schools based on the school's proximity to their homes. It is mandatory for teachers to have a master's degree in education to teach in elementary school. Typically, in elementary school, the same teacher teaches the same class and most of the subjects for several years. Most schools in Finland are public schools that follow a national core curriculum for basic education designed by the Finnish National Board of Education (Finnish National Agency for Education, 2014).

2. Methods

2.1. Participants and procedure

In the present study, 46 Finnish Grade 1 teachers (44 female, 2 male; $M_{age} = 44.84$ years, $SD = 9.10$) and 879 students ($M_{age} = 7.28$ years, $SD = 0.47$) participated from 31 schools within seven municipalities in Central Finland, including rural and urban areas. The teachers' average work experience was 16.35 years ($SD = 9.45$, $Min_{exp} = 0.50$, $Max_{exp} = 39$), and the average class size included 19.22 students ($SD = 4.36$, $Min_{cs} = 7$, $Max_{cs} = 25$). All teachers held a Master of Education degree and were qualified as class teachers. The parents' responses indicated that 41.7 % had completed high school followed by vocational school degree or college level training; 27.5 % had completed polytechnic school or a bachelor's degree; 27.1 % had completed a master's degree; and 3.7 % had completed a doctoral degree.

This study was part of a larger follow-up focusing on the role of teacher and student stress on teacher–child interactions (Lerkkanen & Pakarinen, 2016-2022). In the present study, teacher's eye-tracking video data were used to study teachers' visual focus of attention. Previously, the same eye-tracking video dataset from Grade 1 had been used in studies different from the present one, such as studies on teachers' visual focus of attention in relation to teacher stress, teacher's professional vision, and educational dialogue (Chaudhuri et al., 2021; Muhonen et al., 2020, 2021, 2022). However, the topic of the present study, teachers' visual focus of attention in relation to student's basic academic skills and teachers' individual support for students in literacy and math, has not been investigated previously. In 2017, approval from the university's ethics committee was received before the commencement of the study (Finnish Advisory Board on Research Integrity [TENK], 2013). The data for the present study were collected during the spring semester of 2018. Teachers were invited by phone or email to participate in the study. Participation in this study was voluntary, and written consent was obtained from the teachers and students' parents before data collection. The data restoration was carried out according to the university's ethical committee and the European Union's General Data Protection Regulation guidelines.

The teachers filled in questionnaires on background information, and they rated their individual support for students in their classrooms. The assessment of students' basic academic skills in literacy was conducted as an individual test, and the math assessment was conducted as a group test on a regular school day by trained research assistants. The teachers filled in a questionnaire concerning their individual support for each participating student in literacy and math. The purpose of this questionnaire was to obtain an overall assessment of teacher's individual support for a student, rather than focusing solely on the day of eye-tracking data collection. It is important to note that since the same teacher teaches all subjects in Grade 1, they were able to rate individual support for students in both literacy and math.

The teachers' visual focus of attention in authentic classroom settings was investigated using mobile eye-tracking technology. The eye-tracking videos of teachers were recorded during the second lesson of the normal school day using Tobii Pro Glasses 2 (Tobii AB, Danderyd, Sweden) for a period of 20–25 min starting from the beginning of the lesson. The lesson structure and content were not predetermined, and the teachers had the freedom to carry out their tuition based on their preferences and the typical agenda of the school day. These recordings consisted of 22 math lessons, 20 literacy lessons, and four activity-based lessons (for example, art and crafts, and a Saint Valentine's day activity). The four activity-based lessons were included in the larger data since these lessons had references to components of literacy and math. In addition, math and literacy lessons also included activities at different stages of the lesson to ensure a multimodal learning approach for students. In Grade 1, it is typical for teachers to practice integration and multidisciplinary learning across subjects since both literacy and math are equally considered as basic foundational academic skills (Finnish National Agency for Education, 2014). To ensure appropriate data quality, a 3-point calibration of the eye-tracking glasses was conducted by two trained research assistants before each recording. The course of the lesson, the seating plan in the classroom, and the materials used during the recording were also noted. In the present study, the Tobii Pro Glasses 2 (see Tobii AB, 2018) that was used had the following features: four cameras for corneal reflection and pupil tracking with scene camera resolution of 1920 × 1080 pixels at 25 frames per second. The visual angle of the scene camera was 82 degrees horizontal and 52 degrees vertical. The frame dimensions were 179 × 159 × 57 mm. For further investigation using the case study design, two classrooms in which math lessons were taught during eye-tracking recording were selected: one with more overall high teachers' individual support for students and one with overall low teachers' individual support for students in math.

2.2. Measures

2.2.1. Teachers' visual focus of attention

Teachers' areas of interest (AOIs) were identified as the targets where teachers looked during the lesson using Tobii Pro Analyser software v. 1.128. In the present study, during the manual fixation mapping process, AOIs such as the students, instructional materials (such as materials required for teaching and learning), and non-instructional materials (areas such as walls, tables, curtains, windows, etc.) were considered as the targets where teachers focused their visual attention. Drawing from previous research showing that manual coding was best suited when the total dwell time on a target was required to answer the research question (Holmqvist et al., 2015), we decided to use manual mapping of the teachers' eye-gaze behavior in the form of fixations in the eye-tracking recordings using a coding criterion. However, in the present study, only students were considered for further analysis of the teachers' visual focus of attention. Only those eye-tracking video recordings with 70 % and above gaze sample percentages were selected for the study to ensure that one or both eyes were detected during 70 % of the recording's duration. Based on the coding criteria, screenshots of the video recordings were used to define the AOI in the eye-tracking videos. The coder started manual gaze mapping when the teacher first looked at a student AOI in the classroom and ended coding when the teacher took off the mobile eye-tracking glasses. The two coders who were assigned to code the eye-tracking videos held master's degrees in teacher education and had experience collecting eye-tracking recordings in authentic classroom settings. The intercoder reliability was checked by double coding 20 % of the videos from the whole dataset. Double coding agreement ranged from 84.80 % to 94.03 %.

We followed the fixation metrics explained by Holmqvist et al. (2015). One fixation typically lasted 200–300 milliseconds. The fixation metrics, such as total fixation duration, average fixation duration, and fixation counts for each student, were obtained after coding the eye-

tracking recordings to investigate teachers' visual focus of attention. Total fixation duration, and average fixation duration metrics were measured in milliseconds (ms), and fixation count was represented by an integer. The total fixation duration and average fixation duration on a target suggested that the longer the fixation duration on a target, the deeper was the information processing. The fixation counts or the number of fixations on a target showed the noticeability and importance of a specific target; for example, higher fixation counts indicated greater importance of the target. Another eye-tracking study determined that shorter fixation durations and a greater number of fixations on task-relevant areas indicate improved information processing and selective focus of attention (Gegenfurtner et al., 2011).

2.2.2. Students' basic academic skills

Students' basic academic skills were measured in literacy and math. First, literacy skills were measured using the "ARMI− Luku- ja kirjoitustaidon arviointimateriaali 1. Luokalle" test battery (Lerkkanen et al., 2006) translated as "Literacy assessment material for 1st grade" is a Finnish tool for assessing reading accuracy in Grade 1. The test consisted of increasingly difficult words ranging from 2- to 16-syllables. The research assistant showed one word at a time (20 words in total) to each student individually, and the student read each word aloud. The sum of correct responses to the items determined the total score out of a maximum score of 20. Cronbach's alpha of the ARMI test battery was 0.61.

Second, math skills were measured using the Basic Arithmetic Test (BAT; Aunola & Räsänen, 2007). BAT is a 28-item timed test of three minutes where students are presented with arithmetic operation questions in addition (14 items, e.g., 2 + 1 =? and 3 + 4 + 6 =?) and subtraction (14 items, e.g., 4–1 =? and 20–2–4 =?). Students are required to perform basic calculations with speed and accuracy. The number of correct items determines the sum score out of a maximum score of 28. Cronbach's alpha of the BAT was 0.84. For further analysis, both the test scores were standardized, and investigated in relation to teachers' visual focus of attention indicators. However, for in-depth investigation using two case studies, only students' math test scores were considered.

2.2.3. Teachers' individual support for students

Teachers rated the need for instructional support for each individual student using nine questions related to teachers' support in (a) reading, (b) writing, and (c) math. For literacy (six items), teachers rated individual support provided to each student during a single day in reading words, reading fluency, reading comprehension, writing words, word-level spelling, and writing text. For math (three items), teachers rated individual support provided to students in number counting, basic math problems, and verbal math problems. The teacher rated each student on the basis of the individual support they offered in literacy and math learning on a typical school day compared with the other children in the classroom on a 5-point scale: 1 = Substantially less than other students, 2 = Somewhat less than other students, 3 = An equal amount as other students, 4 = Somewhat more than other students, and 5 = Substantially more than other students (Silinskas et al., 2015). For further analyses, scores obtained from items related to teachers' individual support for students in reading and math were standardized and investigated in relation to teachers' visual focus of attention indicators. However, for in-depth investigation using two case studies, only teachers' individual support for students in math was considered. The Cronbach's alphas for items indicating individual support in literacy and math were 0.97 and 0.94, respectively. In addition, Pearson's correlation showed a negative association between students' basic academic skill level and teachers' individual support for students in literacy ($r = -0.425$, $p = .003$) and math ($r = -0.287$, $p = .056$).

2.3. Analyses

First, using IBM SPSS Statistics 27 (IBM, Armonk, NY, USA), Pearson correlation analysis was conducted to investigate the association between teachers' visual focus of attention and students' basic academic skills and teachers' individual support for students in literacy and math using classroom aggregates across the whole sample of 46 classrooms. Second, two example classrooms with math lessons were selected for the case study based on teachers' ratings of individual support for students in math skills: one with high teacher individual support for students in math and the other classroom with low teacher individual support for students in math. The classroom characterized by high teacher individual support for students in math had a higher-than-average teacher individual support score than the overall score of the 46 classrooms in this study, whereas the classroom characterized by low teacher individual support for students in math had a lower teacher individual support score than the average of the whole sample in math. In-depth investigations of the selected teacher's visual focus of attention were conducted in three phases. First, the Mann–Whitney *U* test was used to examine the differences in teachers' visual focus of attention (in terms of the eye-tracking variables) between two classrooms with math lessons shown in the eye-tracking recordings, one characterized by high and the other by low teacher individual support scores in math. Second, in the two selected classrooms, the Mann–Whitney *U* test was again used to examine differences in teachers' visual focus of attention metrics between two student groups characterized by their high and low teacher-reported individual support scores in math skills, respectively. Third, a visual representation of teachers' visual focus of attention was created using the variables of fixation counts, academic skills, and teachers' individual support for students in math. In case study classrooms, the teachers' fixation counts indicated the number of times the teacher fixated on a student to process information during their math lessons.

3. Results

3.1. Teachers' visual focus of attention in relation to students' basic academic skills and teachers' individual support for students in literacy and math

The first research question concerned the extent to which teachers' visual focus of attention was associated with students' basic academic skills and teachers' individual support for students in literacy and math. Descriptive information related to the classroom aggregates of the study variables can be seen in Table 1. As shown in Table 2, Pearson correlation analysis showed that teachers' fixation counts negatively correlated with students' basic academic skills in literacy ($r = -0.47$, $p < .001$) and math ($r = -0.31$, $p < .05$). In addition, fixation counts positively correlated with teachers' individual support for students in literacy ($r = 0.41$, $p < .001$) and math ($r = 0.33$, $p < .05$). However, no other associations were found between the other eye-tracking metrics and

Table 1
Descriptive information on students' basic academic skills, teachers' individual support for students, and teachers' visual focus of attention in 46 classrooms.

	Mean (*SD*)	Min	Max
Students' Basic Academic Skills			
Literacy[b]	18.68 (2)	6.67	20
Math[b]	9.84 (2.15)	4.33	14.20
Teachers' individual support for students (rated 1–5)			
Literacy[b]	2.91(0.46)	1.94	4.33
Math[b]	2.68 (0.43)	1.55	4.22
Teachers' visual focus of attention			
1. Total Fixation Duration[a] (s)	26.99 (11.91)	10.62	72.64
2. Average Fixation Duration[a] (s)	0.40 (0.11)	0.21	0.87
3. Fixation Counts[a]	62.89 (24.16)	27.64	134

[a] Per student in the classroom.
[b] Per classroom.

Table 2
Pearson correlations between teachers' visual focus of attention and teachers' individual support for students and students' basic academic skills in 46 classrooms.

	Teachers' individual support for students		Students' basic academic skills	
	Literacy	Math	Literacy	Math
Teachers' visual focus of attention				
1. Total Fixation Duration	0.212	0.193	−0.185	−0.217
2. Average Fixation Duration	−0.085	−0.017	0.091	−0.083
3. Fixation Counts	0.414**	0.336*	−0.477**	−0.314*

** $p < .001$.
* $p < .05$.

student-related variables.

3.2. Two teachers' visual focus of attention in high and low teachers' individual support classrooms

To answer the second research question, using a case study design, we investigated in what way student's basic academic skills and teachers' individual support for students in math were reflected in teachers' visual focus of attention during math lesson. Further investigation involved identifying two classrooms, one characterized by high teacher's individual support and one characterized by low teacher's individual support for students in math. A Mann–Whitney *U test* was used to investigate how the three eye-tracking metrics, namely, total fixation duration, average fixation duration, and fixation counts, varied between the two teachers during a math lesson in the two respective classrooms. The test showed statistically significant differences in teachers' visual focus of attention, particularly in average fixation duration, teachers' individual support for students, and basic academic skills in math (see Table 3). More detailed descriptions of the two classrooms are presented in Figs. 1 and 2. In these visual representations of the case study, teachers' visual focus of attention and teachers' individual support for students and students' basic academic skills have been demonstrated in terms of fixation counts. This use of fixation counts was based on the earlier findings of the present study that showed teachers' fixation counts were associated with students' basic academic skills and teachers' individual support for students in math (see Table 2).

Table 3
Mann–Whitney U test results showing difference between classroom of high teacher individual support classroom (HTISC) and classroom of low teacher individual support classroom (LTISC).

	Mean (*SD*)		Median (*Mdn*)		*U*	*p*
	[a] HTISC	[b] LTISC	[a] HTISC	[b] LTISC		
Teachers' visual focus of attention						
Total fixation duration	17.14 (12.34)	11.91 (7.40)	14.61	10.46	192.50	0.212
Average fixation duration	485.07 (129.65)	350.36 (115.59)	479.50	330.50	248.50	0.002*
Fixation count	32.93 (20.08)	33.45 (20.08)	28.50	28	152.50	0.962
Teachers' individual support for students						
Literacy	2.79 (1.51)	1.98 (1.41)	2.58	1.50	196.50	0.170
Math	3.03 (1.48)	1.78 (1.04)	3.83	1.66	216.50	0.041*
Students' basic academic skills						
Literacy	19.71 (0.46)	17 (5.83)	20	19	208.00	0.083
Math	12.07 (4.54)	9.50 (4.75)	11.50	9	224.00	0.023*

* $p < .05$.
[a] $n = 14$ students present.
[b] $n = 22$ students present.

3.2.1. One teacher's visual focus of attention in the classroom of high teacher's individual support for students

The teacher in this classroom was 41 years old, with 17 years of work experience, including 10 years in the current workplace at the time of data collection. Out of the class size of 23, seven students did not have parental permission to participate in the study, and two students were absent. Therefore, there were 14 students (10 boys and 4 girls) present during the math lesson at the time of the eye-tracking recording. The teacher reported that 57.14 % of the students needed higher-than-average teacher individual support in the classroom, and 42.8 % needed lower-than-average teacher individual support. However, 78.57 % of the students had a higher-than-average math skill level, and 21.42 % of the students had lower-than-average math skills, compared with that of all 46 classrooms. A detailed account of the descriptive information of the students' math skill levels, the teacher's individual support for students in math, and the teachers' visual focus of attention on the students during the first 20 min of a math lesson is shown in Appendix 1. In this classroom, the average score of the teacher's individual support for students in math ($M = 3.03$, $n = 14$) and average math skill scores ($M = 12.07$, $n = 14$) were higher than the average score (see Table 1) of all 46 classrooms in the sample. On average, from the high teacher individual support group in math, a student received 13.42 s of total fixation duration, 426.5 ms average fixation duration, and 28.5 fixation counts, whereas a student from the low teacher individual support group in math received 22.12 s of total fixation duration, 563.16 ms average fixation duration, and 38.8 fixation counts from the teacher.

The Mann–Whitney *U* test within the classroom of high teacher's individual support for students showed that only average fixation duration ($U = 8.00$, $p = .03$) out of the three fixation metrics used in this study varied significantly between the students with higher and lower teacher individual support for students in math: high teacher individual support students ($Mdn = 415.40$, $n = 8$) received less teachers' visual focus of attention (measured with average fixation duration) compared with low teacher individual support students ($Mdn = 526.50$, $n = 6$). Additionally, students' math skills ($U = 5.00$, $p = .01$) varied between high teacher individual support students ($Mdn = 10$, $n = 8$) and low teacher individual support students ($Mdn = 15$, $n = 6$). In the same classroom, teacher individual support for students in math skills ($U = 48.00$, $p = .002$) also varied significantly between high teacher individual support students ($Mdn = 4.16$, $n = 8$) and low teacher individual support students ($Mdn = 1.49$, $n = 6$).

Fig. 1 demonstrates how the teacher's visual focus of attention in terms of fixation counts varied with the teacher's individual support for students and academic performance in math in the high individual support classroom. The fixation counts indicated the number of times fixations occurred in teachers' eye movements to take in information from a student. Among students with high teacher individual support, students 2, 8, 11, and 12 supported findings from the first part of this study showing that teachers gave high visual focus of attention to students with lower academic skills in math and higher teacher individual support. In addition, among students with low teacher individual support, students 6, 7, and 13 seemed to support findings from the first part of this study showing that teachers gave lower visual focus of attention to students with higher math skills and lower teacher individual support than the classroom average. However, there were some exceptions. In fact, despite having lower teachers' individual support scores and higher math scores than the classroom average, students 4 and 14 were fixated on twice as often as the other students. In addition, other exceptions among students with high teacher individual support were students 3, 5, 9, and 10, who received relatively less teachers' visual focus of attention in the form of fixation counts despite their low math skills and high teacher individual support. Another exception was student 1, who scored lower in math skills than the classroom average, had low teacher individual support, and was fixated on fewer times by the teacher.

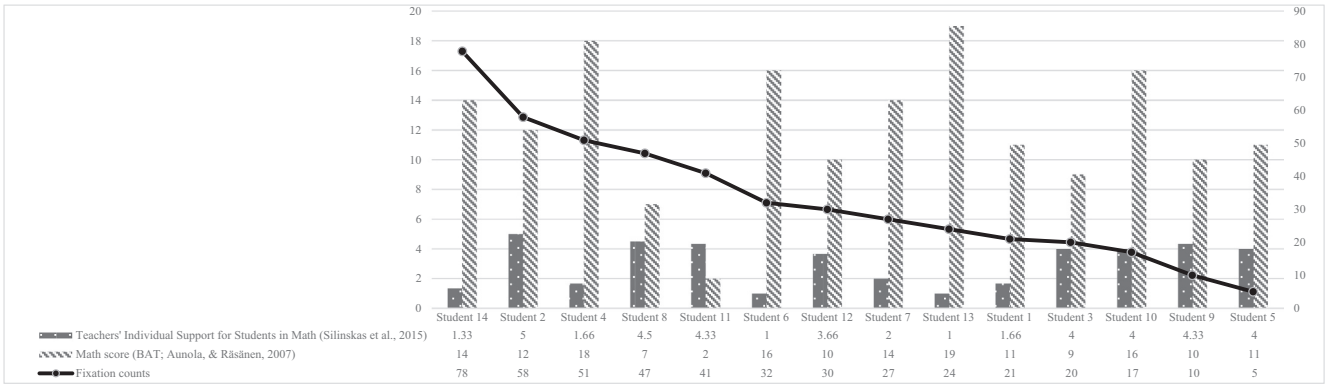

Fig. 1. Teacher's individual support for students, academic performance in math and teacher's fixation counts in high individual support classroom.
Note. Students 2, 3, 5, 8, 9, 10, 11 and 12 have greater individual support requirement in math according to the teacher.

3.2.2. One teacher's focus of attention in the classroom of low teachers' individual support for students

A teacher 50 years of age with 18 years of work experience, including three years and six months in the current workplace, taught a math lesson during eye-tracking recordings in the classroom with low teacher individual support for students' math skills. The low individual support classroom had a class size of 24 students (17 boys, 7 girls), all of whom were seven years of age at the time of data collection. Overall, 22 students (16 boys, 6 girls) were present, and two students were absent at the time of the eye-tracking recording. This classroom had the lowest overall teachers' individual support for students in math skills (M = 1.78, n = 22) and lower math skills scores (M = 9.50, n = 22) in relation to the average of the total sample of 46 classrooms (see Table 1). According to the teacher, 13.60 % of the students needed higher-than-average teachers' individual support in math skills, and 86.40 % of students needed lower-than-average teachers' individual support in math skills. Overall, 40.90 % of the students scored higher than average, and 59.10 % of the students scored lower than average in math skills compared with the total sample of 46 classrooms. Descriptive information about the students' math skills, their teacher's individual support for students in math, and the teacher's visual focus of attention on students during the first 20 min of a math lesson are shown in Appendix 2. On average, in this classroom, students in the high individual support group in math received 15.73 s of total fixation duration, 441 ms of average fixation duration, and 35.33 fixation counts during the eye-tracking recording, whereas students in the low individual support group, on average, received 11.31 s of total fixation duration, 33.15 fixation counts, and 336.05 ms of average fixation duration of the teacher's visual focus of attention during the eye-tracking recording.

The Mann–Whitney U test for the low individual support classroom showed that teacher's visual focus of attention did not vary statistically significantly between students characterized with high and low teachers' individual support for students in math skills. Students' math skills (U = 7.00, p = .04) in the low individual support classroom differed significantly between high individual support students (Mdn = 5, n = 3) and low individual support students (Mdn = 9, n = 19). Lastly, teachers' individual support for students in math (U = 57.00, p = .001) in this classroom differed significantly between high individual support students (Mdn = 4.33, n = 3) and low individual support students (Mdn = 1.33, n = 19).

Fig. 2 demonstrates the variation in the teacher's visual focus of attention based on low teacher individual support scores and math skills in the low teacher individual support classroom. Overall, 17 out of 24 students had lower teacher individual support scores than the class average. Among students with low teacher individual support scores, 12 students (see Fig. 2, students 1, 6, 5, 15, 18, 11, 13, 12, 2, 19, 4, and 10) received relatively lower teachers' visual focus of attention in terms of fixation counts than others in the classroom, even though some of these students had lower scores in math than in the classroom average (see Fig. 2, students 1, 15, 11, 2, and 10). However, the case of student 13 was similar to our earlier finding, wherein the student had high math skills and low teacher individual support and was fixated on relatively fewer times than the other students. Furthermore, only students 9, 14, and 21 scored lower than the classroom average in math skills and had higher teacher individual support than other students. However, the teacher's fixation counts were somewhat similar for these three students, albeit lower than for some other students in this classroom (e.g., students 8 and 16). Some exceptions were found: students 3 and 17 had higher-than-classroom average math scores and lower teachers' individual support, but were fixated on more frequently by the teacher. In addition, students 7, 8, 16, and 20 had less-than-classroom average math scores and had lower teacher individual support, but the teacher fixated on these students more than those students with high teacher individual support.

4. Discussion

This study investigated how teachers' visual focus of attention is associated with students' basic academic skills and teachers' individual support for students in literacy and math in authentic classroom settings. The results indicated that teachers' fixation counts negatively correlated with students' basic academic skills in literacy and math. In addition, the teachers' fixation counts positively correlated with the teachers' individual support for students in literacy and math. The two case studies showed that there was a significant difference in teachers' visual focus of attention in terms of average fixation duration between the high and low teacher individual support classrooms. In addition, students in low individual support classrooms received less average fixation duration overall than students in high individual support classrooms.

The first finding from our study showed that teachers' visual focus of attention was related to students' basic literacy and math skills and to teachers' individual support for students in these skills. In particular, teachers' fixation counts were found to be positively associated with teachers' individual support for students in literacy and math and negatively associated with student's basic literacy and math skills. This result appears to indicate that students who had low basic academic skills in literacy and math and high teacher-reported individual support received more teachers' visual focus of attention in the form of fixation counts. This result aligns with previous studies which showed that students with low academic skill levels in reading and math received more individualized support from teachers in Grade 1 (Nurmi et al., 2012; Silinskas et al., 2015). This result is also in line with previous eye-tracking studies reporting that teachers focused more on relevant areas in the classroom where students struggled and showed less interest

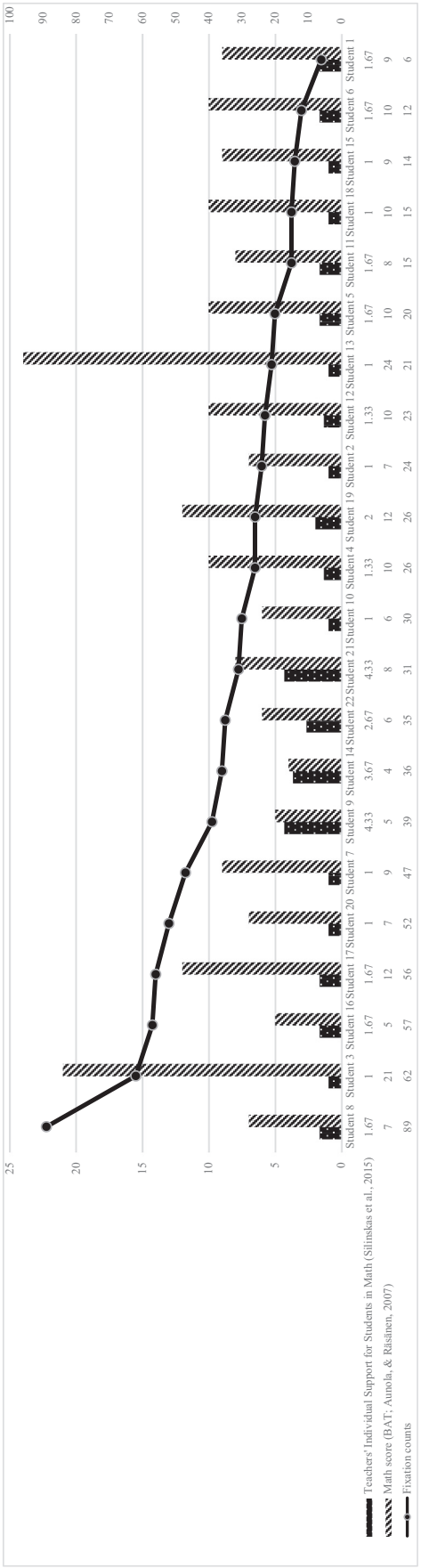

Fig. 2. Teachers' individual support for students, academic performance in math and teacher's fixation counts in low individual support classroom.
Note. Students 9, 14, and 21 have greater individual support requirement in math according to the teacher.

in academic activities (Dessus et al., 2016; Seidel et al., 2020). In line with Classroom Management Script model developed by Wolff et al. (2020), our results may also reflect that teachers can use their prior knowledge of students' academic skills and the amount of individual support they typically provide for students as cues to notice students in the classroom. It may also be that teachers were aware of students' requirements and looked at some students more to provide support and guidance in the classroom. For example, Gegenfurtner et al. (2011) reported that a higher number of fixations indicated improved information processing, increased awareness, and selective focus of attention on targets. In addition, teachers' improved judgment accuracy in relation to students' assessment has been linked to higher fixation counts and shorter average fixation durations on student-related areas (Schnitzler et al., 2020). Therefore, it could be possible that a teacher's visual focus of attention in the form of high fixation counts on students could be linked to improved noticing of students' learning-related issues.

The in-depth investigation of the two classrooms revealed more variation in the teachers' visual focus of attention in terms of students' skills in math and the individual support provided by the teacher. The difference in average fixation duration in the two case-study classrooms could indicate a difference in teachers' monitoring and noticing of students during their lessons. It is important to acknowledge that teachers' visual focus of attention in authentic classrooms follows a complex process. As students, regardless of their academic skills and the teachers' individual support provided, are not challenged equally with every lesson or activity, teachers need to actively modify their visual focus of attention to monitor and support the students accordingly. The results showed that the two selected classrooms seemed to show significant differences in teachers' visual focus of attention in terms of average fixation duration, student's math skills, and teachers' individual support in math. This result is similar to previous research by Dessus et al. (2016) showing that teachers spread their visual focus of attention unevenly due to variations in teachers' individual support for students and the academic skill levels of students in a lesson. The teachers' gaze behavior in the high teacher individual support classroom indicated that students with high teacher-reported individual support were noticed less, as shown by the lower average fixation duration; however, in the low individual support classroom, no statistically significant difference was seen between high and low individual support student groups.

In the high individual support classroom, there were more students with high teacher-reported individual support, which could have made it difficult for the teacher to prioritize their focus of attention on all the students. Surprisingly, students with high teacher-reported individual support received somewhat lower teachers' visual focus of attention, such as lower fixation counts, than those with low teacher-reported individual support during math lessons. It could be possible that there were some unpredictable issues in terms of classroom management and student behavior requiring teachers' immediate attention in the form of selective visual focus of attention (Tatler et al., 2014) that could have influenced the teacher's cognitive load (Prieto et al., 2017). Additionally, there were students in this classroom who were noticed more by the teacher, despite their low teacher-reported individual support in math skills. This appears to be in line with previous research by Goldberg et al. (2021) suggesting that irrespective of students' academic skill levels, teachers' visual focus of attention could be more often directed toward students showing interactive learning-related behaviors that support the progress of classroom instruction rather than those students who showed disruptive behavior and may interrupt the lesson.

In the low teacher individual support classroom, there were no significant variations in the teacher's visual focus of attention between students from the high and low teacher-reported individual support groups. This could be due to the fewer students with high teacher-reported individual support in this classroom. The teacher focused their visual attention on some students more times despite their low teacher individual support in math, similar to the teacher in the high teacher individual support classroom. As Haataja et al. (2019) showed,

teachers tend to look more times at students when they provide encouragement and motivation toward the task in a math lesson. It is possible that the teacher in this classroom needs to engage and interact with other students more than students with high teacher-reported individual support. Therefore, it is important to note that the teacher probably does not only look at students based on their individual support in academics, but also interacts with them during lessons. This could be in line with previous research showing that younger students in elementary school could attract more visual cues from the teacher by showing interactive (Goldberg et al., 2021) or disruptive behavior (Wolff et al., 2016; Yamamoto & Imai-Matsumura, 2013). Previous research has shown that teachers' visual focus of attention is more on those students to whom they provide individual feedback (Cortina et al., 2015). It is also possible that the teacher intentionally tried to focus her visual attention more comparably on the group of high teacher individual support students. However, the low math skill level and low teacher-reported individual support for students in this classroom could suggest that there could be a difference between the actual students' requirements and the teacher's individual support in math skills that is rendered to the students.

These examples explain some possibilities of the variation in teachers' visual focus of attention with respect to the amount of high and low teacher individual support for students in the classroom; however, more in-depth investigation is required to learn about the challenges and scope of improving teachers' visual focus of attention in such classrooms.

4.1. Implications of the study

Currently, there is not much known about how teachers notice important student-related cues and events while teaching; thus, the present study makes a significant contribution to this area of research. Eye-tracking studies have provided important insights into potential objectives for teachers' professional development, such as (a) describing a classroom situation that encourages teachers to improve their identification of teaching and learning components, (b) helping teachers to explain and practice reasoning about a situation, and (c) helping teachers to predict classroom events by encouraging them to apply their knowledge in practice (Seidel et al., 2020; Seidel & Stürmer, 2014). The present study could also open discussions and reflections related to teachers' noticed areas in the classroom for improving teachers' individual support for students and basic academic skills during pre- and in-service programs. Both student teachers and experienced teachers can benefit from knowing their visual focus of attention patterns in the classroom and whether they attend to all students who require their attention and support in relation to their learning and behavior. Therefore, eye-tracking could be used in teacher training to generate awareness of their visual focus of attention in the classroom environment in authentic settings among pre- and in-service teachers. In addition, this knowledge could be used to identify the resources needed to engage students (e.g., special needs educators or teaching assistants) and enhance the relevance of in-service training for teachers in terms of teachers' awareness of the support to be rendered to students in the classroom.

4.2. Limitations and future research directions

The present study has some limitations, but it also offers prospects for further research. First, in the present study, mobile eye-tracking technology could have been affected by contextual factors in the classroom. For example, the teachers' characteristics, such as age, teaching experience, stress levels, and work engagement, and the classrooms' characteristics, such as physical space, time in the school day, and lighting, could have influenced the teachers' visual focus of attention. Future studies might want to investigate the role of classroom-related and teacher-related factors in teacher visual focus of attention in more detail. Second, the teachers participated voluntarily irrespective of their age and work experience, and teaching experience was not controlled for in the analyses. Although the teachers' work experience was not related to their visual focus of attention parameters in the current study, future studies could investigate the role of work experience as prior research has shown a link between teachers' professional vision and work experience (Gegenfurtner et al., 2020; Keller et al., 2021; Seidel & Stürmer, 2014; van den Bogert et al., 2014). Third, this study was a cross-sectional investigation of teachers' visual focus of attention, students' basic academic skills, and their teacher-rated individual support for students. A longitudinal approach from fall to spring in one academic year or more could provide an insight into how teachers' visual focus of attention may vary based on changing teachers' individual support for students and their academic development. Fourth, teachers' visual focus of attention needs to be carefully separated from the amount of teacher individual support actually rendered to students. While attention is necessary for specific actions, noticing the student-related individual support alone may not be sufficient for teachers to effectively manage the classroom and achieve the learning objectives. Thus, further research is needed to investigate teachers' visual focus of attention as a mediating factor between perceived student needs and teacher support for individual students and their learning. Fifth, the present study showed that teachers' visual focus of attention is associated with students' academic performance and teachers' individual support for students. However, students and teachers' actual behaviors during the eye-tracking recording were not described in the analyses, which could be considered a limitation. Therefore, in the future, researchers could investigate actual teacher and student behaviors in relation to visual focus of attention, for example, what behaviors the students show at the respective moment of teacher fixation and whether these behaviors differ between students with low or high individual support from the teacher. In addition to student behavior, teachers' visual focus of attention should be studied in combination with other student characteristics in future research, such as temperament, motivation, self-regulation skills, and social skills since they might relate to students' academic performance in early school years. Sixth, in this study, the relationship between teachers' visual focus of attention, students' basic academic skills and teachers' individual support for students were not analyzed separately for math and literacy. In future research, differentiating between the teachers' visual focus of attention across different subjects would be interesting to show potential subject-specific variations in terms of teachers' visual focus of attention and individual support for students. Seventh, since only literacy and math skills without the involvement of students' behavior and self-regulation were considered, the type of support provided by the teacher may therefore not have been clear since literacy and math skills are not the only issue involved in determining teachers' individual support for students. Eighth, in the present study, teachers' visual focus of attention was measured for only 20–25 min during a lesson and teachers' individual support was measured only for the general support the teacher provided to the students. Therefore, it may not be suitable to make robust inferences using the case studies based on only two classrooms. Finally, the case-studies provided detailed demonstration on how teachers' visual focus of attention can vary during math lessons among students with different skills and teachers' individual support for students. However, in future research, the verbal communication during the eye-tracking recordings should also be considered in order to explain the teachers' visual focus of attention in more detail. In the future, verbal communication needs to be examined in combination with eye movements for a comprehensive understanding of the teacher's pedagogical actions. Further examination of individual support from the perspective of special needs could add to the understanding of teachers' changing visual focus of attention in the classroom as well. For example, the case of comorbidity among students with special needs could also influence the nature of individual support provided to the student in specific situations. Further studies could also examine teachers' quality of instructional support and the challenges and opportunities in high teacher individual support classrooms in

relation to teachers' visual focus of attention.

4.3. Conclusions

The findings of this study indicate that teachers' visual focus of attention is associated with the students' basic academic skills and the individual support provided by the teachers. However, there seems to be a variation in relation to teachers' visual focus of attention depending on how much individual teacher support the students receive. We found that teachers' visual focus of attention, in terms of fixation counts, was associated positively with teachers' individual support for students and negatively with students' basic academic skills. In addition, attention should be paid to the classroom population to ensure that they include a manageable ratio of students with different needs so that the teacher will be able to provide them with the required attention. Further investigation of these findings is needed to gain a better understanding of various student characteristics that could influence teachers' visual focus of attention in the classroom.

Declaration of competing interest

We wish to confirm that there are no known conflicts of interest associated with this publication that could have appeared to influence the work reported in this paper.

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Appendix 1

Descriptive scores of students' math skill, teacher's individual support for students in math skills and teacher's visual focus of attention in higher teacher individual support classroom.

	Math skills (BAT; Aunola & Räsänen, 2007)	Teachers' Individual Support in Math (Silinskas et al., 2015)	Total fixation duration (ms)	Average fixation duration (ms)	Fixation counts
Student 1	11	1.66	9934	473	21
Student 4	18	1.66	26,925	528	51
Student 6	16	1	16,790	525	32
Student 13	19	1	11,653	486	24
Student 14	14	1.33	46,693	599	78
Student 7	14	2	20,728	768	27
Student 2	*12*	*5*	*34,560*	*596*	*58*
Student 3	*9*	*4*	*11,333*	*567*	*20*
Student 5	*11*	*4*	*1259*	*252*	*5*
Student 8	*7*	*4.5*	*19,009*	*404*	*47*
Student 9	*10*	*4.33*	*3078*	*308*	*10*
Student 10	*16*	*4*	*7096*	*417*	*17*
Student 11	*2*	*4.33*	*18,629*	*454*	*41*
Student 12	*10*	*3.66*	*12,433*	*414*	*30*

Note. *Student.* Those students who had higher than overall average scores for teachers' individual support in math.

Appendix 2

Descriptive scores of students' math skill levels, teacher's individual support of students in math skills and teacher's visual focus of attention in low teacher individual support classroom.

	Math score (BAT; Aunola & Räsänen, 2007)	Teachers' Individual Support in Math (Silinskas et al., 2015)	Total fixation duration (ms)	Average fixation duration (ms)	Fixation counts
Student 1	9	1.67	760	127	6
Student 2	7	1	9774	407	24
Student 3	21	1	20,448	330	62
Student 4	10	1.33	12,932	497	26
Student 5	10	1.67	5977	299	20
Student 6	10	1.67	3838	320	12
Student 7	9	1	20,608	438	47
Student 8	7	1.67	24,066	270	89
Student 10	6	1	11,153	372	30
Student 11	8	1.67	5437	362	15
Student 12	10	1.33	7795	339	23
Student 13	24	1	5757	274	21
Student 15	9	1	5697	407	14
Student 16	5	1.67	19,009	333	57
Student 17	12	1.67	23,186	414	56
Student 18	10	1	3858	257	15
Student 19	12	2	8575	330	26
Student 20	7	1	14,432	278	52

(*continued on next page*)

(*continued*)

	Math score (BAT; Aunola & Räsänen, 2007)	Teachers' Individual Support in Math (Silinskas et al., 2015)	Total fixation duration (ms)	Average fixation duration (ms)	Fixation counts
Student 22	6	2.67	11,593	331	35
Student 9	*5*	*4.33*	*12,313*	*316*	*39*
Student 14	*4*	*3.67*	*26,604*	*739*	*36*
Student 21	*8*	*4.33*	*8295*	*268*	*31*

Note. *Student.* Those students who had higher than overall average scores for teachers' individual support in math.

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III

ASSOCIATION BETWEEN THE TEACHER–STUDENT RELATIONSHIP AND TEACHER VISUAL FOCUS OF ATTENTION IN GRADE 1: STUDENT TASK AVOIDANCE AND GENDER AS MODERATORS

by

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