Author(s): Muhonen, Heli; Pakarinen, Eija; Lerkkanen, Marja-Kristiina

Title: Do teachers' professional vision and teaching experience always go hand in hand? Examining knowledge-based reasoning of Finnish Grade 1 teachers

Year: 2021

Version: Published version

Please cite the original version:

Muhonen, H., Pakarinen, E., & Lerkkanen, M.-K. (2021). Do teachers' professional vision and teaching experience always go hand in hand? Examining knowledge-based reasoning of Finnish Grade 1 teachers. Teaching and Teacher Education, 106, Article 103458. https://doi.org/10.1016/j.tate.2021.103458

Teaching and Teacher Education 106 (2021) 103458

Contents lists available at ScienceDirect

Teaching and Teacher Education

journal homepage: www.elsevier.com/locate/tate

Do teachers' professional vision and teaching experience always go hand in hand? Examining knowledge-based reasoning of Finnish Grade 1 teachers

Heli Muhonen*, Eija Pakarinen, Marja-Kristiina Lerkkanen

Department of Teacher Education, University of Jyväskylä, P.O. Box 35, 40014, Jyväskylä, Finland

HIGHLIGHTS

- 54 Finnish Grade 1 teachers reasoned eye-tracking videos of classroom actions.
- Teachers' professional vision in relation to teaching experience was explored.
- Teaching experience correlated negatively with knowledge-based reasoning.
- Three teachers with differing amounts of experience were examined qualitatively.
- The qualitative examination provided concrete examples and broadened the findings.

ARTICLE INFO

Article history:
Received 17 February 2021
Received in revised form
10 May 2021
Accepted 10 July 2021
Available online xxx

Keywords:
Teachers' professional vision
Knowledge-based reasoning
Teaching experience
Retrospective think-aloud interview
Mixed-method research

ABSTRACT

This mixed-method study explored 54 Finnish Grade 1 teachers' professional vision and teaching experience. Teachers' retrospective think-aloud interviews, conducted while watching their eye-tracking recordings of classroom actions, were analysed according to the domains of knowledge-based reasoning. Negative associations between teaching experience and amount of knowledge-based reasoning were found. The qualitative examination of three teachers with different amounts of teaching experience provided concrete examples and broadened the findings. We suggest that teachers' knowledge-based reasoning should be seen not only as an ability that increases with experience but also as an ability that can be trained in early career stage.

1. Introduction

Teachers' professional vision is acknowledged as one of the key factors reflecting teachers' performance and expertise (Goodwin, 1994; Seidel & Stürmer, 2014). Teachers' professional vision has been conceptualised as their use of professional knowledge through two domains: first to *notice* meaningful features of classroom situations and then to engage in *knowledge-based reasoning* to interpret and reason about the noticed information (Berliner, 2001; Seidel & Stürmer, 2014; Sherin & van Es, 2009). Prior research on teachers' professional vision has been especially interested in investigating the development of professional vision in relation to teaching experience, which starts building from teachers' pre-service training and continues to their early, mid and late in-service career (Berger et al., 2018). Based on multiple prior studies, it has been suggested that teacher expertise is associated with elaborated knowledge-based reasoning of classroom situations (e.g., Kim & Klassen, 2018; Meschede et al., 2017; Schäfer & Seidel, 2015). Compared to novice teachers, expert teachers have been shown to have more contextualised and advanced classroom knowledge and to be more capable of integrating their knowledge into multidimensional classroom events (Berliner, 2001; Carter et al., 1988; Hattie, 2003).

Despite the multiple studies on teachers' professional vision and expertise, the previous research includes some shortcomings. First, two teacher experience levels (early-career vs. late-career teachers or pre-service vs. in-service teachers) have been predominantly

* Corresponding author.
E-mail addresses: heli.j.muhonen@jyu.fi (H. Muhonen), eija.k.pakarinen@jyu.fi (E. Pakarinen), marja-kristiina.lerkkanen@jyu.fi (M.-K. Lerkkanen).

https://doi.org/10.1016/j.tate.2021.103458

compared when examining teachers' professional vision and cognitive processes. An exception is Kim and Klassen (2018), who investigated the teachers of three experience levels and suggested that studying teachers with more than two experience levels, as well as utilising both the quantitative and qualitative analysis approaches, are needed in order to gain a richer and more nuanced understanding of teachers' professional development. A second shortcoming is that the prior research has been especially interested in investigating the development of teachers' professional vision through special training programs and courses of pre- and in-service teachers (e.g., Santagata, 2009; Sherin & van Es, 2009; Stürmer et al., 2013; van Es & Sherin, 2008). In these studies, the quality and development of teachers' professional vision was measured by having teachers observe and comment on video recordings of other people's teaching. The findings showed that systematic observation of teaching fosters the development of the teachers' professional vision. However, there are significantly fewer studies that have utilised video recordings of teachers' own classroom actions. One of the few studies of this kind is Seidel et al. (2011), who found that teachers who watched video clips of their own teaching noticed more meaningful components of teaching and learning but were less self-reflective in reasoning their critical events compared to teachers who watched other teachers' teaching. In recent years, in addition to the interventional approach, the innovative research methodology of eye-tracking has been utilised to study teachers' professional vision. These studies have shown that compared to novice teachers, expert teachers are more able to distribute their attention evenly across the classroom (van den Bogert et al., 2014) and monitor it consistently (Cortina et al., 2015), and they are less distracted by task-irrelevant classroom events (McIntyre & Foulsham, 2018). Eye-tracking methodology has been predominantly utilised to study teachers' professional vision in terms of their noticing, but there are hardly any studies which have utilised eye-tracking together with interviews to study teachers' knowledge-based reasoning (as an exception, see Muhonen et al., 2021).

The present study aims to address this research gap by utilising the mixed-method approach to first investigate the associations between the different domains of teachers' knowledge-based reasoning and work experience (little, sample average and long teaching experience) and then to qualitatively describe how three teachers with different amounts of teaching experience reason about their classroom actions in terms of these different domains. The study utilises mobile eye-tracking to enable teachers to watch their own eye-tracking recordings and comment on their classroom actions and focus of attention during the observation.

1.1. Teachers' professional vision and knowledge-based reasoning

Stemming from Goodwin's (1994) concept of professional vision, teachers' professional vision describes teachers' ability to perceive and make sense of relevant classroom situations (Berliner, 2001; Sherin, 2001; Star & Strickland, 2008). It is one of the key components of teachers' professional competence, since teachers need to pay attention to situations which foster or prevent students' learning in order to be able to reflect on and respond to them (Hammerness et al., 2002). Although the definitions of teachers' professional vision vary to some extent, they all include two main components: *noticing* and *knowledge-based reasoning* (van Es & Sherin, 2002). Teachers' ability to *notice* describes how they pay attention to situations in the classrooms that are meaningful for teaching and learning (Seidel & Stürmer, 2014). The present study focuses on exploring the second component of teachers' professional vision, *knowledge-based reasoning*, in which teachers use their existing knowledge to interpret the situations they notice (Blomberg et al., 2011).

Prior research has predominantly conceptualised teachers' knowledge-based reasoning by differentiating between three qualitatively different domains: description, explanation, and prediction (e.g., Berliner, 2001; Borko et al., 2008; Seidel et al., 2011; Sherin & van Es, 2009). In *describing,* teachers talk about their classroom observations and share information, without further evaluation or argumentation (Seidel et al., 2017). For example, teachers might simply verbalise that they see students writing down their homework. In *explaining,* teachers use their professional knowledge in order to reason about or justify the classroom situations (Schäfer & Seidel, 2015). For example, teachers might verbalise that they chose to work with the students individually to be able observe their pronunciation more accurately. Lastly, through *prediction,* teachers draw conclusions about what might happen in the future in the classroom (for instance, how students will learn), thus linking the noticed situations with their broader professional views of teaching and learning (Seidel & Stürmer, 2014). For instance, a teacher might verbalise that based on the current situation and skills of the students, they will learn to read within the next couple of months. Previous studies have shown that teachers predominantly utilise description in their knowledge-based reasoning and have more difficulties with explaining and predicting (Muhonen et al., 2021; Oser et al., 2010). In fact, explanation and prediction have been suggested as the more challenging domains of knowledge-based reasoning for teachers, with prediction being the most challenging (Seidel & Stürmer, 2014).

Studies on teachers' professional vision have framed it as pedagogical competence that is vital for achieving high levels of teaching quality (Gegenfurtner et al., 2020). Ideally, professional vision is teachers' ability to transfer knowledge about pedagogical principles and concepts to authentic classroom situations and to relate them to their instructional support (Stürmer et al., 2013). Prior research has shown that teachers' professional vision links with their instructional quality and consequently with student learning (Kersting et al., 2012; Roth et al., 2011; Sherin & van Es, 2009). It has also been reported that effective teachers' professional vision is oriented toward supporting teacher-student interactions and differentiated instruction (Keppens et al., 2019). These findings support the view that professional vision is a distinctive feature of expertise (Sabers et al., 1991).

1.2. Teaching experience and expertise

Teacher expertise and teaching experience are often used parallel to each other despite of their differences. The common assumption is that the length of teaching experience promotes teachers' effectiveness, knowledge and skills (King Rice, 2013). It has been suggested that teachers experience significant mastery progression especially in their early career stage (first 5–10 years of teaching experience) (King Rice, 2013), but in some cases also in their late career stage (30–39 years of teaching experience) (Berger et al., 2018; Huberman, 1992). Regarding the definition of occupational expertise, expertise builds on person's work-related knowledge that accumulates over long periods of time, during which correct and incorrect skill application and problem solving has been experienced (Cornford & Athanasou, 1995). Based on this definition, the length of teaching itself does not guarantee the level of expertise but it is also the quality of the experience that matters. However, it is important to acknowledge, that in the present study, teachers' expertise was measured only in terms of teachers' teaching experience.

In the very early stage of career, the learning process of novices is found to be time consuming, but the abilities to process relevant

information gain as the skills are practised and schemas are built to process information efficiently (Clark & Feldon, 2005; Schön, 1987). Over time, as the automated knowledge of experts grows and takes less space in their working memory, experts tend to experience less cognitive load in their performance compared to their novice colleagues (Brown & Bennett, 2002; Feldon, 2007). Therefore, based on their teaching experience, teachers may possess different abilities to process relevant teaching and learning related information in their classrooms (Feldon, 2007).

1.3. Teaching experience and professional vision

A large number of the previous studies on teachers' professional vision have been interested in studying the links between professional vision, teaching experience, and professional development (e.g., Gegenfurtner et al., 2020; Sherin, 2001; Sherin & van Es, 2009). The prior research suggests that professional vision is a skill that develops and increases when a teacher's expertise grows (Gegenfurtner et al., 2020; Lehtinen et al., 2020). Teachers with long teaching experience have been found to demonstrate more advanced professional vision and ability to process classroom information as compared to their novice colleagues (Berliner, 2001; Gegenfurtner et al., 2020; Meschede et al., 2017; Seidel & Prenzel, 2007). Studies focusing on teacher cognition have shown that expert teachers are more capable of noticing situations selectively, and they interpret those situations more accurately and holistically as compared to novice teachers (Borko & Livingston, 1989; Palmeri et al., 2004). It is suggested that expert teachers have a rich repertoire of classroom knowledge, which they utilise to explain and understand classroom phenomena (Carter et al., 1988). On the other hand, teachers in the early stages of their career (including pre-service teachers) have been found to have more limited knowledge of how to notice and interpret complex classroom events, without special training (Stürmer et al., 2013). Moreover, it has been suggested that novice teachers are more likely to experience cognitive overload in highly complex classroom situations due to their lack of experience (Kim & Klassen, 2018).

Also, in terms of the three domains of knowledge-based reasoning, differences based on teaching experience have been found. For example, prior studies have shown that expert teachers often describe concerns related to teaching and learning when analysing classroom events, whereas novice teachers tend to describe concerns related to teacher and student characteristics, behaviour, and disciplinary issues (Tsui, 2003). In addition, novice teachers have been found to struggle with explaining and predicting in their knowledge-based reasoning (Oser et al., 2010). The study of Gegenfurtner et al. (2020) showed that in-service teachers utilised more explanation in their knowledge-based reasoning compared to pre-service teachers. Further, it was found that in their reasoning, the in-service teachers used more self-monitoring and more predictions of teacher actions than the pre-service teachers.

1.4. The aim of the study

Based on the prior research, teaching experience and professional vision are seen as walking hand in hand. Hardly any studies have shown contradictory results. Prior studies have been conducted predominantly through the interventional approach to study teacher development or to compare two teacher experience levels. However, utilising authentic (non-interventional) classroom data of teachers in diverse career stages and combining both qualitative and quantitative analysis of knowledge-based reasoning can provide more in-depth insight into the phenomenon of teachers' professional vision. Therefore, the present mixed-method study aims to broaden the understanding of teachers' professional vision by posing the following two research questions:

1. To what extent are the different domains of teachers' knowledge-based reasoning associated with teachers' work experience?
2. How do teachers with different amounts of teaching experience reason about their eye-tracking recordings in terms of description, explanation, and prediction?

2. Methods

2.1. Participants

The present study is part of a larger longitudinal research study focusing on Finnish primary school teachers, students, and their parents (Lerkkanen & Pakarinen, 2017-2022). The research project was reviewed and received ethical approval from the university's Ethics Committee in 2017. Both the teachers and the children's parents gave their written consent for their participation in the study prior to the data collection. The guidelines of the university's Ethics Committee were carefully followed during the data processing, and the video recordings and questionnaires were made anonymous.

The study sample consisted of 54 Finnish Grade 1 teachers (50 females, 4 males) and their students. On average, the teachers were 44.6 years old, and all had a master's degree in education, which is a requirement for primary school teachers in Finland. The students ($n = 780$) were approximately seven years old, and 49% of them were girls. The education of the students' parents ($n = 577$) varied from no vocational education to a doctorate (*Mode* = vocational school degree of 12 years' education), representing the typical parental education distribution in Finland. The data collection was conducted in the fall of 2017, a couple of months after the students had entered primary school. On average, there were 17.8 students (minimum 6, maximum 23) present in the classroom during the eye-tracking video recordings. This number reflects the typical average size of a Finnish Grade 1 class.

2.2. Measures and procedure

Eye-tracking video recordings. Eye-tracking 20-min video recordings were conducted in each participating teacher's classroom during one lesson on a normal school day. The teachers wore a Tobii Pro Glasses 2 mobile eye-tracking device that collected both the visual data of the teachers' focus of attention and the audio data of the classroom interactions. Before the recording, two trained research assistants set and calibrated the eye-tracking glasses, using a one-point calibration. The accuracy of the calibration and the data analysis was confirmed by research assistants who asked the teacher to look at three set points on the wall at the beginning of the video recording to verify that the teachers' gaze met the three points. It was also confirmed that each teacher felt comfortable wearing the classes and natural moving around the classroom during the recording. The research assistant removed the equipment from the teacher after the 20 min of recording. Regarding the apparatus, the sampling rate of the Tobii Pro Glasses 2 eye tracker was 50 Hz (25 frames per second). The eye tracker yielded a 1920×1080 pixels video capturing 52° vertically and 82° horizontally.

Retrospective think-aloud (RTA) interviews. After the eye-tracking video recordings, the teachers were invited to watch their own 20-min recording in the company of a research assistant. In this RTA interview, the teachers were asked to recall what they were thinking during the eye-tracking recording and explain why

they acted the way they did. All the teachers received precisely the same instructions, and no additional questions (clarifying or expanding ones) were asked while watching the video. The recordings of the RTA interviews were conducted by a trained research assistant using Screencast-*O*-Matic software, which records both audio and visual data. A similar type of RTA-interview protocol has been suggested in previous eye-tracking studies (see e.g., Guan et al., 2006; Hyrskykari et al., 2008) for gathering information on a participant's thought process, especially their reasoning and intentions. At the end of the interview, the teachers were asked about their experience of wearing the mobile eye-tracking device. Majority of the teachers responded having a neutral or pleasant experience, and that wearing the eye-tracking device did not have much effect on their teaching or classroom choices.

Teacher work experience. The teachers completed a questionnaire in which they reported their years of teaching experience in primary schools. On average, the teachers had 16.08 years of teaching experience (SD = 9.43), which varied from a minimum of 0.5 years to a maximum of 39 years. For one teacher (out of a total 54), the information on teaching experience was missing.

2.3. Analysis

Qualitative analysis of the RTA interviews. In the first analysis phase, the teachers' knowledge-based reasoning was examined in the RTA interviews through their reflections, reasoning, and intentions related to their focus of attention and classroom actions. In the beginning, the 54 teachers' RTA interview recordings were transcribed by trained research assistants, and the analysis of the transcripts was conducted with Atlas. ti software. The first author was responsible for the analysis, although research triangulation was applied among the research team when needed. The researcher started the analysis process by reading through the transcripts in order to verify their quality and accuracy and to get an overview of the data. Next, the analysis units were identified and coded according to the domains of knowledge-based reasoning by applying the analysis framework based on the previous work of the research team (see Muhonen et al., 2021). The analysis framework was built on the concept of teachers' knowledge-based reasoning and its three domains, as suggested in the prior research (e.g., Seidel & Stürmer, 2014; Sherin & van Es, 2009): 1) description (teacher's ability to identify, differentiate, and classify teaching and learning components); 2) explanation (teacher's ability to link the observed classroom situation to professional knowledge); and 3) prediction (teacher's ability to use professional knowledge to forecast learning-related consequences). In addition to the three main domains, the framework included sub-levels for the domains, which were driven from the data in the research team's previous research (see Muhonen et al., 2021). Fig. 1 presents the structure of the analysis framework. The analysis units were defined as separate statements or thoughts of the teachers and were coded individually. The content of the teachers' statements could include their thoughts about themselves, the students, school in general, etc.

After identifying each analysis unit, the researcher made a decision as to whether the unit statement represented the domain of description, explanation, or prediction. Analysis units representing description occurred the most frequently in the sample and included the largest variety of information. Therefore, they were coded into two sub-levels. The first sub-level examined the *focus* of the teacher's description—whether the description statement focused on current teacher action, current student action, current joint action (teacher and student together), teacher-related information/elaboration (teacher's goals, strategies, beliefs, feelings), student information (student's characteristics, behaviour, skills, social relationships), general classroom information (routines, classroom/school activities and tasks, information about equipment), or teacher self-reflection (realising and noticing own behaviour, elaboration). After coding the focus of the description unit, a second code was given to the same description unit. The second sub-level examined the *content* of the teacher's description, which could relate to pedagogy (educational and pedagogical actions, goals, and strategies), learning/performance/development (academic performance, learning social or behavioural skills, physical development), classroom management/behaviour (classroom management routines and actions, teacher's and students' non-academic behaviour and actions), social relations/emotions (personal characteristics, expressed emotions and interaction), or not applicable (NA; not related to any of the categories). The following are some examples of the coded description units:

> "It is really important for me to activate them as much as I can and invite them towards more dialogic discussion." [description focus of teacher information/elaboration; description content of pedagogy]

> "This buddy here is so clever and really can do his job independently." [description focus of student information; description content of learning/performance/ development]

> "You don't realise how busy it is till you see this." [description focus of teacher self-reflection; description content of classroom management/behaviour]

The analysis units of teacher explanations were coded within one sub-level: whether teachers provided explanations including *practical knowledge* (explanations for actions or thoughts based on practical explanations and behavioural reasons) or *pedagogical/ conceptual knowledge* (explanations for actions or thoughts based on educational concepts or pedagogical knowledge). The analysis units representing *prediction* (expectations, goals and hopes for student learning, classroom actions and teaching) occurred very infrequently in the sample and, therefore, no sub-level could be determined for them. The following are some examples of the coded explanation and prediction units:

> "I did this only because I wanted to get them quickly and efficiently to the classroom." [explanation with practical knowledge]

> "It is important to practise this every day since knowing addition and subtraction creates the basis for students' later math skills." [explanation with pedagogical/ conceptual knowledge]

> "I have high expectations for the students to start doing this independently at some point." [prediction]

Twenty percent of the teachers' RTA interview transcripts (n = 11) were double-coded by a second person to ensure the reliability of the analysis. This was done in such a way that the second rater gave codes to the analysis units predetermined by the main rater. The inter-rater reliabilities for each code type were calculated as intraclass correlation coefficients (ICC). The ICCs were found to range between 0.72 and 0.98, therefore suggesting a substantial level of agreement. For a more detailed description of the sub-levels of teachers' knowledge-based reasoning and their analysis unit examples, see Appendix 1.

Quantitative analysis of teachers' knowledge-based reasoning and teaching experience. After identifying the analysis units and coding them among the domains and sub-levels of knowledge-based reasoning, Pearson correlation analysis was utilised to

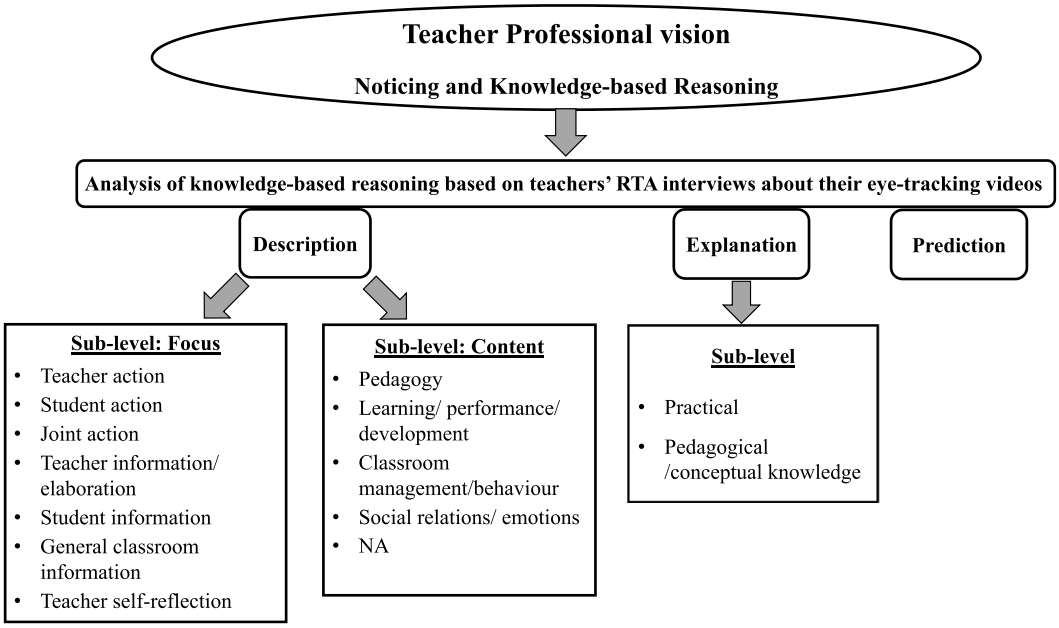

Fig. 1. Structure of the analysis framework of teachers' knowledge-based reasoning (Muhonen et al., 2021).

examine the correlations between teaching experience and the different domains and sub-levels of knowledge-based reasoning. The correlation analysis was conducted using IBM SPSS Statistics 26.

Identifying three groups of teachers with different amounts of teaching experience. The final phase of the analysis was to identify three groups of teachers with different amounts of teaching experience (little, sample average and long teaching experience) in order to explore their knowledge-based reasoning in more detail. From each teacher group, one teacher was selected as an example case of the group. The three teachers were randomly selected by casting lots. *The teacher with little teaching experience* was drawn from the group of teachers having more than −1 standard deviation teaching experience from the sample average of 16.08 years. This means that in this group teachers had less than 6.65 years of teaching experience. *The teacher with sample average teaching experience* was drawn from the group of teachers having ± 1 standard deviation teaching experience from the sample average of 16.08 years. This means that in this group teachers' teaching experience varied between 6.65 and 25.52 years. *The teacher with long teaching experience* was drawn from the group of teachers having more than +1 standard deviation of teaching experience from the sample average of 16.08 years. This means that in this group teachers had more than 25.52 years of teaching experience. Descriptive information of the three teacher groups and detailed descriptions of the selected three teachers' knowledge-based reasoning, along with excerpts, are provided in the results section.

3. Results

3.1. Associations between teachers' knowledge-based reasoning and teaching experience

The first research question examined the extent to which the different domains of teachers' knowledge-based reasoning associate with teachers' work experience. Descriptive information regarding the three domains of teachers' knowledge-based reasoning and their sub-levels are presented in Table 1. The teachers reflected on their eye-tracking recordings predominantly through description (4996 units) and utilised explanation (507 units) and prediction (10 units) less frequently.

Overall, the Pearson correlation analysis showed a marginally significant negative association between the number of analysis units per teacher and the teaching experience ($r = -0.266$, $p = .054$), meaning that the more experienced the teachers were, the less they reasoned their eye-tracking recording, and vice versa. The correlation analysis also showed several negative associations between teachers' work experience and the different domains and sub-levels of knowledge-based reasoning (see Table 2). Teaching experience was found to correlate negatively with the overall use of description ($r = -0.273$, $p = .048$). In addition, several marginally significant correlations were found: teaching experience correlated negatively with teachers' description focus on student information ($r = -0.245$, $p = .077$) and teacher self-reflection ($r = -0.242$, $p = .080$). There was also a marginally significant negative association between teaching experience and the description content of pedagogy ($r = -0.271$, $p = .050$), classroom management/behaviour ($r = -0.242$, $p = .080$), and teachers' use of pedagogical/conceptual explanation ($r = -0.243$, $p = .079$).

3.2. Teachers with different amounts of teaching experience and their knowledge-based reasoning

While the first part of the results section showed interesting negative correlations between teachers' work experience and their knowledge-based reasoning, the second research question focused on describing in more detail how teachers with different amounts of teaching experience reason about their eye-tracking recordings in terms of description, explanation, and prediction. Three groups of teachers with different amount of teaching experience were identified: teachers with little teaching experience ($n = 12$), teachers with sample average teaching experience ($n = 28$) and teachers with long teaching experience ($n = 13$), Table 2 shows the descriptive information of the three teacher groups with respect to the domains of knowledge-based reasoning.

From each teacher group, one teacher was randomly selected to

Table 1
Descriptive information of the total sample (n = 54) knowledge-based reasoning and correlations between teaching experience and knowledge-based reasoning.

	Units	Unit mean per teacher	Std. Deviation	Correlations with teaching experience
Description				
Description focus				
Teacher action	478	8.85	10.113	-.195
Student action	391	7.24	6.466	-.214
Joint action	152	2.81	3.650	.034
Teacher information/elaboration	1729	32.02	20.805	-.198
Student information	1609	29.80	20.124	-.245†
General classroom information	231	4.26	5.003	-.183
Teacher self-reflection	406	7.54	5.907	-.242†
Total	4996	92.52	12.28	-.273*
Description content				
Pedagogy	1235	22.87	20.128	-.271†
Learning/performance/development	1212	22.44	16.015	-.166
Classroom management/behaviour	2014	37.30	20.073	-.242†
Social relations/emotions	420	7.78	7.885	-.155
NA	15	2.13	2.488	-.112
Total	4996	92.52	13.88	-.273*
Explanation				
Practical	224	4.15	3.310	.052
Conceptual/pedagogical	283	5.24	4.287	-.243†
Total	507	9.34	6.01	-.144
Prediction	10	.19	.479	.164

Note. ***p < .001, **p < .01, *p < .05, †p < .08.

Table 2
Descriptive information of knowledge-based reasoning among three teacher groups with different amounts of teaching experience.

	Teachers with little teaching experience[a] (n = 12)		Teachers with sample average teaching experience (n = 28)		Teachers with long teaching experience[a] (n = 13)	
	Mean[b]	Std. Deviation	Mean[b]	Std. Deviation	Mean[b]	Std. Deviation
Description focus						
Teacher action	13.75	16.074	8.14	8.077	5.77	5.703
Student action	9.50	8.118	7.00	5.944	6.23	5.833
Joint action	2.58	3.679	2.68	3.497	3.54	4.196
Teacher information/elaboration	39.67	31.701	30.43	17.175	29.31	15.569
Student information	38.92	29.250	28.57	17.854	25.08	12.665
General classroom information	6.00	8.975	3.93	3.495	3.08	1.801
Teacher self-reflection	9.25	5.691	8.25	6.216	4.85	4.688
Total	119.67	15.547	89.00	11.666	77.86	11.103
Description content						
Pedagogy	34.67	33.824	20.64	13.687	17.77	11.159
Learning/performance/development	30.34	26.519	20.50	10.892	20.63	11.412
Classroom management/behaviour	44.33	27.988	36.86	18.129	32.00	15.519
Social relations/emotions	7.83	6.250	8.89	9.886	5.54	3.152
NA	2.50	2.939	2.11	2.644	1.92	1.847
Total	119.67	17.965	89.00	13.268	77.86	12.117
Explanation						
Practical	4.42	3.502	3.39	2.671	5.38	4.214
Conceptual/pedagogical	7.75	6.240	4.54	3.605	4.38	2.815
Total	12.17	7.861	7.91	4.734	9.77	6.234
Prediction	0.33	0.778	0.18	0.390	0.08	0.277

Note.
[a] In relation to sample average.
[b] Unit mean per teacher.

serve as an example case representing the group. In this section, the three example cases of teachers with different amounts of teaching experience are presented by describing their use of knowledge-based reasoning and giving concrete excerpts of their reasoning. Table 3 shows the number of analysis units representing the domains of knowledge-based reasoning among the three teacher cases: a teacher with little teaching experience, a teacher with sample average teaching experience, and a teacher with long teaching experience.

3.2.1. Teacher with little teaching experience

The first case teacher was one of the least experienced primary school teachers (6 months' experience) in the sample. However, she was a qualified kindergarten teacher and had some previous work experience in kindergarten. In her class, there were 21 students (11 boys and 10 girls), of which four were reported to need special support in learning, and three students needed special support with behavioural and socioemotional challenges. The eye-tracking recording was conducted during a whole-class math lesson.

Overall, the teacher with little teaching experience in primary school reasoned her eye-tracking recording relatively broadly and,

Table 3
Descriptive information of the three example teachers with different amounts of teaching experience and their knowledge-based reasoning.

	Teacher with little teaching experience	Teacher with sample average teaching experience	Teacher with long teaching experience
Description focus			
Teacher action	2	6	2
Student action	9	11	0
Joint action	0	1	1
Teacher information/elaboration	53	20	7
Student information	71	58	16
General classroom information	5	8	1
Teacher self-reflection	7	4	1
Total	147	108	28
Description content			
Pedagogy	43	15	4
Learning/performance/development	64	35	6
Classroom management/behaviour	36	46	9
Social relations/emotions	3	10	7
NA	1	2	2
Total	147	108	28
Explanation			
Practical	2	3	2
Conceptual/pedagogical	8	3	1
Total	10	6	3
Prediction	0	0	0

in total, 157 analysis units were found in her RTA interview. The teacher reasoned her recording predominantly through description (147 units), which was the most common style in the whole study sample. The description focus of the teacher consisted mainly of comments describing student information (71 units) and teacher information/elaboration (53 units), whereas the other types of description focus occurred more infrequently (see Table 2).

Student information: "And then here in the back row are the students that I really know can solve the task themselves."

Teacher information/elaboration: "I have made the seating order by placing the students who need more of my help in front of the class."

Teacher self-reflection: "Next time, I should do better than this and make the written instructions really clear."

Regarding the description content, the teacher shared comments most frequently related to learning/performance/development (64 units), her pedagogy (43 units), and classroom management/behaviour (36 units). The description content related to social relations/emotions was rare (three units), and there were also no applicable comments in this area.

Learning/performance/development: "Even in his sleep he can do these calculations, but for him, the challenge is keeping up with the teaching and staying focused."

Learning/performance/development: "And here the goal was predominantly for them to learn and understand the basic idea of bingo."

Pedagogy: "I thought I could motivate them better toward the task by using iPads."

Classroom management/behaviour: "Usually, I organise this by having them come to the blackboard one at a time."

The teacher's knowledge-based reasoning focused on explaining occurred less frequently during the RTA interview. Out of the total 10 explanation units, the majority (eight units) included conceptual/pedagogical explanations of the teacher's and students' classroom actions. Comments including practical explanations occurred more infrequently (two units), and there were no prediction-related comments found in the RTA interview.

Conceptual/practical explanation: "But now, I made the decision because I wanted to see that each one of them could complete at least one decomposition calculation."

Conceptual/practical explanation: "And of course I feel bad that not all of them can give an answer, but what we are trying to practise here is that it can't always be your turn."

3.2.2. Teacher with sample average teaching experience

The second case teacher had an average amount (16 years) of teaching experience in primary school, and she had worked her entire teaching career in the same school. She had no additional occupational qualifications besides her primary school teacher qualification. In her class, there were 24 students (11 boys and 13 girls), of which nine were reported to need special support in learning, and six students needed special support with behavioural and socioemotional challenges. The eye-tracking recording that the teacher commented on was conducted during a whole-class math lesson.

In the teacher's RTA interview, a total of 114 analysis units were found. In line with the other teachers in the sample, the teacher with sample average teaching experience reasoned her eye-tracking recording predominantly through description (108 units). The description focus of the teacher consisted mainly of comments describing student information (58 units), teacher information/elaboration (20 units), and student action (11 units). The other types of description focus occurred more seldom (see Table 2).

Student information: "These guys are the ones who are often more interested in the papers of others."

Teacher information/elaboration: "And, for many educational activities, I think it is good to work collectively together."

Student action: "Those [C17] and [C15] are just messing around there."

The description content of the teacher with sample average teaching experience consisted mostly of comments on classroom management/behaviour (46 units), learning/performance/development (35 units), and pedagogy (15 units). The description content related to pedagogy occurred in 15 analysis units, while the content of social relations/emotions occurred in 10 analysis units, and two comments were not applicable.

Classroom management/behaviour: "It often takes such a long time to get the actual lesson started."

Learning/performance/development: "Quite a lot of them are already able to read the working instructions themselves."

Pedagogy: "We have been practising addition and subtraction, so this is a very basic lesson in which we are training more of this."

The teacher's knowledge-based reasoning related to explaining occurred infrequently during the RTA interview. In total, six units of explanation were found. Three of these units represented conceptual/pedagogical explanations, and three represented practical explanations. In addition, there were no prediction-related comments found in the RTA interview of this teacher.

Practical explanation: "Because it is the winter clothing season now, it takes a long time for the children to get to the classroom, and I always have wait for the last ones."

Conceptual/pedagogical explanation: "That's why we had to practise with their attentiveness a bit more, so they could learn to notice if there is a plus or minus sign in the calculation."

3.2.3. Teacher with long teaching experience

The third case teacher with long teaching experience (39 years) in primary school was one of the most experienced primary school teachers in the sample. She had taught 26 years in her current workplace and had no additional occupational qualifications besides that of primary school teacher. In her class, there were 20 students (10 boys and 10 girls), of which she reported five needed special support in learning, two needed special support with behavioural and socioemotional challenges, and one needed special support with the Finnish language. The eye-tracking recording was conducted during a whole-class literacy lesson.

Overall, the teacher with long teaching experience reasoned her eye-tracking recording scarcely, and she felt uncomfortable watching the video and explaining her actions. In total, 31 analysis units were identified in the RTA interview of this teacher. The teacher reasoned her eye-tracking recording predominantly through description (28 units). Regarding the description focus, the teacher predominantly shared student-related information (16 units). Her description content related to teacher information/elaboration (seven units).

Student information: "[C2] is very active in raising his hand. He very often raises his hand."

Student information: "[C3] is a bit like that, she is in her own world and thoughts."

Teacher information/elaboration: "After all, I thought it was nicer to have the story at the beginning of the lesson than at the end."

The teacher's description content was focused most frequently on classroom management/behaviour of the students (nine units), social relations/emotions (seven units), and learning/performance/development of the students (six units). Description related to the teacher's pedagogy was rare (four units).

Classroom management/behaviour: "See, they wave their legs so vigorously."

Social relations/emotions: "Here in Grade 1, things like that can turn into broad conversations. If you let them carry on, it can turn into a long story in which they all want to share their thoughts."

Learning/performance/development: "[C17] doesn't know how to say phone K, so his speech is a bit unclear."

As the teacher's knowledge-based reasoning was predominantly focused on description, the domains of explanation and prediction remained scant. Explanation units occurred only three times during the interview, and there was no prediction found.

4. Discussion

The present study aimed to investigate teachers' professional vision in relation to teaching experience in primary school. Finnish Grade 1 teachers' RTA interviews were analysed in terms of the domains of knowledge-based reasoning and examined both quantitatively and qualitatively. Teaching experience was found to correlate negatively with the amount of knowledge-based reasoning and also with the different domains and sub-levels of knowledge-based reasoning. The qualitative descriptions of three cases of teachers with different amounts of teaching experience provided concrete examples of teachers' knowledge-based reasoning and broadened the findings. The teacher with little teaching experience was found to reason her eye-tracking recording broadly and diversely, whereas the teacher with long teaching experience reasoned her eye-tracking recording scarcely in terms of the three domains of knowledge-based reasoning.

Based on the first research question, the first part of the study investigated the associations between different domains of teachers' knowledge-based reasoning and work experience. Prior research has strongly argued that teachers' professional vision is a skill that increases and develops when their expertise grows (Gegenfurtner et al., 2020; Lehtinen et al., 2020). Several previous studies have shown that compared to their novice colleagues, teachers with extensive teaching experience demonstrate more developed professional vision and ability to process and reason classroom information (e.g., Berliner, 2001; Gegenfurtner et al., 2020; Meschede et al., 2017; Seidel & Prenzel, 2007). However, surprisingly, the findings of the present study of Grade 1 classrooms showed negative associations between teachers' knowledge-based reasoning and teaching experience. Considering the amount of teachers' knowledge-based reasoning, the results suggest that the more experienced the teachers were, the less they reasoned their classroom actions from the eye-tracking recordings, and vice versa.

It is impossible to provide a definite explanation for this unexpected finding but there are diverse options for explanation. One explanation may link to the current high quality of teacher education in Finland, which has improved over the past decades. In the 1990s (when some of the participating teachers received their teacher training), the teacher training in Finland was criticised for being too normative, and theoretical studies were detached from the reality of the schools (Säntti & Salminen, 2015). Since that time, however, the requirements and quality of teacher education have been significantly raised. Today, primary school teachers in Finland are required to have a master's degree, which requires five to six

years of studies. In addition, although the universities can independently decide on the content of their teacher education, the link between teaching and research is emphasised in every Finnish university, which guarantees that the education is based on the most recent research information. Moreover, the Finnish teacher education involves guided teaching practice yearly, starting from the very first year, which offers the teacher students a possibility to combine theory and practice. The main idea behind the several teacher training periods is to support the students to develop as independent teachers who can reflect on their actions and develop their teaching skills during their university studies, not just when they graduate and begin teaching. Because the teachers with less teaching experience received their teacher education more recently, their higher use of knowledge-based reasoning may reflect the aims and content of the current teacher education programs in Finland.

Another explanation for the negative correlations found may link with more automated performance and knowledge that grows through experience. As Feldon (2007) suggests, teacher expertise is accompanied with automaticity and more effortless performance, but on the other hand repeated classroom procedures may become ingrained or even difficult to become aware of for the teachers. Since automated skills and knowledge are not available for person's conscious monitoring (Clark & Feldon, 2005; Feldon, 2007) the teachers with long teaching experience may struggle to pay attention to and reason their automated classroom behaviour. On the hand, teachers with less teaching experience may still be more conscious about their actions and reasons behind them since their classroom behaviour may not be as automated.

Third, explanation may link with the fact that teaching is acknowledged as a demanding job, and recent studies have shown that teachers experience high work-related stress (e.g., Aloe et al., 2014; Herman et al., 2020). High teacher stress has been linked to lower professional commitment, performance (Buettner et al., 2016), and self-reflection (Muhonen et al., 2021). Although teacher education in Finland is a very popular field of study, and universities are in a position to select the most motivated and well-suited applicants for their programmes, the demanding nature of the work may tire teachers over the years. An excessive amount of duties and responsibilities lead to teachers' experience of long-term stress (even burnout) and, as a result, of eventual cynicism toward their work (Salmela-Aro et al., 2011), which may also be reflected in the experienced teachers' lower level professional vision and knowledge-based reasoning.

Teaching experience was also found to correlate negatively with the different domains of knowledge-based reasoning and their sub-levels. First, associations were found predominantly among the domain of description, which was most often used by the teachers when reflecting on their eye-tracking recordings (4996 units in total). Prior studies have shown that in their knowledge-based reasoning, novice teachers tend to describe concerns related to teacher and student characteristics, behaviour, and disciplinary issues (Tsui, 2003). The findings of the present study are, to some extent, in line with the previous findings suggesting that the less experienced the teachers were, the more they shared student information and the more their description content was related to classroom management/behaviour. On the other hand, prior research has also shown that expert teachers more often describe their concerns and thoughts related to teaching and learning (Tsui, 2003). The findings of this study, however, showed a negative association between teaching experience and description content of pedagogy and pedagogical/conceptual explanations. Perhaps even more interestingly, a negative association was also found between teaching experience and teachers' self-reflection. These findings suggest that even less experienced Finnish Grade 1 teachers are able to focus on the pedagogical aspects in their knowledge-based reasoning and can realise and notice new aspects related to their performance in terms of pedagogy or classroom management. It may be that the teachers with less teaching experience benefitted from watching their eye-tracking videos the most but were also more sensitive and open to professional development compared to their more experienced colleagues.

Based on the second research question, the second part of the study aimed to describe in more detail how teachers with different amounts of teaching experience reason about their eye-tracking recordings. The purpose of the qualitative examination of three teacher cases was to provide concrete examples of teachers' knowledge-based reasoning and therefore to broaden the findings of the quantitative analysis. The teacher with little teaching experience was found to reason her eye-tracking recording broadly and diversely. The teacher with sample average teaching experience used less knowledge-based reasoning, but still more compared to the teacher with long teaching experience, who reasoned her eye-tracking recording scantily. In terms of the description focus, a similar type of pattern occurred among all three teachers: their descriptions were predominantly focused on student information and teacher information/elaboration. However, more diversity could be seen within the description content: the teacher with little teaching experience described mostly content related to learning/performance/development and pedagogy, whereas the other two teachers described mostly content of classroom management/behaviour and learning/performance/development. In line with the results of the correlation analysis, these teacher cases suggest contradictory findings to previous studies that have highlighted that expert teachers focus more on teaching and learning, while novice teachers favour content related to behaviour and discipline (Tsui, 2003). In terms of explanation, the prior research suggests that novice teachers tend to struggle with explaining and predicting in their knowledge-based reasoning (Oser et al., 2010), and in-service teachers utilise more explanation in their knowledge-based reasoning compared to pre-service teachers (Gegenfurtner et al., 2020). However, in the present study, the qualitative examination of the three example teacher cases validated the results of the correlation analysis, showing that the teacher with little teaching experience utilised explanation the most (predominantly, conceptual/pedagogical explanation) compared to the two other teachers.

4.1. Implications, limitations, and future directions

This study has important practical and methodological/theoretical implications. Based on the findings, which are somewhat contradictory to the predominant prior research, we suggest that teachers' knowledge-based reasoning should not be seen only as an ability that increases with experience. Teachers with only a short teaching career can possess a high-quality professional vision that can be trained beginning in pre-service teacher education. It is important that teachers become aware of the reasons for and the goals of their actions in the classroom during their everyday teaching. We therefore suggest that strong attention should be paid to the training of teachers' professional vision in pre-service and in-service teacher training. Starting from pre-service teacher education, teachers should be provided with the knowledge and practical training on how to reflect on and reason about classroom events. Attention should be paid also to the training and development of in-service teachers who have served as teachers for a long period of time and therefore have received their teacher education earlier (some of them even decades ago). Through training experienced teacher can be encouraged to reflect and pay attention to their classroom performance that through years may have become automated and more routined. The use of eye-tracking

methodology could be utilised in this training. In addition, a special focus of the training should be given to the practices of explaining and predicting. The teachers in this study utilised explanations and especially predictions rarely while reasoning about their eye-tracking recordings. Thus, it seems evident that despite the length of teaching experience, teachers need practice in explaining and predicting their classroom actions.

Concerning the study design and methodology, most previous studies that have investigated teachers' professional vision and knowledge-based reasoning have utilised classroom video recordings filmed from an objective perspective (e.g., Blomberg et al., 2011; Seidel et al., 2011; Sherin & van Es, 2009). By adding a more personal approach to the field of professional vision and allowing teachers to reflect on their own performance, the present study investigated teachers' knowledge-based reasoning through RTA interviews that were based on teachers' own eye-tracking video recordings of their classroom situations. This study also adds to the previous research by investigating teaching experience both as a continuous variable and through three cases of teachers with different amounts of teaching experience. Previous studies have mainly compared two teacher experience levels (early-career vs. late-career teachers or pre-service vs. in-service teachers), and many have utilised the interventional approach. Therefore, the results of this study are of a high importance, since it did not include any intervention, and the data describes the authentic state of the Finnish Grade 1 teachers' knowledge-based reasoning concerning their own classroom actions. In addition, the coding of knowledge-based reasoning was based on the analysis framework developed in the research team's previous study (See Muhonen et al., 2021). Although the framework was based on robust prior research on teachers' knowledge-based reasoning and its three domains (e.g., Seidel & Stürmer, 2014; Sherin & van Es, 2009), it was important to validate the functionality of the data-driven sub-levels that add to the existing literature on knowledge-based reasoning.

This study has some limitations that should be considered. First, the sample size of 54 teachers was small, which may have decreased the power of the statistical testing and contributed to the mostly marginally significant correlations. However, from a qualitative point of view, the study sample can be considered good. Second, the subjects of the eye-tracking recordings were not controlled for, meaning that the subjects varied within the recordings on which the teachers commented. Therefore, it is important to acknowledge that the lesson subject may have had an impact on the teachers' reasoning. Third, the same instruction for the RTA interview was provided to all the participating teachers. The teachers were asked to recall what they were thinking during the eye-tracking recording and reason their actions during the recorded classroom activities. The interviewing research assistants followed a strict protocol and did not ask any expanding or clarifying questions of the teachers. However, in the future, some expanding and clarifying questioning could be used to encourage teachers' elaboration, since some of the participating teachers found it challenging to recall their thoughts and reasoning about the classroom actions. Fourth, though the RTA-interviews were organised privately to respect the sensitive nature the situation, some teachers may have experienced the situation uncomfortable, which may have influenced on the extent and content of their reasoning. In addition, it is important to acknowledge, that the use of eye-tracking technology may have been especially unfamiliar for some of the most experienced teachers, which may have taken their attention away from their reflections. In the future, broader teacher interviews may help in understanding the development of teachers' professional vision and expertise. Finally, the results were found in a particular cultural and educational setting, that is, in the early years of Finnish primary schools. As there is a high possibility of variation in how primary education and teacher education are organised, there is a need to replicate these findings in other cultures and educational settings, ideally with a larger sample size.

4.2. Conclusions

On the basis of the findings, it may be concluded that in the case of Finnish Grade 1 teachers, their teaching experience and use of knowledge-based reasoning are linked. However, contrary to the prevailing understanding, the links between teaching experience and the diverse domains and sub-levels of knowledge-based reasoning were found to be negative. The qualitative examination of three teacher cases broadened the links by showing concrete examples how the teacher with little teaching experience reasoned her eye-tracking recording more broadly, whereas the teacher with long teaching experience reasoned her eye-tracking recording rather scantily. The present study contributes to the field of knowledge-based reasoning by suggesting that teachers' ability to use knowledge-based reasoning may not necessarily increase with teaching experience. Even teachers in the early stages of their careers seem able to elaborate on their knowledge-based reasoning of classroom situations, which may be explained by their high-quality teacher education and openness to professional development. On the other hand, regarding the long teaching experience, there may be several reasons for the lower ability to interpret and reason about the noticed classroom information. Experienced teachers' scant reasoning may be explained by their more automated performance and knowledge, which may prevent conscious self-monitoring, Other explanations may rely on their teacher education occurring long ago, along with the increasing demands of teaching, which can lead to long-term teaching-related stress. In addition, the use of mobile eye-tracking technology and watching the video of eye movements may have been especially unfamiliar for some of the most experienced teachers. We highlight in this study the importance of teacher education and teaching practice in the training of teachers' professional vision.

Acknowledgements

The study was funded by the Academy of Finland (No. 317610), the Finnish Work Environment Fund, and Ella and Georg Ehrnrooth Foundation. We would like to thank Professor Antje von Suchodoletz for supporting the design of the analysis framework. The design of the analysis framework was funded by the New York University Abu Dhabi Research Enhancement Fund (No. RE059).

Appendix 1. Domains and sub-levels of teachers' knowledge-based reasoning and their analysis unit examples

Description	
Description focus	
Teacher action	"Here I am walking to the classroom."
Student action	"He just keeps drawing and drawing."
Joint action	"Here we sing together as one big choir."
Teacher information/elaboration (goals, strategies, beliefs, feelings)	"I really try to build strong interactions and relationships with my class."
Student information (characteristics, behaviour, skills, social relations)	"This one is such a clever girl, but hard working as well."
General classroom information (routines, classroom/school activities and tasks, information about equipment)	"The special education teacher visits our classroom two days a week."
Teacher self-reflection (realising and noticing one's behaviour, elaboration)	"While watching this, I am realising how restless my attention actually is."
Description content	
Pedagogy (educational and pedagogical actions, goals, and strategies)	"I like to utilise group and pair work basically every day, for least 5 min, to support their interactions."
Learning/performance/development (academic performance, learning social or behavioural skills, physical development [age])	"Half of the class can already read fluently, but there are still students who need to practise it."
Classroom management/behaviour	"I am trying to tell them to calm down and to put their books away."
Social relations/emotions	"Something had happened between them, a fight or argument during the break."
NA (not applicable comments)	"On Tuesdays, I try to leave early, as that is my hobby day."
Explanation	
Pedagogical/conceptual knowledge (explanations for actions or thoughts based on educational concepts or pedagogical knowledge)	"I give them reading homework almost every day, because learning to spell and read are important learning goals in Grade 1."
Practical (explanations for actions or thoughts based on practical explanations and behavioural reasons)	"Here, I didn't start before every single one had their mouths closed and eyes on me, simply because I did not want to have a shouting match with them."
Prediction	
(Expectations, goals and hopes for student learning and for more general classroom actions and teaching)	"I can see their development in pair work, and I hope this development continues for us to be able to work and interact fluently, even in larger groups."

References

Aloe, A. M., Shisler, S., Norris, B. D., Nickerson, A. B., & Rinker, T. W. (2014). A multivariate meta-analysis of student misbehavior and teacher burnout. *Educational Research Review, 12*, 30–44. https://doi.org/10.1016/j.edurev.2014.05.003

Berger, J.-L., Girardet, C., Vaudroz, C., & Crahay, M. (2018). Teaching experience, teachers' beliefs, and self-reported classroom management practices: A coherent network. *SAGE open, 8*(1), 1–12. https://doi.org/10.1177/2158244017754119

Berliner, D. C. (2001). Learning about and learning from expert teachers. *International Journal of Educational Research, 35*, 463–482. https://doi.org/10.1016/S0883-0355(02)00004-6

Blomberg, G., Stürmer, K., & Seidel, T. (2011). How pre-service teachers observe teaching on video: Effects of viewers' teaching subjects and the subject of the video. *Teaching and Teacher Education, 27*, 1131–1140. https://doi.org/10.1016/j.tate.2011.04.008

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

Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education, 24*(2), 417–436. https://doi.org/10.1016/j.tate.2006.11.012

Borko, H., & Livingston, C. (1989). Cognition and improvisation: Differences in mathematics instruction by expert and novice teachers. *American Educational Research Journal, 26*(4), 473–498. https://doi.org/10.3102/00028312026004473

Brown, S. W., & Bennett, E. D. (2002). The role of practice and automaticity in temporal and nontemporal dual-task performance. *Psychological Research, 66*, 80–89. https://doi.org/10.1007/s004260100076

Buettner, C. K., Jeon, L., Hur, E., & Garcia, R. E. (2016). Teachers' social–emotional capacity: Factors associated with teachers' responsiveness and professional commitment. *Early Education & Development, 27*(7), 1018–1039. https://doi.org/10.1080/10409289.2016.1168227

Carter, K., Cushing, K., Sabers, D., Stein, B., & Berliner, D. (1988). Expert-novice differences in perceiving and processing visual classroom information. *Journal of Teacher Education, 39*, 25–31. https://doi.org/10.1177/002248718803900306

Clark, R., & Feldon, D. (2005). Five common but questionable principles of multimedia learning. In R. Mayer (Ed.), *The cambridge Handbook of multimedia learning (cambridge handbooks in psychology* (pp. 97–116). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511816819.007.

Cornford, I., & Athanasou, J. (1995). Developing expertise through training. *Industrial & Commercial Training, 27*(2), 10–18. https://doi.org/10.1108/00197859510082861

Cortina, K. S., Miller, K. F., McKenzie, R., Epstein, A., & Feng, G. (2015). Where low and high inference data converge: Validation of CLASS assessment of mathematics instruction using mobile eye tracking with teachers. *International Journal of Science and Mathematics Education, 13*(2), 389–403. https://doi.org/10.1007/s10763-014-9610-5

van Es, E., & Sherin, M. G. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interactions. *Journal of Technology and Teacher Education, 10*(4), 571–596. Retrieved from https://pdfs.semanticscholar.org/c253/d8a8436583754a70c862ddea603366d71665.pdf.

van Es, E., & Sherin, M. (2008). Mathematics teachers' "learning to notice" in the context of a video club. *Teaching and Teacher Education, 24*(2), 244–276. https://doi.org/10.1016/j.tate.2006.11.005

Feldon, D. F. (2007). Cognitive load and classroom teaching: The double-edged sword of automaticity. *Educational Psychologist, 42*(3), 123–137. https://doi.org/10.1080/00461520701416173

Gegenfurtner, A., Lewalter, D., Lehtinen, E., Schmidt, M., & Gruber, H. (2020). Teacher expertise and professional vision: Examining knowledge-based reasoning of pre-service teachers, in-service teachers, and school principals. *Frontiers in Education, 5*, 59. https://doi.org/10.3389/feduc.2020.00059

Goodwin, C. (1994). Professional vision. *American Anthropologist, 96*, 606–633. https://doi.org/10.1525/aa.1994.96.3.02a00100

Guan, Z., Lee, S., Cuddihy, E., & Ramey, J. (2006). The validity of the stimulated retrospective think-aloud method as measured by eye tracking. In *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '06)* (pp. 1253–1262). ACM Press. https://doi.org/10.1145/1124772.1124961.

Hammerness, K., Darling-Hammond, L., & Shulman, L. S. (2002). Toward expert thinking: How curriculum case writing prompts the development of theory-based professional knowledge in student teacher education. *Teaching Education, 13*(2), 221–245. https://doi.org/10.1080/1047621022000007594

Hattie, J. (2003). Teachers make a difference: What is the research evidence?. In *Paper presented at the building teacher quality: What does the research tell us ACER research conference, melbourne, Australia*. Retrieved from http://research.acer.edu.au/research_conference_2003/4/.

Herman, K. C., Prewitt, S. L., Eddy, C. L., Savale, A., & Reinke, W. M. (2020). Profiles of middle school teacher stress and coping: Concurrent and prospective correlates. *Journal of School Psychology, 78*, 54–68. https://doi.org/10.1016/j.jsp.2019.11.003

Huberman, M. (1992). Teacher development and instructional mastery. In A. Hargreaves, & M. G. Fullan (Eds.), *Understanding teacher development* (pp. 122–142). New York, NY: Teachers College Press.

Hyrskykari, A., Ovaska, S., Majaranta, P., Räihä, K.-J., & Lehtinen, M. (2008). Gaze path stimulation in retrospective think-aloud. *Journal of Eye Movement Research, 2*(4). https://doi.org/10.16910/jemr.2.4.5

Keppens, K., Consuegra, E., Goossens, M., De Maeyer, S., & Vanderlinde, R. (2019). Measuring pre-service teachers' professional vision of inclusive classrooms: A video-based comparative judgement instrument. *Teaching and Teacher*

Education, 78, 1–14. https://doi.org/10.1016/j.tate.2018.10.007
Kersting, N., Givvin, K., Thompson, B., Santagata, R., & Stigler, J. (2012). Measuring useable knowledge: Teachers' analyses of mathematics classroom videos predict teaching quality and student learning. *American Educational Research Journal, 49*(3), 568–589. https://doi.org/10.3102/0002831212437853
Kim, L. E., & Klassen, R. M. (2018). Teachers' cognitive processing of complex school-based scenarios: Differences across experience levels. *Teaching and Teacher Education, 73*, 215–226. https://doi.org/10.1016/j.tate.2018.04.006
King Rice, J. (2013). Learning from experience? Evidence on the impact and distribution of teacher experience and the implications for teacher policy. *Education Finance and Policy, 8*(3), 332–348. https://doi.org/10.1162/EDFP_a_00099
Lehtinen, E., Gegenfurtner, A., Helle, L., & Säljö, R. (2020). Conceptual change in the development of visual expertise. *International Journal of Educational Research, 100*, 101545. https://doi.org/10.1016/j.ijer.2020.101545
Lerkkanen, M.-K., & Pakarinen, E. (2017-2022). *[Teacher and Student Stress and Interaction in Classroom (TESSI] study*. Finland: University of Jyväskylä.
McIntyre, N. A., & Foulsham, T. (2018). Scanpath analysis of expertise and culture in teacher gaze in real-world classrooms. *Instructional Science, 46*(3), 435–455. https://doi.org/10.1007/s11251-017-9445-x
Meschede, N., Fiebranz, A., Möller, K., & Steffensky, M. (2017). Teachers' professional vision, pedagogical content knowledge and beliefs: On its relation and differences between pre-service and in-service teachers. *Teaching and Teacher Education, 66*, 158–170. https://doi.org/10.1016/j.tate.2017.04.010
Muhonen, H., Pakarinen, P., & Lerkkanen, M-K. (2021). *Professional vision of Grade 1 teachers experiencing different levels of work-related stress*. Manuscript submitted for publication.
Oser, F., Heinzer, S., & Salzmann, P. (2010). The measurement of the quality of professional competence profiles of teachers. *Unterrichtswissenschaft, 38*(1), 5–29.
Palmeri, T. J., Wong, A. C.-N., & Gauthier, I. (2004). Computational approaches to the development of perceptual expertise. *Trends in Cognitive Sciences, 8*(8), 378–386. https://doi.org/10.1016/j.tics.2004.06.001
Roth, K. J., Garnier, H. E., Chen, C., Lemmens, M., Schwille, K., & Wickler, N. I. (2011). Videobased lesson analysis: Effective science PD for teacher and student learning. *Journal of Research in Science Teaching, 48*, 117–148. https://doi.org/10.1002/tea.20408
Sabers, D., Cushing, K., & Berliner, D. (1991). Differences among teachers in a task characterized by simultaneity, multidimensional, and immediacy. *American Educational Research Journal, 28*, 63–88. https://doi.org/10.3102/00028312028001063
Salmela-Aro, K., Pietarinen, J., & Pyhältö, K. (2011). Teacher–working-environment fit as a framework for burnout experienced by Finnish teachers. *Teaching and Teacher Education, 27*, 1101–1110. https://doi.org/10.1016/j.tate.2011.05.006
Santagata, R. (2009). Designing video-based professional development for mathematics teachers in low-performing schools. *Journal of Teacher Education, 60*(1), 38–51. https://doi.org/10.1177/0022487108328485
Säntti, J., & Salminen, J. (2015). Development of teacher education in Finland 1945–2015. *Hungarian Educational Research Journal, 5*(3), 1–18.
Schäfer, S., & Seidel, T. (2015). Noticing and reasoning of teaching and learning components by pre-service teachers. *Journal for Educational Research Online, 7*(2), 34–58.
Schön, D. A. (1987). *Jossey-Bass higher education series.Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey-Bass.
Seidel, T., & Prenzel, M. (2007). How teachers perceive lessons—assessing educational competencies by means of videos. *Zeitschrift für Erziehungswissenschaft, 10*, 201–216.
Seidel, T., & Stürmer, K. (2014). Modeling and measuring the structure of professional vision in preservice teachers. *American Educational Research Journal, 51*(4), 739–771. https://doi.org/10.3102/0002831214531321
Seidel, T., Stürmer, K., Blomberg, G., Kobarg, M., & Schwindt, K. (2011). Teacher learning from analysis of videotaped classroom situations: Does it make a difference whether teachers observe their own teaching or that of others? *Teaching and Teacher Education, 27*(2), 259–267. https://doi.org/10.1016/j.tate.2010.08.009
Seidel, T., Stürmer, K., Prenzel, M., Jahn, G., & Schäfer, S. (2017). Investigating pre-service teachers' professional vision within university-based teacher education. In D. Leutner, J. Fleischer, J. Grünkorn, & E. Klieme (Eds.), *Competence assessment in education. Methodology of educational measurement and assessment* (pp. 93–109). Cham, Switzerland: Springer.
Sherin, M. G. (2001). Developing a professional vision of classroom events. In T. L. Wood, B. S. Nelson, & J. Warfield (Eds.), *Beyond classical pedagogy: Teaching elementary school mathematics* (pp. 75–93). Mahwah, NJ: Erlbaum.
Sherin, M. G., & van Es, E. A. (2009). Effects of video club participation on teachers' professional vision. *Journal of Teacher Education, 60*(1), 20–37. https://doi.org/10.1177/0022487108328155
Star, J. R., & Strickland, S. K. (2008). Learning to observe: Using video to improve pre-service mathematics teachers' ability to notice. *Journal of Mathematics Teacher Education, 11*(2), 107–125. https://doi.org/10.1007/s10857-007-9063-7
Stürmer, K., Könings, K. D., & Seidel, T. (2013). Declarative knowledge and professional vision in teacher education: Effect of courses in teaching and learning. *British Journal of Educational Psychology, 83*, 467–483. https://doi.org/10.1111/j.2044-8279.2012.02075.x
Tsui, A. (2003). *Understanding expertise in teaching: Case studies of second language teachers*. Cambridge: Cambridge University Press.