Keeping track of expert teachers: Comparing the affordances of think-aloud elicited by two different video perspectives.

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Abstract

Verbal data from think-aloud is uniquely unobtrusive and non-reactive. It can therefore generate real-time insight into how expert teachers think. Our paper analyses data from two video-stimulated retrospective think-aloud approaches. The first approach used videos of others' teaching as stimuli for participating teachers' think-aloud. The second approach involved the teachers' own-perspective videos, overlaid with the teachers' own gaze patterns that were simultaneously recorded. In all, the study sets out to investigate how these two approaches differ with regard to their respective potential for uncovering expert teacher cognition. Others' videos elicited more think-aloud responses than gaze-cued own-perspective videos, especially the operational aspects of classroom teaching. Interaction analysis revealed expert–novice differences to vanish when only think-aloud responses to gaze-cued own-perspective videos were considered. Classroom relationships might be integral for any teacher's navigation of classroom instruction, regardless of expertise.

Keywords: Think-aloud, teacher expertise, verbal reports, eye-tracking, video stimuli.

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Knowing how expert teachers think is essential to understanding why they are so effective at supporting learning and what novices can emulate. By studying expert teachers' cognitions, novices can efficiently discover educational approaches that are most likely to be optimally effective (Wolff, Boshuizen, et al., 2016). Even greater potential may be found from tracing experts' actions from moment to moment whilst mapping these to experts' underlying cognitions, as long as adequate consideration is given to novices' own learning needs (M. T. H. Chi, 2013). Such an approach simultaneously provides cognitive and behavioural demonstrations of what expert teaching looks like in real-world situations.

Think-aloud is a methodology with unique potential to generate exceptional insight into teacher expertise. By obtaining think-aloud verbalisations, expertise researchers are able to trace each moment of what can be regarded as 'optimal' task performance as cognitive dimensions are identified that support expert task performance in classroom teaching. Whereas verbal reporting is typically decontextualized from relevant professional settings and have reactivity effects on subsequent task performance, the real-time commentaries from think-aloud protocols provide uniquely unobtrusive insight into how experts operate from moment to moment (Fox et al., 2011).

In addition to these methodological advantages of think-aloud on its own, video-stimulated think-aloud can gain further access to experts' task-related cognition. Videos from teachers' professional context can serve as more dynamic cognitive prompts than, for

example, written scenarios. They thereby significantly enhance participants' access to—and reports of—relevant knowledge and memories. Moreover, such video stimuli protect participants from the additional cognitive load and time consumption, as entailed by thinking aloud concurrently with task performance (Ericsson & Simon, 1980): this advantage is critically important when investigating expertise in high-pressured professions such as teaching, especially when dependents are involved (who, in this case, are students). Eye-tracking is the recording of participants' eye gaze and can also be used as part of video-stimulated think-aloud. Cued retrospective reporting refers to the use of participants' own gaze patterns as a cognitive cue in addition to video stimuli (van Gog et al., 2005). However, gaze can also be recorded during think-aloud itself (Wolff, Jarodzka, et al., 2016).

In this paper, we compare two eye-tracking studies that take two different approaches to video-stimulated think-aloud. Participating teachers in one study thought out loud whilst watching *others' videos* of actual classroom teaching a second time and being recorded by a static eye-tracker. Participating teachers in the other study thought out loud whilst watching their own gaze patterns overlaid onto *own-perspective video* recordings of their own teaching, which were captured by mobile eye-tracking technology (or eye-tracking 'glasses') shortly before their think-aloud session. Thus, we demonstrate the complementary affordances and constraints of differing approaches to video-stimulated think-aloud for eye-tracking investigations into teacher expertise.

With our introduction, we outline think-aloud methodology and its particular affordances for teacher expertise research. We situate our two think-aloud approaches (i.e., *others' videos* and *gaze-cued own-perspective videos*) within the broader context of other think-aloud approaches which we generally introduce in order of technological complexity. Wherever possible, we provide examples of how each evolution of this approach has been used to investigate teacher expertise. Finally, we outline our framework for classifying media-stimulated think-aloud utterances before stating the research hypotheses for this paper.

Think-aloud plays a unique role in expertise research

Verbal data is an established approach to accessing task-related thought processes (see Howe, 1991 for review and discussion). However, the 'think-aloud' approach is unique due to its unobtrusive quality. Unlike alternative verbal methods (e.g., Fallshore & Schooler, 1995; McIlroy et al., 2012), think-aloud has been shown to yield objective task-related data that is unaffected by the data collection procedures themselves, especially the interviewer.

Think-aloud differs from traditional verbal analysis in important ways. Traditional verbal reporting procedures are introspections whose involved and interpretive processes are obtrusive: here, researchers function as facilitators of the verbalisation procedure which itself demands participant training. In contrast, think-aloud protocols focus on cognitions

that accompany task performance (Ericsson & Fox, 2011): researcher presence is minimised and think-aloud procedures demand no additional training in order for participants to meet research requirements. Instead of inviting new thoughts on research-specific questions (information recoding, i.e., 'level 3' verbalisation, Ericsson & Simon, 1980), think-aloud research invites only verbal reports of information that has already been processed as part of participants' task performance ('level 2' verbalisation of already encoded information, Ericsson & Simon, 1980). An example of the latter, think-aloud form of verbalisation is to report perceived hazards whilst driving (Key et al., 2016). Unlike traditional, interpretive verbal reporting, therefore, think-aloud is reliably nonreactive in nature and has no effect on concurrent (Dickson et al., 2000) or subsequent task performance (or behaviour, Fox et al., 2011).

Think-aloud can either be done concurrently with, or retrospectively after, participants' task performance. Concurrent think-aloud has the methodological advantage of limiting over-interpretation as participants cannot over-interpret as long as they need to concentrate on their professional task—which, in think-aloud research, take priority over the research task (e.g., "take your time and concern yourself with performance", Ericsson & Simon, 1980, p. 228). In practice, retrospective think-aloud becomes more relevant with increasing task difficulty (Sokolov, 1972) and time-sensitivity (i.e., when the task must be completed with urgency, e.g., in air traffic control, Triplett et al., 2014). In pressured professions (e.g., teaching), it would be problematic to make additional research demands upon participants, lest their task performance and their service-users (e.g., students) be affected. Compared with concurrent think-aloud, retrospective think-aloud has the methodological advantage of giving participants the opportunity to combine past with current cognitions for greater richness of insight into expertise (Newell & Simon, 1972).

Think-aloud is particularly informative in expertise research due to its potential to offer real-time insight into optimal task performance as shown by experts (Crutcher, 1994). Existing expertise research has used think-aloud to investigate professional expertise such as medicine (e.g., Boshuizen & Schmidt, 1992), translation (Roth et al., 2013), human-computer interaction (P. Y. Yen & Bakken, 2009), financial problem-solving (Hershey et al., 1990), orchestral conductors (Bergee, 2005), computer programming (C.-Z. Yen et al., 2012) and computer gaming (Hong & Liu, 2003). Think-aloud for expertise research has typically involved participants reporting their thoughts concurrently with (i.e., during) their task performance. For example, in their study of medical expertise, Boshuizen and Schmidt (1992) presented participants with sequential pieces of information about a pancreatic case whilst participants thought out loud. According to such think-aloud research, experts tend to display deeper professional knowledge and understanding and to apply higher-level thinking.

Think-aloud has also been used to investigate educational expertise specifically, including instructional designers (Perez et al., 1995), teachers' understanding of student assessment criteria (Leinhardt, 1983) and their internet-use in classroom instruction (Levin et al., 1999). As in research into non-educational expertise, participants were invited to think-aloud concurrently with their task performance. For example, Perez colleagues (1995) audio and video-recorded participants as they thought out loud whilst designing instructions for how to troubleshoot a diesel engine. As in other professions, educational experts display deeper understanding of strategies for how and why education should be carried out, when compared with educational novices. Experts also use principles and apply these creatively in their decision-making, unlike novices who use "deterministic [and] linear" logic (Perez et al., 1995, p. 321).

Think-aloud in expertise research using video stimuli

Research on expertise can use videos as stimuli for the think-aloud process. Instead of using written scenarios or images from the participant's professional context, videos of cases can be shown whilst participants think-aloud as they solve a professional problem.

This approach to video-stimulated think-aloud is not common in educational research since videos described in the next sections of this article are more feasible to develop. However, such video-stimulated think-aloud has been used to investigate non-educational expertise such as in law enforcement (Bond, 2008). In this study, participants were asked to think-aloud during the second viewing of each video, with the first viewing solely for familiarisation. Think-aloud data from this study revealed law enforcement experts to use non-verbal cues significantly more than novices. Using this approach, expert triathletes have been found to relate video content to the their own performance progress more than novices and to respond to these thoughts proactively (Baker et al., 2005).

Video-stimulated think-aloud *with eye-tracking*. Professional expertise research can take advantage of two real-time streams of expert teacher task performance by collecting gaze and think-aloud data. Video stimuli are always involved in such research, but the video perspective can vary.

The most common way by which gaze data has been used with think-aloud is for gaze data to be recorded (or eye-tracked) during video-stimulated concurrent think-aloud of cases or scenarios from participants' own professional context. Whilst viewing videos of actual and imitated infant seizures, *think-aloud* data showed medical experts to examine more diagnostic hypotheses than novices whilst their *eye-tracking* data revealed more time spent looking at diagnostically relevant regions (Balslev et al., 2012; for the same think-aloud approach, see Gegenfurtner & Seppänen, 2013)

Think-aloud expertise research using *others' videos*

Participants can take on an observer's perspective during video-stimulated think-aloud by showing the participant someone else performing a professional task. Thus, think-aloud is elicited by others' task performance videos. Participants are usually given an opportunity to view the video once for familiarisation before commenting during the second-viewing (e.g., Bond, 2008).

Although little research has combined think-aloud with the use of others' videos as stimuli, this approach has been implemented in educational research. Kerrins and Cushing (2000) invited participating teachers to report what caught their attention and any observations that they were making during second viewing though this occurred only after researchers invited evaluative (i.e., specific and interpretive) responses to first-viewing of the videos, which deviates from think-aloud guidance (e.g., Ericsson & Simon, 1980). In line with previous think-aloud research, educational experts revealed a focus on seeking out the purposes, rationales and strategies underlying the videoed events.

Others-video think-aloud *with eye-tracking*. The others-video approach to video-stimulated think-aloud can be integrated with eye-tracking by using a static eye-tracker to record participants' gaze whilst watching task performance videos of another practitioner in their professional context. Advantages of this approach incorporate those from using others' videos (see discussion above), with the added strength of two parallel streams of cognition triangulating each other. To our knowledge, no research has been conducted using this approach other than our own. *In our others-video study, participants were invited to view videos of others' teaching twice. To ensure that the first viewing was solely about familiarisation, no comments were invited during or after the first viewing. Think-aloud comments were invited during second viewing of our videos, such that our static eye-tracking study was a retrospective think-aloud design using others' videos.*

Think-aloud expertise research using participants' *own videos*

Video-stimulated think-aloud can also be achieved by video-recording participants during their task own performance. This video of the participant is then shown to the participant him or herself during a subsequent think-aloud session. Accordingly, think-aloud using videos of oneself is often retrospective.

Whereas the others-video approach can elicit deeper analyses than own-videos in terms of core components of classroom instruction (Kleinknecht & Schneider, 2013; Seidel et al., 2011[1]), the own-video approach potentially prompts greater immersion (Kleinknecht & Schneider, 2013) — or the sensation of being spatially located in the videoed environment (Wissmath et al., 2009). Own-videos also better enable teachers to access their educational knowledge, especially among experts when compared with novices (Seidel et al., 2011).

[1] Note that both citations utilised structured verbal and written responses rather than think-aloud protocols.

Furthermore, video-stimulated think-aloud lessens cognitive load for participants. It does so by removing the research demand for participants to verbalise their thoughts whilst professional demands are being made during task-performance (as would occur in concurrent think-aloud)—without losing events coinciding with task-performance. Indeed, classroom teaching is one such profession in which it is impossible to carry out teaching responsibilities whilst thinking-aloud for research purposes. When participants view videos of oneself, they receive more dynamic cues than mere memories, transcripts or photographs collected during task performance.

Educational expertise research has imposed parameters around the responses that participants can make in response to participants' videos of themselves (for self-evaluation as in Mosley Wetzel et al., 2017; or to identify and explain decision-making, as in Westerman, 1991). Others have additionally pre-selected video segments to be viewed (to support recall of decision-making cues, Housner & Griffey, 1985). Through these attempts at think-aloud in response to own-videos, educational experts have revealed greater focus on students' progress in learning whilst applying strategies for classroom management, whereas novices were preoccupied with whole class interest with limited strategies (Housner & Griffey, 1985; Westerman, 1991).

However, a full implementation of think-aloud methodology would replay videos in an unstructured fashion during think-aloud, without pre-selection by researchers. As in video-free think-aloud, participants simply report the thoughts they had at the time of their (now video-recorded) task performance. Dunn et al. (1996) did this when they video-recorded participating physicians during consultations before, immediately afterwards, playing this video recording to participants. During this video-stimulated retrospective think-aloud session, participants would pause the video to report thoughts they had at the time[2]. Among other skills, expert physicians are particularly able to regulate and maintain focus during consultations while keeping important information in mind without taking notes. Thus, think-aloud research using participants' own videos has uncovered the centrality of long-term knowledge in professional expertise (Dunn et al., 1996).

Own-video think-aloud *with eye-tracking*. Eye-tracking (or gaze-recording) can occur whilst participants watch video recordings of their own task performance. For example, participant gaze has been recorded whilst participants watched videos of themselves cycling on a previous occasion (Zeuwts et al., 2016). No expertise research has been conducted that has been known to show videos of participants' own task performance to them during eye-tracking. Nevertheless, wider teacher vision research has used think-aloud to investigate the benefits of using participants' own videos and found that expert

[2] A number of studies have used video-stimulated think-aloud to investigate consultations. For a pharmaceutical example, see Croft et al. (2018). For a school psychologist example, see Lozinski (2012).

teachers notice more details when commenting on their own videos compared with expert teachers viewing others' videos (Seidel et al., 2011).

Think-aloud expertise research using videos from one's *own perspective*

Another approach to video-stimulated think-aloud is to show participants videos of their own task performance from their own perspective. This can be achieved via head-mounted cameras. These video recordings are then played back to participants as soon as possible (e.g., within one hour) as an aid for recall of their task performance (M. M. Omodei & McLennan, 1994).

Head movement have been shown to enhance participant memories of the recalled event (Kipper, 1986). Video cameras are captured from the centre of the participants' foreheads so that, during replay, the participant is able to immerse themselves into their own perspective of the task that they had performed, uncensored by researchers (M. Omodei et al., 2002). The immersion is further enhanced by the environmental focus of the video instead of a focus on participants themselves, such that think-aloud—rather than self-conscious self-evaluation—occurs occur as a result (M. M. Omodei & McLennan, 1994; Unsworth, 2001). Compared with free recall, own-perspective video-stimulated think-aloud has been found to prompt four times as much detail in memories of decision-making related events and processes (M. Omodei et al., 2005). Indeed, memories may be better activated via own-perspective video recordings because of the videos preserve the context of participants' experiences (Unsworth, 2001).

Geologists (Callahan, 2013) and orienteers (Eccles et al., 2006) have produced concurrent verbalisations during task performance that was video-recorded with head-mounted equipment. Although these expertise studies recorded head-mounted videos, the concurrent approach did not take full advantage of the insight that head-mounted own-perspective videos have to offer alongside retrospective think-aloud. Other than the present research, no known research has attempted to apply this methodology to investigate educational expertise.

Own-perspective video think-aloud *with eye-tracking*. Participants' own gaze can be used as a cue in addition to video stimulus during think-aloud, an approach known as *cued retrospective reporting* (van Gog et al., 2005). Compared with videos on their own, videos overlaid with recorded gaze patterns have been found to prompt significantly more think-aloud relating to the operational and problem-solving cognitions, probably due to the added process nature of gaze cues (Hansen, 1991). More reports of explanatory and metacognitive cognitions are also prompted by videos with gaze cues compared with videos without gaze cues during retrospective think-aloud (van Gog et al., 2005). This is achieved by first showing videos from participants' own professional contexts when gaze is recorded but no verbalisations are yet invited. At the next stage, however, retrospective think-aloud is

invited, now with the same participant's gaze recording overlaid onto the video. Using this approach, Jarodzka and colleagues (2010) found experts' *think-aloud* data to show greater use of knowledge-based shortcuts and greater *gaze* flexibility than novices (cf. McIntyre et al., 2017 regarding expert teachers' gaze flexibility). Think-aloud data revealed more specific evaluations whilst gaze data revealed more comprehensive screening during internet searches among domain experts than novices (Brand-Gruwel et al., 2017).

Using mobile eye-trackers with head-mounted cameras, own-perspective videos can be recorded during participants' own task performance in their real-world context. Such recordings show head-mounted videos from the participant's own-perspective with the participant's own gaze overlaid on top. Other than the present authors' own research, no known expertise (esp. expert vs. novice) investigations have implemented this approach. However, outside of the expertise literature, harvester operators have been asked to wear eye-tracking glasses during task performance before viewing this gaze-cued own-perspective video, not to think-aloud but rather, to "explain their actions, what they had looked at, or describe their reasoning in a review of the work and decision process" (Häggström et al., 2015, p. 99). *In contrast, retrospective think-aloud* was *fully implemented in our mobile eye-tracking (gaze-cued own-perspective) study on teacher expertise in which participating teachers viewed head-mounted videos overlaid with their own gaze*.

Our think-aloud framework for investigating teacher expertise

The present paper utilises one specific framework of teacher expertise, which was selected because it was developed using and therefore directly relates to video-stimulated think-aloud (Wolff et al., 2017). This framework explores the following five overarching categories (for full details, see online Supplemental Material 1): *perception and interpretation*, the depth with which teachers process classroom information; *themes and focus*, for example regarding students' attention and discipline and the teacher's role in the classroom scenario; *timescale*[3], whether the past, present or future tense is used by the observing teacher; *global processing*, including the number of viewpoints represented and the integration of different actors' perspectives; and *classroom relationships*, the affect observed in the classroom scenario and the interactions among students and the teacher.

This framework was deemed exceptionally relevant to the present analysis because it was developed using a closely related research design: namely, think-aloud verbalisations elicited by video stimuli within the context of an eye-tracking study. Moreover, a review of relevant literature indicated that comparable coding schemes in the field of research were scarce. As such, we were confident that it would apply to the data in the present analysis. The framework was developed using grounded theory over many iterations with rigorous

[3] Note that this category was dropped in the present analyses due to strong cross-correlation with *themes and focus*.

consultations of academic and practitioner experts in teacher effectiveness, especially classroom management.

In this cited research (Wolff et al., 2017), expert–novice differences emerged that coincided with related research employing other methodological frameworks: experts were found to demonstrate deeper thinking by making more inferences (cf. Clark & Peterson, 1984), to discuss a wider range of themes (cf. Doyle, 2006), to adopt more global processing by considering more viewpoints with greater certainty and to demonstrate greater continuity throughout their commentaries (cf. Sato et al., 1993).

To contextualise our selected framework (Wolff et al., 2017) with existing video-stimulated research on teacher expertise, we expected others' videos (used within our static eye-tracking study) to elicit deeper analyses from teachers via more comprehensive considerations regarding a wider range of the teacher cognitions listed above (cf. Kleinknecht & Schneider, 2013; Seidel et al., 2011). On the other hand, we expected own-perspective videos (used within our mobile eye-tracking study) to prompt greater immersion, as shown by verbal reports relating to *classroom relationships* (cf. M. Omodei et al., 2005; Seidel et al., 2011). Greater use of knowledge (Seidel et al., 2011) was also expected from think-aloud whilst viewing own-perspective videos as shown by more verbalisations that relate to *perceptions and interpretations*, which excel with increasing professional knowledge.

The Present Study

Existing scholarly knowledge of teacher expertise (e.g., Leinhardt, 1983) can be developed through further use of think-aloud protocols. Even more insight can be gained when think-aloud is video-stimulated (e.g., Seidel et al., 2011), especially in conjunction with eye-tracking (e.g., Brand-Gruwel et al., 2017). Therefore, the present paper seeks to investigate the differing insights into teacher expertise that can be gained via two video perspectives in retrospective think-aloud: namely, the use of *others' videos* versus *gaze-cued own-perspective videos*. Static eye-tracking technology can make use of others' videos, whereas mobile eye-tracking come with own-perspective videos. We present analysis of how each think-aloud video perspective contains differing affordances when investigating teacher expertise.

Hypothesis 1: Video perspective (i.e., others' videos vs. gaze-cued own-perspective videos) will predict differing teacher think-aloud.

In particular, others' videos were expected to reveal deeper analyses, as shown by a greater variety of cognitions reported in relation to important components of classroom instruction (cf. Kleinknecht & Schneider, 2013; Seidel et al., 2011). Accordingly, we expected more total think-aloud utterances to be elicited compared with own-perspective videos.

On the other hand, gaze-cued own-perspective videos will accompany more detailed noticing and deeper immersion as shown by references to *classroom relationships*[4] (M. Omodei et al., 2002; Seidel et al., 2011) as well as more references to one's own knowledge via utterances relating to *perception and interpretation* (Kleinknecht & Schneider, 2013). In line with previous research, we further expected gaze cues in the own-perspective videos to elicit more operational and problem-solving think-aloud (Hansen, 1991), as indicated by think-aloud regarding *themes and focus*. Gaze-cued own-perspective videos were also expected to prompt more explanations and metacognition (i.e., perception and interpretation, van Gog et al., 2005).

Hypothesis 2: We anticipated the video perspective to interact with expertise in think-aloud verbalisations. Given the anticipated importance of each video perspective and teachers' expertise in predicting teachers' think-aloud, we explored how these two factors combine to predict teacher cognition. On the basis of the above predictions, we specifically expected gaze-cued own-perspective videos to elicit deeper cognition (i.e., more utterances relating to perception and interpretation) and for this to be particularly true among experts (e.g., Boshuizen & Schmidt, 1992; Seidel et al., 2011), with fewer such utterances among novices viewing gaze-cued own-perspective videos. We additionally expected gaze-cued own-perspective videos to elicit more references to *classroom relationships,* especially among experts when compared with novices, due to experts typically immersing themselves more successfully than novices during think-aloud (Seidel et al., 2011).

Method

The present research primarily compared two video perspectives that can be used in retrospective think-aloud. The first study invited responses to *others' videos* of classroom teaching whilst participants were being eye-tracked. The second study invited responses to *gaze-cued own-perspective videos* from participants' own classroom teaching. Both studies have individually been published elsewhere with focuses distinct from the present one (e.g., McIntyre et al., 2020; Wolff, Jarodzka, et al., 2016).

The two studies analysed in this article differed in two ways (Table 1 summarises the between-study differences). The differences associated with the dissimilar research approaches (according to video perspectives, i.e., others' videos vs. gaze-cued own-perspective videos) that are necessary for the present research purposes we refer to as *category 1 differences*[5]. The differences that are due to the data originating from separate studies we refer to as *category 2 differences*.

[4] Italicised terms in this article refer to components of our think-aloud coding scheme.

[5] For example, the use of other practitioners' task performance in others-video think-aloud rather than the participant's own is intrinsic to the others-video design. This feature is meant to differ from that in gaze-cued own-perspective research, in which the videos will take on the participant's own perspective.

Since category 1 differences are related to the first and central hypothesis of this paper, we contend that only category 2 discrepancies are potential concerns that need to be addressed, which we do now. One category 2 confound (or difference) is the country difference between the two studies. However, this is addressed and resolved by the existing cultural research on teaching that find Dutch and English education sufficiently comparable (e.g., Hofstede, 1986) and excel in the same dimensions of teacher expertise (Blömeke et al., 2016). The other category 2 confound is sample size and is addressed by our analytic method (i.e., proportion analysis). By analysing talk proportions rather than frequencies, the present analysis side steps the confound of differing sample sizes across the two studies. The remaining differences between studies are category 1 differences that enable the present investigation.

Each of the two studies in this article will now be outlined, followed by the analytic approach for bringing the two studies together to answer the present research questions.

[Insert Table 1 about here]

Study 1: Eye-tracked during retrospective think-aloud using others' videos

Participants. Sixty-five teachers from six secondary schools in the Netherlands participated. Experts were recruited following Palmer, Stough, Burdenski and Gonzales' (2005) selection criteria: (1) years of teaching experience, (2) teacher performance ratings, (3) social recognition of excellence (e.g., selection by senior leadership team as 'expert' for the present study), and (4) additional qualifications (e.g., extra school responsibilities, Masters-level qualifications). Experts (N = 33) had M = 23.32 years' (SD = 11.23) experience in the profession; novices (N = 32) were pre-service teachers from a Dutch teacher training program with up to M = 1 year (SD = .00) of experience in the profession. Among experts, 23 males and 10 females participated; among novices, 16 males and 16 females participated.

Apparatus. Video stimuli of authentic classroom lessons were presented using the eye-tracking provider's in-house experimental platform, Experiment Centre 3.0, and were shown on a 22-inch laptop screen with 1680x1050 pixel resolution. Video-stimulated think-aloud was recorded using a standard microphone attached to the laptop. Eye movements were captured with a remote SMI RED250 eye tracking system had a temporal resolution of 250Hz and was mounted on the computer screen using the eye-tracking provider's in-house gaze-recording software, iView X 3.0. The eye-tracker was calibrated to the participant using a 13-point calibration system at the start of the experiment, followed by five-point validations (or calibration check-points) before presenting each of the four video stimuli.

Procedure. The experiment took 50 minutes. First participants provided demographic data pertaining to age, teaching experience, subjects taught or being studied, signed consent and release forms, and were familiarised with the eye tracking equipment

(Holmqvist et al., 2011) as well as the process of performing retrospective think-aloud. Participants viewed videos of four different classroom situations depicting actual lessons, but the teacher and students were unfamiliar to them. During the experiment they were asked to imagine themselves as the teacher in these situations and verbalise freely about anything they found relevant to classroom management.

Each video was viewed twice: the first viewing familiarised participants with video content to facilitate thinking aloud during the second viewing, which immediately followed the first. Before the second viewing, participants received the prompt, "We will play the video a second time. While the video is playing, please think aloud and express what you were thinking when you saw the video for the first time." Participants were prompted to continue talking when they remained silent for extended periods (e.g., 20 seconds). They were free to talk for as long as they wished and were asked to confirm when their think-aloud was complete. Eye movements were recorded throughout all video-viewing, but only eye movements during the second-viewing were linked directly to the retrospective thinking aloud.

Study 2: Retrospective think-aloud using gaze-cued own-perspective videos

Participants. Twenty UK teachers in one secondary school participated. Experts were identified using Palmer et al.'s (2005) criteria described above. Novices in the sample least conformed to these criteria and contrasted most with the experts in these respects. Experts (N = 10) had M =11 years (SD = 7.36) in the profession; novices (N = 10) had M = 3.23 years (SD = 2.46). In both the expert and novice sub-groups, four males and six females participated.

Apparatus. Teacher gaze was recorded using Tobii 1.0 eye-tracking glasses. Data rate was 30Hz, making one key frame one thirtieth of a second. The eye-tracker was calibrated to each participant using a nine-point calibration system. The glasses yielded a 640 x 480px video: 56 degrees horizontally, 40 degrees vertically. This eye-tracker made simultaneous recordings of the classroom scene and audio as well as the teacher gaze: this then constituted the gaze-cued own-perspective videos to be used during think-aloud.

The retrospective commentaries were recorded using a screen-recording software, Camtasia. Camtasia is installed separately and in addition to the eye-tracking analysis software, Tobii Studio 3.2.0. The gaze-cued own-perspective video was simultaneously presented using the eye-tracking software and recorded on-screen. The screen-recorder also recorded the interview audio, namely the audio from the gaze-cued own-perspective video and that from the interview itself.

Procedure. The procedure for collecting teachers' eye-tracking data is described in greater detail elsewhere (McIntyre et al., 2017). In brief, each participating teacher wore the eye-tracker during a lesson falling within the natural course of their curriculum. The eye-

tracking lasted for a total of ten minutes' worth of teacher-centred learning. Once eye-tracking was completed, a think-aloud appointment was scheduled with the teacher as soon after eye-tracking as possible (i.e., on the same day).

The think-aloud appointment lasted 30 minutes. During the appointment, the functionalities of the screen-recording software were explained. Next, the participant was given a tour of the gaze-cued own-perspective video-viewing interface (especially what and where the gaze cursor was) and the task of think-aloud commentary was explained to the participant. A short section of that participant's gaze-cued own-perspective video was presented to demonstrate how he or she might provide a think-aloud commentary in relation to that section. The participant then had a chance to practise the task before the 'real' commentary began. Throughout the session, participants had the option to pause the video when they wished to commentate, or to commentate over the video while it continued playing. If neither occurred, the first author would pause the video and invite think-aloud from the participant.

Analysis

The present manuscript reports a top-level summary of extensive mixed analysis (Onwuegbuzie & Hitchcock, 2015). Micro-level qualitative thematic analysis was applied to the think-aloud verbal data. We then ensured that research implications could emerge by drawing principles out from the micro-level detail. We did this by synthesising the micro-level thematic coding in terms of categories of teacher cognition before conducting quantitative analyses of how each respective think-aloud approach elicits differing teacher cognition more than the other think-aloud approach. Detailed analytic information and examples can be found across Supplemental Materials 1, 2, and 3.

Codes. The coding scheme used in both studies is derived from (Wolff et al., 2017) and should be consulted for more information concerning the development of coding categories, codes, and their definitions. Coders for the verbal data in both eye-tracking studies were trained by the creator of the original coding scheme. The coding scheme consisted of five categories of codes: *Perceptions and Interpretations, Themes & Focus, Temporality, Cumulative Cognitive Processing Codes* and *Relational Codes* (for full code explanations, see online Supplemental Material 1; for think-aloud excerpts as raw data examples of each thematic code, see online Supplemental Material 2). With one exception (*Cumulative Cognitive Processing*), all codes were applied to *idea units* in think-aloud transcripts: that is, sentence-like segments that expressing a clear thought or idea within each participant's think-aloud transcript.

However, codes under *Cumulative Cognitive Processing* were applied to the entire think-aloud transcripts, as these codes sought to distinguish expert-novice differences in participants´ overall expression of viewpoints, the degrees of interrelatedness between

actors and events, the temporal continuity of events and the level of certainty they had about what they were saying. Thus, whole transcripts were annotated as either taking single or multiple viewpoints, as either highly, partially or not-integrated, as discussing time with a sense of continuity or discontinuity, and as expressing certainty or uncertainty.

Code merges. Codes were analysed at three levels. First, coded data remained as they were when first coded: individual, *unmerged codes*. Next, codes underwent a *mid-merge,* which led each category to contain a smaller number of codes. Finally, codes underwent a *full merge* which collapsed all codes under the same theme. In other words, unmerged codes pertain to the codes taken straight from the original coding scheme. Even within the original scheme, these unmerged codes fell under five over-arching categories: these were used to perform full merges. Within each over-arching category, we also identified thematic clusters of (unmerged) codes: these thematic clusters were to conduct mid-merges (for full contents of each merge, see online Supplemental Material 1).

In analysis, *themes and focus* (full-merge 2) was found to have identical findings to *timescale* (full-merge 3). Accordingly, we left the latter full-merge and all sub-codes out of this report. However, this decision explains the jump from full-merge 2 to full-merge 4 in our report.

Inter-rater reliability. In both datasets, the primary coder applied the coding scheme to all verbal data. A second coder then coded 10% of the datasets. Because categorical data was coded, Cohen's Kappa was used as the reliability metric (de Vries, Elliott, Kanouse & Teleki, 2008). Weighted Kappa was used to take into account differing transcript lengths across participants (Cohen, 1968). Coding of the verbal data from the static eye-tracking study reached $K_w = .87$, near perfect agreement; coding of verbal data from the mobile eye-tracking study reached $K_w = .79$, substantial agreement (Viera & Garrett, 2005).

Statistical analyses. The present data was transformed into proportions and analysed using beta regression for two reasons: to address the differing sample sizes across the two datasets in the present analysis and to address the inability for count data to satisfy Gaussian assumptions. Zero-inflated variables are those containing zero values: these were present in parts of our data and as such were analysed using zero-inflated beta regression. The gamlss package (Rigby & Stasinopoulos, 2001, 2005) in R (Ihaka & Gentleman, 1996) was used to run beta regression analysis. Variables were all subjected to the standard BE model except those containing zeros, which were analysed using the BEZI family (Ospina, 2006; Ospina & Ferrari, 2010). Although the heteroskedastic nature of proportions is incorporated into beta regression analysis (Ferrari & Cribari-Neto, 2004), the logit link default for both BE and BEZI models meant that absent heteroscedasticity was not a

problem. The Cox-Snell residual (i.e., Rsq() from gamlss() package) was computed as our metric for goodness of fit.

The present data was analysed three times, once for each level of code merge. Unmerged codes each analysed as an outcome measure of video perspective with expertise (i.e., expert vs. novice) as covariate (model 1). Each was then analysed as an outcome measure of the video-perspective × expertise interaction term (model 2). Data from the *mid-merge* and *full merge* were then analysed as outcome measures of the same two beta regression models. Although miscellaneous verbalisations received the code *uncoded* (or *incomprehensible*), these are not addressed in the present paper. Rather, this category demonstrates the comprehensive approach to coding. Sub-group analyses were run to probe every statistically significant interaction.

Talk proportions were dependent variables throughout our analyses, with one exception. Counts were analysed to examine the subsidiary expectation in Hypothesis 1 that total think-aloud utterances would differ between the two video perspective conditions. Generalised regression models were run in R using the glm() function (Geyer, 2003). The Poisson family was used along with the default logit link function. The deviance residual (i.e., Dsquared () from modEvA () package, Barbosa et al., 2013) was computed as our metric for goodness of fit. As in the proportion analyses, the first model included video perspective as predictor and expertise as covariate (model 1); the second model analysed the interaction between video perspective and expertise (model 2).

To compare conditions (i.e., video perspectives) on the overall quantity of utterance that each video perspective elicits, proportion measures proportions were summed across the whole sub-group from each video perspective dataset: these yielded the 'total think-aloud utterance' measures. The differing sample sizes between the datasets were then taken into account by dividing the video perspective condition's summed proportion by its sample size. A beta regression model was run to confirm whether differences between video perspective conditions were statistically significant (shown in Table 2, which is additional to the main one shown in Supplemental Material 2).

Results

Results are organised according to this article's hypotheses[6]. General findings relating to the total utterance count will be reported for Hypothesis 1 only. Under both hypotheses, analyses of the data from the *full merge* is reported. For more meaningful results, each fully merged code's *mid-merge* codes, and their *unmerged* codes, are reported before analyses of the next fully merged code are addressed. Due to the large volume of codes, only statistically

[6] Due to the large quantity of codes, only statistically significant findings are reported.

significant results are reported. For full analytic results regarding total think-aloud utterances across video perspective conditions (i.e., others' videos vs. gaze-cued own-perspective videos), see Tables 2 and 3. For full analytic results regard talk *proportions*, see online Supplemental Material 2. Example utterances for each unmerged code are shown in Supplemental Material 3. The reader is invited to keep online Supplemental Material 1 at hand for clarity on which code is being referred to at each point.

The effect of video perspective on teacher cognition

Hypothesis 1 anticipated others' videos to prompt significantly different think-aloud responses to gaze-cued own-perspective videos. Others' videos ($\sum$ = .11) elicited significantly higher quantities of total think-aloud utterances than gaze-cued own-perspective videos ($\sum$ = .05), D = .43, b = -.30, s.e. = .02, z = -16.85, p < .001. Table 2 contains the full generalised regression outcomes for total think-aloud utterances. Table 3 shows the full descriptive statistics for total think-aloud utterance comparisons.

[Insert Tables 2 and 3 about here]

[Insert Figure 1 about here]

Classroom relationships. As expected, gaze-cued own-perspective videos led to more teacher talk regarding *classroom relationships* (full-merge 5) than others' videos (Figure 1), B=1.73, s.e.= .07, t = 24.41, p <.001. This indicates that gaze-cued own-perspective videos is linked with more talk about relations and interactions in the classroom.

The mid-merge codes under *classroom relationships* (full-merge 5) showed that gaze-cued own-perspective videos prompted more teacher talk relating to *affect* (mid-merge 15) than others' videos, B=2.35, s.e.= .14, t = 16.37, p <.001. Under *affect* (mid-merge 15), the unmerged code that was also discussed more in relation to gaze-cued own-perspective videos than with others' videos was *relational affect* (unmerged 50), B=1.77, s.e.= .13, t = 13.47, p <.001.

Another mid-merge code under *classroom relationships* (full-merge 5) discussed more in response to gaze-cued own-perspective videos was *relational links* (mid-merge 16), B= 1.34, s.e.= .08, t = 17.65, p <.001. Unmerged codes under *relational links* (mid-merge 16) further supported more discussion on *relational links* (unmerged 53), B= 2.52, s.e.= .10, t= 24.10, p <.001 and *teacher-to-student links* (unmerged 56), B=2.35, s.e.= .14, t =16.37, p <.001.

Perception and interpretation. Compared with gaze-cued own-perspective videos, others' videos prompted more teacher talk on *perception and interpretation* (full-merge 1, Figure 1), B=-.45, s.e.= .03, t = -14.53, p <.001. There was likely more variation in

the perceptions and interpretation in verbalisations prompted by others' videos than gaze-cued own-perspective videos.

Mid-merge codes under *perception and interpretation* (full-merge 1) were also discussed more in response to others' videos than gaze-cued own-perspective videos, namely *perception* (mid-merge 1), B= -.79, s.e.= .11, *t*= -7.11, *p* <.001. The unmerged code under A1 that provided further support was *visual perception* (unmerged 2), B=-.81, s.e.= .12, *t* =-7.01, *p* <.001.

In terms of other mid-merge codes under *perception and interpretation* (full-merge 1), *reasoning* (mid-merge 4) was also mentioned more in relation to others' videos than gaze-cued own-perspective videos, B=-.75, s.e.= .12, *t* = -6.39, *p* <.001. Unmerged codes under *reasoning* (mid-merge 4) corroborating this pattern were *explanation or reasoning* (unmerged 11), B=-.56, s.e.= .10, *t* = -5.58, *p* <.001, and *lesson structure* (unmerged 12), B= -1.24, s.e.= .26, *t* =-4.74, *p* <.001. Our expectation that others' videos would prompt deeper-level teacher cognition was therefore supported.

Themes and focus. Others' videos also prompted more discussions on teaching *themes and focus* (full-merge 2) than gaze-cued own-perspective videos (Figure 1), B= -.32, s.e.= .02, *t* = -17.67, *p* <.001. This suggests that viewing others' videos yielded more statements with a distinct theme and focus than gaze-cued own-perspective viewing.

Under *themes and focus* (full-merge 2), others' videos prompted more discussions regarding the mid-merge code of *student engagement* (mid-merge 5), B=-.49, s.e.=.10, *t*=-5.04, *p* <.001. Under *student engagement* (mid-merge 5), the unmerged code, *Attention toward off-task students* (unmerged 17), B=-1.22, s.e.=.15, *t* = -8.15, *p* <.001, was likewise discussed more in response to others' videos rather than gaze-cued own-perspective videos.

Under *themes and focus* (full-merge 2), others' videos prompted more teacher talk regarding *student behaviour* (mid-merge 6) than gaze-cued own-perspective videos, B=-1.61, s.e.=.16, *t*= -10.09, *p* <.001. Under *student behaviour* (mid-merge 6), the unmerged codes, *norms relating to problematic behaviour* (unmerged 20), B=-1.15, s.e.= .29, *t* = -3.90, *p* <.001, and *norms relating to notable posture* (unmerged 22), B=-1.00, s.e.= .42, *t* =-2.38, *p*=.02, were similarly discussed more in response to others' videos than gaze-cued own-perspective videos. Such analytical teacher talk reflects deeper cognition which, again, was prompted more by others' videos than by gaze-cued own-perspective videos.

Cumulative cognitive processing[7]. Unmerged codes found *multiple viewpoint* (unmerged 40, under mid-merge 11), B=-.40, s.e.= .12, *t*= -3.23, *p* =.002, *highly integrated perspective* (unmerged 41, under mid-merge 12), B=-.45, s.e.= .14, *t* = -3.15, *p* =.002, *scope continuous time* (unmerged 44, under mid-merge 13), B=-.74, s.e.= .10, *t* = -7.13, *p* <.001,

[7] Because of the way this category of codes were applied to full think-aloud transcripts, it was not appropriate to merge codes so analyses are only reported regarding unmerged codes.

and *certainty* (unmerged 46, under mid-merge 14), B=-.79, s.e.= .12, t = 6.80, p <.001, were discussed more with regard to others' videos than gaze-cued own-perspective videos. Once more, deeper reflections—now on perspective- and time-related matters—occurred more in relation to others' videos than to gaze-cued own-perspective videos.

The combined effect of video perspective and expertise on teacher cognition

Hypothesis 2 anticipated video perspective to combine with teacher expertise in the prediction of teacher cognition as reported through think-aloud. Specifically, *classroom relationships* (full-merge 5) were expected to be a function of this perspective–expertise interaction. Indeed, the only fully merged codes that showed a significant video-perspective x expertise interaction is *classroom relationships* (full-merge 5; Figure 3), B= -.29, s.e.= .14, t = -2.06, p = .04.

[Insert Figure 2 about here]

To probe this significant interaction, sub-group analyses were run. When watching others' videos, expert teachers reported more thoughts relating to classroom relationships than novices, b = .45, s.e. = .10, t = 4.46, p < .001. On the other hand, expertise differences in thoughts relating to classroom relationships disappeared in response to gaze-cued own-perspective videos (b=.16, s.e.= .08, t= 1.97, p = .07). Among experts, gaze-cued own-perspective videos prompted more discussion of classroom relationships than did others' videos, b = 1.61, s.e. = .08, t = 19.86, p < .001. This pattern also held among novices, b = 1.87, s.e. = .12, t = 16.08. p < .001.

The mid-merge code under *classroom relationships* (full-merge 5) that supported the interaction between video perspective and expertise was *relational links* (mid-merge 16), B= -.29, s.e.= .15, t = -1.90, p =.06. Under *relational links* (mid-merge 16), the unmerged code with a significant video-perspective x expertise interaction is teachers' talk regarding *relational links* (unmerged 53), B=-.30, s.e.= .14, t = -2.19, p = .03. When interactions were probed, the same patterns emerged with regard to both sub-levels of *relational links* (mid-merge 16, unmerged 53) as for *classroom relationships* (full-merge 5). Table 4 displays the full regression outcomes from these sub-group analyses.

[Insert Table 4 about here]

Discussion

The present article explored the relative advantages of two think-aloud approaches to expertise research. Specifically, we compared the use of *others' videos* versus *gaze-cued own-perspective videos* for investigations of teacher expertise. We found overall support for our hypotheses: each video perspective gained differing insight into teacher expertise during

retrospective think-aloud (Hypothesis 1) and video perspective did interact with expertise to predict aspects of teacher cognition, especially classroom relationships (Hypothesis 2).

The first hypothesis postulated that others' videos would prompt deeper teacher reflection than gaze-cued own-perspective videos. Indeed, participating teachers reported a significantly larger number of think-aloud comments in response to others-videos than gaze-cued own-perspective videos. Our analyses thus supported previous research claims that others' videos prompt a higher quantity of teacher reflection (see also Kleinknecht & Schneider, 2013; Seidel et al., 2011).

Others' videos enable teachers to access knowledge and analytic thought

Although some findings met our expectations, some analytic outcomes opposed these. One such finding was the way others' videos elicited more think-aloud regarding operational and problem-solving (i.e., *themes and focus*) than gaze-cued own-perspective videos. However, this unexpected result may relate to methodological factors. Whereas the sample in cited gaze-cued own-perspective research consisted only of novices (Hansen, 1991), the present sample involved experts as well. The professional task of classroom teaching is also arguably more complex than Hansen's (1991), whose participants performed an on-screen text-based task. These differences might explain the differing effects of the gaze-cued own-perspective approach to think-aloud research on expertise.

Moreover, given the time elapsed since the cited research, it is likely that the gaze-cues from the present research have significantly improved, resulting in a qualitatively different think-aloud experience for participants. As such, we may simply be reporting an update on the technological 'effects' of gaze-cued own-perspective videos on think-aloud responses. Nevertheless, others-videos also prompted more think-aloud relating to teachers' explanations and meta-cognition (van Gog et al., 2005), as measured by *perceptions and interpretations* and *cumulative cognitive processing* (i.e., perspectivity and time-related matters). The cited research made use of more recent eye-tracking technology, so that technological advancement may not explain the present unexpected findings. One possible explanation, instead, might be the difference between gaze-cued own-perspective video stimuli derived from laboratory-based task-performance (van Gog et al., 2005) versus real-world, classroom teaching as in our mobile eye-tracking data.

Although the two cited studies on which we based Hypothesis 1 use gaze-cued own-perspective videos as we did, they also used laboratory equipment and screen-based tasks. Although other preceding teacher research have used videos of classroom teaching from naturalistic settings (Kleinknecht & Schneider, 2013), these have only compared others' videos with own-videos—which are to be carefully distinguished from own-perspective videos, on the basis of the video camera position and the visual perspective each provides. No preceding teacher expertise research has used stimuli quite as immersive as ours, which

combined the own-perspective video with the participants' own gaze-cues. It thus appears that immersing teachers into their own teaching experiences (as with our gaze-cued own-perspective videos) may limit their access to more regulated and analytical cognitions. Indeed, one can imagine that it would be more difficult to stand back to look at one's own use of core teaching components when research stimuli engages one more vividly with the lived experience.

Real-world immersion optimises investigations of classroom relationships

As anticipated in Hypothesis 1, gaze-cued own-perspective videos prompted greater immersion than others' videos. This was supported by more think-aloud responses relating to *classroom relationships* in response to gaze-cued own-perspective videos (M. Omodei et al., 2002; Seidel et al., 2011). As anticipated in Hypothesis 2, video perspective did indeed combine with expertise to predict teachers' think-aloud regarding *classroom relationships*.

However, expert–novice differences on this theme vanished from think-aloud was subsetted by video perspective (Hypothesis 2). Whereas expertise differences are retained for think-aloud responses to others' videos, these disappear among respondents to gaze-cued own-perspective videos. *Classroom relationships* may be of equal importance to both experts and novices when provided with the gaze-cued own-perspective view on classroom instruction, especially when this perspective is additionally overlaid with their own gaze patterns. It may thus be that *classroom relationships* are central to teachers' experiences of classroom teaching and their relevance becomes more prominent when videos from their own perspective—accentuated by displays of their own attentional patterns—are being replayed.

Our think-aloud analyses echo existing eye-tracking research that highlight the unique value of real-time videos derived from real-world settings (for a review, see Risko et al., 2012). The potential for participants to socially interact with the videoed actors has been found to increase relational cognitions (Laidlaw et al., 2011). Thus, not only do videos of real people and social interactions prompt teachers' social cognition, but participants' real-world experiences of directly interacting with the people in these videos are likely to enhance immersion which, in turn, increases teachers' cognitions specific to the videoed social context (Foulsham et al., 2011, p. 1920): that is, their classroom relationships.

Implications and Conclusions

Our research findings carry several implications for methodological decision-making in teacher expertise research. One implication is that, wherever possible, future research on teacher expertise should endeavour to use gaze-cued, own-perspective video stimuli to examine teachers' cognitions about classroom relationships. More generally, we would underscore the importance of maximising immersion for investigating teachers' thoughts and behaviours relating to classroom relationships. However, video immersiveness does

seem to come as a trade-off to reduced capacities in other cognitive processes that are important to effective teaching. Together with existing literature, our research suggests that own-videos (cf. Seidel et al., 2011) and own-perspective videos (cf. Jaeger, 2016) have the potential to make the most of the first-person perspective without losing the deep, analytic thought to a more immersive technique.

Future research endeavours might further delineate the role of particular components of each think-aloud approach. This can be done via laboratory investigations that add individual methodological components cumulatively to each think-aloud framework for clarity on the effect of each component of each approach. Alternatively, a special focus can be given to the role of eye-tracking in teachers' think-aloud by developing a coding scheme that seeks out utterances relating to what teachers see at the time of think-aloud, what they saw and looked for during classroom instruction (for studies using own-perspective videos) or what they believe teacher should be looking for (for studies using others' videos). Indeed this is analysis that can be carried out on our own dataset. A further variation of empirical enquiry into the methodological components of video-stimulated think-aloud is to focus on own-perspective videos: how does teacher think-aloud differ when such videos are gaze-cued versus when they are not (i.e., when only head-mounted videos are used)? One other future research endeavour might be to take a thematic focus by asking, what the present thematic analyses entail with regard to teaching in the real-world context. Particular insight can be gained from asking this question of the gaze-cued own-perspective study, since such pedagogical implications have yet to be published from that dataset.

Video-stimulated think-aloud is related to video-stimulated professional development. An exciting strand of expertise research has been exploring the potential of and extent to which gaze-cued video stimuli can support novices' progression towards expertise (e.g., Van Marlen et al., 2018). Our research offers insights relating to this endeavour. Namely, for professional development activities focused on classroom relationships, we recommend the use of immersive stimuli, such as gaze-cued own-perspective videos rather than the use of others-videos. For anything else, we caution against the side effects of video immersion, especially where the profession is contextualised within a dynamic setting in the way that teaching is contextualised within the classroom.

In addition to how teacher professional development can be carried out, the present research also echoes existing literature in its implications for the content of such initiatives. Teachers need to keep on building relevant subject knowledge and instructional strategies: one does not have emphasis over the other. Continual reflection should also be fostered to develop one's ability to process classroom scenarios deeply rather than superficially. Thus, rather than focusing on students' behaviour and task orientation, teachers are called to focus more on students' perspective such as their learning and motivational needs.

Limitations

There is some debate around potential shortcomings of think-aloud methodology. Quite recently, Schooler (2011) published a comment piece wherein he drew attention to the potential for verbalisation in research by necessity involves introspection which can often change, even impair, subsequent performance. Therefore, Schooler warned that think-aloud may have such reactive effects bring about detrimental consequences in professional contexts that the research participants subsequently return to. In response, Ericsson and Fox (2011) emphasised that think-aloud generates distinctive verbal data by accessing thoughts that precede introspection in its very design, requiring no generation of new thoughts or explanation. As such, think-aloud is by definition *not* introspective. Additionally, they refer to meta-analytic evidence against reactivity from think-aloud, in contrast to "introspective methods, which change observed performance and, by inference, task-related processes" (p. 351).

Nevertheless, we are only proponents of the think-aloud method insofar as the approach—or a specific strand of it—is appropriate to the research question. From the cognitive psychological perspective on educational research, the faithful application of this method affords objectivity from traditionally unanticipated channels such as participants' verbal data. However from, for example, the ethnographic, psychoanalytic and therapeutic perspectives, objectivity is not a value to prioritise. In such research endeavours, the subjective experience is of central importance and these are most effectively discovered by probing participants for inferences and repeated recoding of one's representations (i.e., 'level 3' verbalisation, Ericsson & Simon, 1980).

There are between-study differences in novice teachers' experiences in this research. Whereas novices in the *others' video* study were pre-service teachers, novices in the *gaze-cued own-perspective* study were in-service teachers. We adopt the relative approach to expertise (M. T. Chi, 2006) and recognise the importance of context in expertise, especially teacher expertise (Fauth et al., 2020). Context-specific categorisations of expert versus novice teachers matter more when context-specific factors are relevant to teacher cognition: because context-specific assessments and experience are more relevant in the *gaze-cued own-perspective* study, it is more important for expertise to be contextually defined there than in the *others' video* study. Nevertheless, we recognise that this comment does not fully resolve the potential that between-study differences in general professional experience may have played a role in the between-study differences in teachers' verbalised cognitions. A replication of the current study in future might consider resolving this shortcoming in future.

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Tables

Table 1

Summary of methodological similarities and differences between the two studies in our analysis

	Similarities	**Differences**	
	Both studies	***Others' video***	***Own-perspective video***
Design	Expert–Novice comparison	Observer's perspective on the lesson	One's own perspective on the lesson
Stimuli	Real-world secondary school classroom videos	Four standardised videos presenting different situations	One 10-minute video of one teacher's own lesson with controls at data collection and analysis
Procedure	Retrospective think-aloud	Pausing not an option during video-viewing	Pausing allowed while viewing video
Set-up	In participating teachers' own school	Static eye-tracker, attached to computer screen	Mobile eye-tracker worn as glasses during teaching

Note. In the 'vs.' column, the = symbol denotes a similarity between the two datasets and the ≠ denotes a difference between data sets. See introductory paragraph of Method for narrative discussion regarding between-study differences in this paper.

Table 2

Poisson regression outcomes in comparisons of total think-aloud utterances

		D	b	s.e.	z	p
Model 1		.43				
	Video perspective		-.30	.02	-16.85	< .001
	Expertise		.34	.01	23.57	< .001
Model 2		.07				
	Interaction		.04	.008	4.89	< .001

Note. Video perspective was coded as 1 = Others-Videos, 2 = Own-perspective videos. Expertise was coded as 1 = Novice, 2 = Expert.

Table 3

Descriptive statistics for total think-aloud utterances

Video perspective	Expertise	Mean	S.D.	Median	Minimum	Maximum	Range
Others' video	Novice	218.31	46.75	220.50	104.00	308.00	204.00
Others' video	Expert	292.48	57.49	299.00	182.00	464.00	282.00
Own-perspective	Novice	139.80	56.24	132.50	80.00	238.00	158.00
Own-perspective	Expert	237.00	74.98	258.00	126.00	332.00	206.00

Table 4

Sub-group analytic outcomes for Classroom Relationship (full-merge 5)

Subgroup Analysis	Video perspective	Expertise	Talk theme	R^2	b	s.e.	t	p
1	Others-video	Not applicable	FM5 Classroom relationships	.24	.45	.10	4.46	< .001
			MM16 Relational links	.23	.45	.10	4.31	< .001
			UM53 Relational links	.24	.45	.10	4.51	< .001
2	Own-perspective	Not applicable	FM5 Classroom relationships	.16	.16	.08	1.97	.07
			MM16 Relational links	.13	.17	.09	1.75	.10
			UM53 Relational links	.14	.15	.08	1.77	.10
3	Not applicable	Experts	FM5 Classroom relationships	.88	1.61	.08	19.86	< .001
			MM16 Relational links	.80	1.23	.08	14.67	< .001
			UM53 Relational links	.79	1.11	.08	14.16	< .001
4	Not applicable	Novices	FM5 Classroom relationships	.83	1.87	.12	16.08	< .001
			MM16 Relational links	.72	1.48	.13	11.58	< .001
			UM53 Relational links	.72	1.39	.12	11.75	< .001

Note. FM = Full-merge, MM – Mid-merge, UM = Unmerged code.

Figures

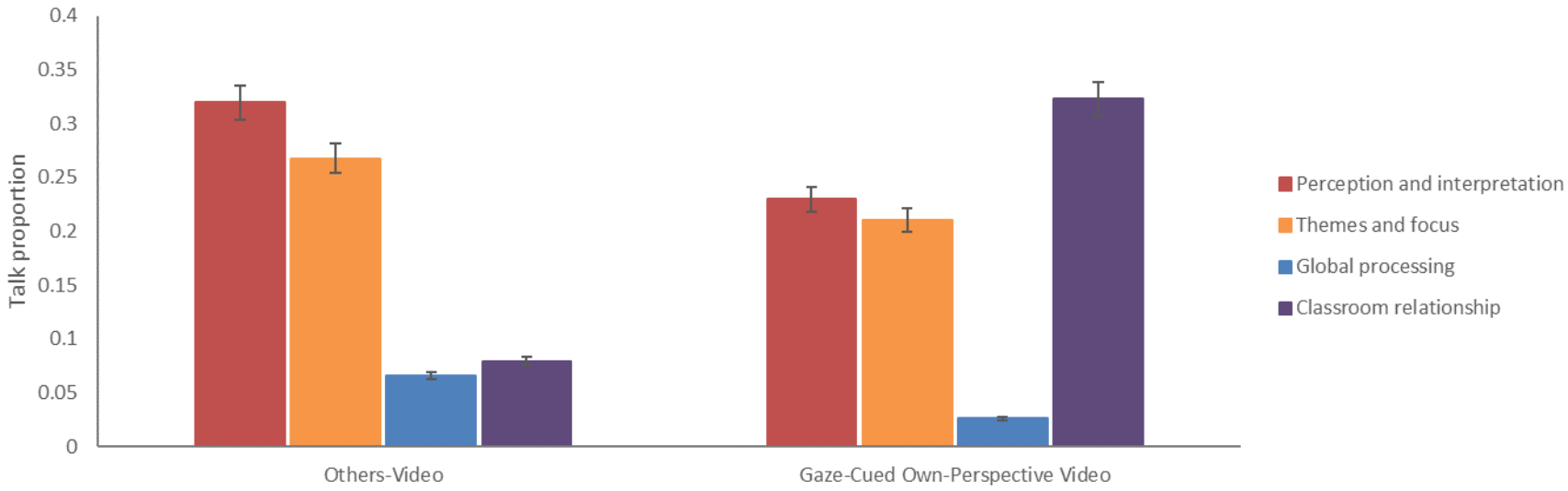

Figure 1. Bar chart showing differences in teachers' think-aloud across video perspectives. All differences were statistically significant.

Figure 2. Line graph showing the effect of expertise on teacher talk for each, others-videos and gaze-cued own-perspective videos. Expertise was only found to moderate video perspective in predicting think-aloud reports of teacher cognition relating to *classroom relationships* (B5).

Supplemental Material 1

Teacher verbalisation categories applied to our think-aloud data and category merges

Code label	Code details	Code definition
Perception and Interpretation (full-merge 1)		***All codes within the Perception and Interpretation category analysed together***
Perception (mid-merge 1)		*Four codes concerning visual and audio perception, descriptions of missing perceptual information, and incomprehensible statements combined into one sub-category named Perception*
Unmerged 2	Type 1.01 Perception Visual	Statements simply describing what is seen in the video
Unmerged 3	Type 1.02 Perception Audio	Statements simply describing what is heard in the video
Unmerged 4	Type 1.03 Perception: Missing Info	Statements mentioning something which cannot be seen or heard, such as people or activities which are not captured by the camera
Unmerged 5	Type 1.04 Perception Incomprehensible Statement	Statements which are incomplete, do not convey a clear meaning, which cannot be coded
Inference (mid-merge 2)		*Two codes concerning inferences, either about students or teachers, combined into one sub-category named Inference*
Unmerged 6	Type 1.05 Inference Student	Suppositions about students' cognitive and/or affective states (ex. what students are thinking or feeling or what their intentions are)
Unmerged 7	Type 1.06 Inference Teacher	Suppositions about the teacher´s cognitive and/or affective states (ex. what the teacher is thinking, feeling, or presumed to be able to hear or see)
Explication of Consequences (mid-merge 3)		*Three codes concerning explications and consequences about student learning, student behaviour, and classroom management combined into one sub-category named Explication of Consequences*
Unmerged 8	Type 1.07 Consequence Student Learning	Speculation about the level of learning or uptake in the lesson. May refer to an individual student or a group of students, including discussion of consequences for learning
Unmerged 9	Type 1.08 Consequence Classroom Management	Speculation about potential outcomes in the lesson with a particular focus on consequences framed in terms of managing the classroom

Unmerged 10	Type 1.09 Consequence for Behaviour	Speculation about an action that a student or the teacher will soon take
Reasoning (mid-merge 4)		*Three codes concerning explanations and reasoning about classroom events, the lesson structure/classroom climate, and the quality of instruction or learning combined into one sub-category named Reasoning.*
Unmerged 11	Type 1.10 Explanation or Reasoning	Statements extending participants' thoughts or thought processing, justifying their inferences and/or predictions, or providing a premise for the actions or intentions being described. Sometimes these statements come across as evaluative.
Unmerged 12	Type 1.10.1 Lesson Structure or Classroom Climate	Comments conveying thoughts about the organization or quality of the lesson structure, flow of the class, or conditions of the classroom overall.
Unmerged 13	Type 1.10.2 Quality of Instruction or Learning	Comments evaluating the instructional and pedagogical choices of the teacher, sometimes in relation to the student's and how appropriate or not these choices are.
Unmerged 14	Type 1.11 Uncoded	
Themes and Focus (full-merge 2)		***All codes within the Themes and Focus category analysed together***
Student Engagement (mid-merge 5)		*Three codes concerning levels of student learning, student attention being on-task, and student attention being off-task combined into one sub-category named Student Engagement.*
Unmerged 16	Type 2.01 Learning	Thoughts focused on outcomes which place the emphasis on individual or collective student learning. This goes beyond simply stating whether or not students are paying attention; collective may refer to a group of students or the whole class.
Unmerged 17	Type 2.02 Attention Student Off-Task	Attention of student(s) is/are not engaged in teacher instruction or lesson activity. Student(s) are actively distracting others, student(s) are actively being distracted by another student, or student(s) are busily engaged in self-created distractions
Unmerged 18	Type 2.03 Attention Student On-Task	Student(s) is/are engaged in lesson activity and listening or interacting with the teacher
Student Behaviour (mid-merge 6)		*Four codes concerning classroom discipline and rules, problematic behaviour, unproblematic behaviour, and noteworthy posture/movements combined into one sub-category named Student Behaviour.*
Unmerged 19	Type 2.04 Discipline and Rules	Thoughts focused on outcomes which place the emphasis disciplinary concerns, particularly disorderly, distracting, or unacceptable behavior and/or involving non-compliance with rules.

Unmerged 20	Type 2.05 Norms Behaviour Problematic	Student behavior explicitly or implicitly described as strange, problematic, or as defying expectations, which may include not being properly prepared to take part in the lesson activity
Unmerged 21	Type 2.06 Norms Behaviour Unproblematic	Student(s) behavior is described as acceptable, in alignment with participant's expectations, or not troublesome
Unmerged 22	Type 2.07 Norms Notable Posture	Student posture or bodily movements explicitly or implicitly described as unusual or noteworthy [how a student is sitting, oriented, or their bearing; sometimes includes falling asleep in class]
Student and Situational Types (mid-merge 7)		*Four codes concerning specific types of students, specific types of situations, contextualized commentary, and generalised commentary combined into one sub-category named Student and Situational Types.*
Unmerged 23	Type 2.08 Type of Student	Reference to a familiar type or kind of student
Unmerged 24	Type 2.09 Type Situation	Reference to a familiar type or kind of classroom event or situation
Unmerged 25	Type 2.10 Commentary Contextised	Thoughts on or about actors and events specific to the situation occurring in the video
Unmerged 26	Type 2.11 Commentary Generalised	Thoughts on or about classroom events and actors which apply in a general manner, not to particular events in the video
Teacher Perspective (mid-merge 8)		*Four codes concerning statements about one´s self as teacher, the teacher´s role and influence, actions taken by the teacher, and the teacher not taking action combined into one sub-category named Teacher Perspective.*
Unmerged 27	Type 2.12 Self-As-Teacher	Commentary or suggestions specifying what the participant would do as a teacher
Unmerged 28	Type 2.13 Teacher Role and Influence	Statements describing the role and influence the teacher has on classroom events, situations, or students
Unmerged 29	Type 2.14 Teacher Action Taken	Statements simply referencing what the teacher says or does
Unmerged 30	Type 2.15 Teacher Does, Sees, Says Nothing	Statements noting that the teacher is not aware of (i.e., does not see) or does not address a problematic classroom event (and presumably should)
Unmerged 31	Type 2.16 Uncoded	
Cumulative Cognitive Processing (full-merge 4[a])		***All codes within the Cumulative Cognitive Processing category analysed together***
Viewpoint (mid-merge code 11)		*Two codes concerning single or multiple points of view expressed combined into one sub-category named Viewpoint.*

Unmerged 39	Type 4.01 Viewpoint Single	Only one point of view is represented, for example, only that of the student(s) or that of the teacher
Unmerged 40	Type 4.02 Viewpoint Multiple	More than one point of view is expressed, for example, that of the student *and* the teacher or that of the participant and actors in the video
Perspective (mid-merge 12)		*Three codes concerning how integrated the expressed perspective is combined into one sub-category named Perspective.*
Unmerged 41	Type 4.03 Perspective Highly Integrated	Reports on what is seen, heard, or understood to be happening which express an interrelated perception of events, accounts for multiple concerns of relevance to classroom management, relates teacher and student interactions *and* conveys a progressing awareness of how various classroom factors interrelate with one another, and also expresses a clear goal related to principles of teaching and learning.
Unmerged 42	Type 4.04 Perspective Partially Integrated	Reports on what is seen, heard, or understood to be happening which express an interrelated perception of events, accounts for multiple concerns of relevance to classroom management, relates teacher and student interactions.
Unmerged 43	Type 4.05 Perspective Nonintegrated	Reports what is seen, heard, or understood to be happening which focus on a single aspect relevant to classroom management [Note: even if multiple events or students are referred to, they are isolated if no connections are described and the protocol overlooks the complexity of interactions]
Scope (mid-merge 13)		*Two codes concerning the timescale of events and the degree of continuity expressed combined into one sub-category titled Scope.*
Unmerged 44	Type 4.06 Scope Continuous Time	Referencing preceding events in the video and describing their relevance in relation to the current or future situation
Unmerged 45	Type 4.07 Scope Discontinuous Time	Scarcely or never references preceding or subsequent events in the video
Certainty (mid-merge 14)		*Two codes concerning the degree of certainty expressed combined into one sub-category named Certainty.*
Unmerged 46	Type 4.08 Certain	The interpretive processing expressed in the description of the event is certain and suggests that further interpretation may be possible, for example, if the video quality were better or if additional information were available a more conclusive interpretation could follow
Unmerged 47	Type 4.09 Uncertain	The interpretive processing expressed in the description of the event is inconclusive, conveys uncertainty, and lacks wording suggesting that the interpretation could be extended

Unmerged 48	Type 4.10 Uncoded	
Classroom Relationships (full-merge 5)		***All codes within the Relational Codes category analysed together***
Affect (mid-merge 15)		*Codes concerning affect treated as one sub-category named Affect.*
Unmerged 50	Type 5.01 Relational Affect	Making observations about the emotions, feelings, or moods of actors in the video [expressed through facial, vocal, or other visible gestures]
Unmerged 51	Type 5.01.1 Negative	For example, sad, angry or nervous.
Unmerged 52	Type 5.01.2 Positive	For example, happy or excited.
Relational Links (mid-merge 16)		*Codes concerning relational links between actors in the video and how they are inter-related combined into one sub-category named Relational Links.*
Unmerged 53	Type 5.02 Relations between actors	Specifying a relationship between actors within the scope of an event (which may be ongoing)
Unmerged 54	Type 5.02.1 Student to Student	Relation between two particular students
Unmerged 55	Type 5.02.2 Student(s) to Group of Students	Relation between the teacher and a student or group of students
Unmerged 56	Type 5.02.3 Teacher to Student(s)	Relation between a student or students and other groups of students, which may include the whole class
Unmerged 57	Type 5.03 Uncoded	
Unmerged 58	General Uncoded	

Note. [a] In analysis, *themes and focus* (full-merge 2) was found to have identical findings to *timescale* (full-merge 3). Accordingly, we left the latter full-merge and all sub-codes out of this report. However, this decision explains the jump from full-merge 2 to full-merge 4 in our report.

Supplemental Material 2

All outcomes from beta regression analyses of think-aloud talk proportions

		Model 1									Model 2 (with interaction)				
			Video perspective				Expertise					Interaction			
		R^2	b	se	t	p	b	se	t	p	R^2	b	se	t	p
FM1		.73	-.45	.03	-14.53	<.001	.05	.02	2.01	.05	.74	-.07	.06	-1.21	.23
	MM1	.59	-.79	.11	-7.11	<.001	-.62	.08	-7.63	<.001	.59	.05	.23	.23	.82
	MM2	.48	1.00	.11	8.83	<.001	.39	.12	3.42	.00	.54	-.78	.22	-3.57	.00
	MM3	.35	1.11	.15	7.47	<.001	.09	.15	.58	.57	.35	.06	.31	.21	.84
	MM4	.48	-.75	.12	-6.39	<.001	.44	.09	5.11	<.001	.48	.09	.24	.37	.71
	UM2	.60	-.81	.12	-7.01	<.001	-.68	.08	-8.09	<.001	.60	.01	.24	.05	.96
	UM3	.04	-.10	.21	-.50	.62	-.27	.14	-1.92	.06	.05	-.28	.47	-.61	.54
	UM4	.01	.12	.15	.77	.44	.04	.17	.21	.83	.01	.22	.47	.47	.64
	UM5	.18	.60	.05	12.66	<.001	-.23	.06	-4.00	<.001	.18	.12	.08	1.49	.14
	UM6	.42	.89	.12	7.70	<.001	.41	.12	3.51	.00	.46	-.57	.23	-2.47	.02
	UM7	.12	.45	.18	2.57	.01	-.23	.18	-1.32	.19	.12	-.18	.38	-.48	.63
	UM8	.18	1.17	.46	2.54	.01	-.51	.17	-3.04	.00	.002	-.05	.12	-.41	.68
	UM9	.02	.29	.20	1.48	.14	.06	.20	.29	.77	.02	-.05	.42	-.11	.91
	UM10	.09	.71	.25	2.89	.00	.02	.24	.07	.94	.09	.13	.54	.24	.81
	UM11	.42	-.56	.10	-5.58	<.001	.35	.08	4.59	<.001	.42	.23	.20	1.12	.26
	UM12	.30	-1.24	.26	-4.74	<.001	.30	.12	2.44	.02	.32	-.73	.52	-1.40	.16
	UM13	.16	-.24	.18	-1.33	.19	.57	.15	3.78	<.001	.17	-.40	.37	-1.09	.28
FM2		.80	-.32	.02	-17.67	<.001	-.06	.01	-4.00	<.001	.80	.01	.04	.28	.78
	MM5	.28	-.49	.10	-5.04	<.001	-.15	.07	-2.02	.05	.28	.00	.19	.01	.99
	MM6	.71	-1.61	.16	-10.09	<.001	-.39	.08	-4.94	<.001	.72	.65	.32	2.06	.04
	MM7	.24	.37	.09	3.92	<.001	.31	.09	3.53	.00	.26	-.27	.19	-1.47	.15

	MM8	.18	.46		.11	4.15	<.001		.16	.10	1.53	.13		.23	-.53		.22	-2.48	.02
	UM16	.13	.26		.14	1.89	.06		.43	.14	2.95	.00		.20	-.77		.28	-2.72	.01
	UM17	.57	-1.22		.15	-8.15	<.001		-.34	.09	-3.75	<.001		.57	.16		.30	.55	.59
	UM18	.18	.55		.12	4.46	<.001		-.15	.11	-1.33	.19		.18	-.04		.25	-.15	.88
	UM19	.22	-.31		.25	-1.25	.22		-.79	.17	-4.56	<.001		.22	.13		.50	.26	.79
	UM20	.37	-1.15		.29	-3.90	<.001		-.35	.10	-3.31	.00		.35	-.43		.07	-6.00	<.001
	UM21	.06	-.06		.18	-.35	.73		-.35	.15	-2.41	.02		.10	.68		.36	1.89	.06
	UM22	.09	-1.00		.42	-2.38	.02		.02	.15	.16	.87		.09	.16		.98	.17	.87
	UM23	.12	.60		.19	3.12	.00		-.34	.20	-1.71	.09		.12	-.22		.40	-.55	.58
	UM24	.02	.16		.19	.83	.41		.23	.21	1.09	.28		.02	-.24		.42	-.56	.58
	UM25	.28	.53		.11	4.96	.00		.33	.10	3.18	.00		.32	-.46		.21	-2.20	.03
	UM26	.16	-.82		.29	-2.79	.01		-.30	.14	-2.20	.03		.16	-.05		.59	-.09	.93
	UM27	.03	-.11		.18	-.59	.55		-.23	.16	-1.51	.14		.03	.20		.36	.56	.58
	UM28	.20	.29		.15	1.95	.05		.58	.14	4.06	<.001		.25	-.70		.29	-2.37	.02
	UM29	.32	.80		.14	5.90	<.001		-.44	.13	-3.29	.00		.32	-.02		.27	-.09	.93
	UM30	.05	.06		.24	.25	.80		-.34	.16	-2.10	.04		.05	-.01		.51	-.01	.99
FM4		.72	-.98		.09	-11.12	<.001		-.35	.06	-6.06	<.001		.72	-.20		.18	-1.12	.27
	MM11	.72	-.95		.09	-11.21	<.001		-.33	.05	-6.07	<.001		.73	-.21		.17	-1.21	.23
	MM12	.72	-.95		.09	-11.21	<.001		-.33	.05	-6.07	<.001		.73	-.21		.17	-1.21	.23
	MM13	.72	-.95		.09	-11.21	<.001		-.33	.05	-6.07	<.001		.73	-.21		.17	-1.21	.23
	MM14	.72	-.95		.09	-11.21	<.001		-.33	.05	-6.07	<.001		.73	-.21		.17	-1.21	.23
	UM39	.19	-1.18	>1.00		.00	1.00		-.78	.19	-4.16	<.001		.19	.78	>1.00		.00	1.00
	UM40	.17	-.40		.12	-3.23	.00		.28	.11	2.64	.01		.33	-1.02		.22	-4.53	<.001
	UM41	.12	-.45		.14	-3.15	.00		.11	.11	.98	.33		.16	-.60		.28	-2.11	.04
	UM42	.15	.00		.17	.00	1.00		-.47	.13	-3.78	<.001		.15	-.06		.44	-.14	.89
	UM43	.08	-1.62	>1.00		.00	1.00		-.69	.28	-2.48	.02		.08	.69	>1.00		.00	1.00
	UM44	.44	-.74		.10	-7.13	<.001		-.02	.07	-.25	.80		.49	-.56		.20	-2.81	.01
	UM45	.03	-1.72	>1.00		.00	1.00		-.56	.37	-1.51	.14		.03	.56	>1.00		.00	1.00
	UM46	.45	-.79		.12	-6.80	<.001		-.19	.08	-2.42	.02		.46	-.33		.23	-1.40	.16
	UM47	.09	.18		.38	.48	.63		-.53	.18	-2.90	.00		.06	-.30		.15	-2.03	.05

FM5		.85	1.73	.07	24.41	<.001	.31	.07	4.42	<.001	.86	-.29	.14	-2.06	.04
	MM15	.67	2.35	.14	16.37	<.001	.05	.12	.44	.66	.67	-.09	.29	-.30	.77
	MM16	.76	1.34	.08	17.65	<.001	.32	.08	4.28	<.001	.77	-.29	.15	-1.90	.06
	UM50	.60	1.77	.13	13.47	<.001	.06	.12	.52	.60	.60	-.10	.26	-.38	.71
	UM51	.00	NA	NA	NA	NA	.12	.24	.50	.62	.00	.06	.12	.50	.62
	UM52	.00	NA	NA	NA	NA	.11	.23	.47	.64	.00	.05	.12	.47	.64
	UM53	.75	1.23	.07	17.42	<.001	.31	.07	4.36	<.001	.77	-.30	.14	-2.19	.03
	UM54	.02	-.26	.19	-1.35	.18	.05	.14	.40	.69	.04	-.45	.38	-1.18	.24
	UM55	.04	-.30	.17	-1.75	.08	.09	.12	.71	.48	.04	-.05	.36	-.13	.89
	UM56	.81	2.52	.10	24.10	<.001	.16	.09	1.91	.06	.81	-.28	.23	-1.23	.22

Note. TA = Think-aloud, FM = Full-Merge; MM = Mid-Merge; UM = Unmerged codes. Video perspective was coded as: Others' videos = 1, Gaze-cued own-perspective videos = 2. Unavailable analyses (indicated by NA) are due to the effect being uncomputable, such as when datapoints were insufficient for analysis.

Supplemental Material 3

Example utterance for each category applied to our think-aloud data.

Code label	Code details	Example utterance (Participant code)
Perception and Interpretation (full-merge 1)		
Perception (mid-merge 1)		
Unmerged 2	Type 1.01 Perception Visual	"OK…So I was trying to sort of get everybody, making sure who was, uh…Watching, just trying to find out who was watching this way." (A6) "So I'm scanning around to say that the information is for everyone to take in, it's not a one-to-one." (A12) "OK I'm just scanning the classroom now just to, just to see Who's been answering the questions that are on the board." (A18)
Unmerged 3	Type 1.02 Perception Audio	"And then I'm listening to Joe here, doing the feedback, and listening to them." (A5) "Make sure everyone knows What they're doing, So I'm just reading the questions out And waiting for responses." (A9)
Unmerged 4	Type 1.03 Perception: Missing Info	"Um, so [name] I can't, can't…I can't hear what he's actually um… [saying]." (A1) "Yes I had a real go at them yesterday about the fact that their exam was very soon." (A5) "By checking them [the boys] I then saw we've got a bit of eh… well, she's obviously laughing at something, be it the glasses, I don't know, but what I perceive is it's with someone on my far left who is off screen now." (A8)
Unmerged 5	Type 1.04 Perception Incomprehensible Statement	[Statements which are incomplete, do not convey a clear meaning, which can not be matched with a code.]
Inference (mid-merge 2)		
Unmerged 6	Type 1.05 Inference Student	"Uh, he's, he's a very Intelligent young man, um, he's quite a sensitive young man as well, um, And, it's, trying to not make him feel as though he, Isn't wanted, in terms of his response, but, also not To allow him to take over the whole." (A1)

		"She's one of my more disruptive girls, So I'm just making sure she's coming in quietly and not disrupting too much, Trying to get her settled." (A2) "I already recognised that they were trouble and they are regularly off task, So I was just making sure that they were doing what they were meant to be doing, And I think I saw at that point that they weren't." (A3)
Unmerged 7	Type 1.06 Inference Teacher	"I think I'd probably seen that they were a little bit, um, maybe, engaged in writing rather than have a [whole class] discussion [as they should have been]." (A3) "I couldn't work out where Jack was moving and then I Realised he hadn't got a chair." (A5) "And I could hear that they Were saying something so I turned round to see what they were doing." (A16)
Explication of Consequences (mid-merge 3)		
Unmerged 8	Type 1.07 Consequence Student Learning	"Um, I'm asking him if he doesn't understand, or knows something, or…Has an answer or something, so then I asked someone to help him." (A1) "And I'm just checking the rest of the room: you can usually tell by facial expressions, if they've got it or not." (A5) "People disagreeing was exactly what I wanted, really, There was some really good discussion, so they're not just thinking about um, what he might include, or what you might not." (A14)
Unmerged 9	Type 1.08 Consequence Classroom Management	"Right, and I'm trying to settle Meg down, there, right Joe's watching." (A5) "There's less distraction there, they're also thinking as a class. Everyone's building on it. It allowed me to control it a lot more easily as well 'cause I could see everyone was focused in on the discussion." (A8) "I'm just scanning the class to really check students are listening, on task, and to make sure that they are doing what they should be doing, if they are…it's a mixed group, so some of the individuals are now—" (A15)
Unmerged 10	Type 1.09 Consequence for Behaviour	"I'm looking at the boy next to the one I'm talking to because I'm expecting him to get involved as well." (A8) "By me looking, I'm expecting they will look, yeah." (A17)
Reasoning (mid-merge 4)		

Unmerged 11	Type 1.10 Explanation or Reasoning	"Sometimes I think I'm quite conscious of eye contact with people and I think, sometimes I kind of go, ooh I've been staring at them while I've been talking, so just, look off somewhere else and then go back to them." (A6) "I'm actually looking at the girl in front, because she's looking sideways, rather than at the boy that was speaking, so I'm looking really at what she's looking at." (A7) "Constantly, I'm constantly looking at the board, trying to almost tease answers out of them, and to try and notice things that will generate myself to make a question that would make or prompt them for an answer." (A10)
Unmerged 12	Type 1.10.1 Lesson Structure or Classroom Climate	"That's why I used the horseshoe layout for this particular lesson; this is not my usual seating plan. However, for this lesson, as it is, it's a discussion, I need them all focusing in on me." (A8) "Constantly, I'm constantly looking at the board, trying to almost tease answers out of them, and to try and notice things that will generate myself to make a question that would make or prompt them for an answer." (A10)
Unmerged 13	Type 1.10.2 Quality of Instruction or Learning	"At this point you notice I actually felt I'm too middle-focused [laughing] and I started moving, and I, in a bit, I go and walk round the room, because I was realising that I was stuck at the front, and not helping, not moving it around as much." (A5) "I look at my own computer screen because in this classroom the interactive whiteboard doesn't work, and the quality is really poor. And so I always end up looking at the desktop so I can look at that one [version] as well." (A10)
Unmerged 14	Type 1.11 Uncoded	
Themes and Focus (full-merge 2)		
Student Engagement (mid-merge 5)		
Unmerged 16	Type 2.01 Learning	"There's less distraction there, they're also thinking as a class. Everyone's building on it. It allowed me to control it a lot more easily as well 'cause I could see everyone was focused in on the discussion." (A8) "Um, the task that we're doing is just trying to get them to think. Think creatively, outside the box." (A10) "Yeah, I'm looking at her—she's doing great this year, She started off very disruptive, I even phoned home to say how well she's sort of performed, I'm sort of conscious of how she is [progressing]." (A11)

Unmerged 17	Type 2.02 Attention Student Off-Task	"Um, yep. Once again going back over there [to the rear right corner] because they tend to take quite a long time to start." (A16) "I'm focusing on him, That's because I've been telling him off particularly, in the lesson, about being too chatty. And Dan, he's very loud, very loud very, so whenever he says anything you're automatically drawn to him because he's louder than anybody else." (A17) "I've got my eye on [name], She's not looking and not Listening now." (A18)
Unmerged 18	Type 2.03 Attention Student On-Task	"So I'm sort of glancing in between Tamsyn and The rest of the class just to make sure that they're actually listening to what they're saying." (A2) "It's funny because there are certain students that I know I'm not looking At, and that's because I know that they're listening." (A6) "So again that's, I'm trying to be positive there he was joining in, he's volunteering answers so I'm really trying to focus on him there." (E1)
Student Behaviour (mid-merge 6)		
Unmerged 19	Type 2.04 Discipline and Rules	"So it was very much trying to get them, beginning of the year was very much don't speak over each other. It was a lot of, don't speak over you, don't speak over you, now." (A7) "And they're nice, nice kids, But they, they um, get themselves into a bit of bother with me by, being either not listening, or talking out of turn." (A18) "It's nice that I've got their enthusiasm, but I'm really trying to get them to not shout out." (A18)
Unmerged 20	Type 2.05 Norms Behaviour Problematic	"But also checking Ellie. [laughs] That she's caught up, that she's late in, and she can be disruptive At times. Just to make sure." (A16) "He's got his issues with behaviour, so it's about drawing him in to the lesson so that he doesn't opt out, 'Cause there are times when he gets completely upset and refuses to join." (A17)
Unmerged 21	Type 2.06 Norms Behaviour Unproblematic	"Yeah so I'm having a look over there just to see that they're getting on. Good yup." (A2) "Now [name], [?] enough attention was drawn to Meg, using the phone, and it took me too long to realise that she was using it like normal young people do, to take a photograph of the worksheet she missed." (A5) "You don't have to have a go at them; I don't have to challenge them, because you know they're behaving really well. But I'm checking." (A8)

Unmerged 22	Type 2.07 Norms Notable Posture	"For example, the girl there is, three of them have got their head down, one of them has got their head up, I know the one with her head up is listening, by the expression on her face." (A7) "And looking at her position, it… is she interested, is she half asleep, is she thinking, you know." (A10) "And spotted that lad that wasn't facing forward." (E1)
Student and Situational Types (mid-merge 7)		
Unmerged 23	Type 2.08 Type of Student	"Uh, I chose Danny…Because, as it happened, I uh, like, to try and, uh…Wonder to different parts of the room and I know that he is a student who,…Is quite confident." (A1) "She's been quite good so far, But she's another one that can be quite distracted." (A2) "[I'm looking at him] because he's my naughty boy [laughing]." (A17)
Unmerged 24	Type 2.09 Type Situation	"Before, she used to try and hide away from it; she knows it's coming now." (A8) "And just Looking around because occasionally some of them will start chatting whilst I'm getting feedback." (A13) "And you get that sometimes, not him but students in general, sometimes. So it was quite half-hearted." (A15)
Unmerged 25	Type 2.10 Commentary Contextised	"I couldn't work out where Jack was moving and then I realised he hadn't got a chair." (A5) "Just watching the… the video, we've got a set of questions, That the ch-the students have answer, regarding the video, So We're gonna recap what we've just uh, just Watched, And see what, see what answers they've got." (A9) "So I'm very conscious here that I was staring at the complete opposite direction into where Marcus is and I'm, and there's a few students who I keep my eye on. And I've almost got my back to him then. So that's bad." (A15)
Unmerged 26	Type 2.11 Commentary Generalised	"That's a very often refrain of mine in the class: 'turn yourself around please'." (A2) "And then I'm just pointing—I think it's 'cause I'm right-handed as well. You have to turn round [to see the board on the left]. You can't really, unless I try and I'm like [laughing, demonstrating] with my left hand..." (A4) "And it's quite intimidating if a teacher just stares at you constantly while you're trying to draw a point out." (A15)

Teacher Perspective (mid-merge 8)		
Unmerged 27	Type 2.12 Self-As-Teacher	"I don't mind if they're like, sort doing things like, twiddling their hands, or something. If that's a – not a distraction, if it adds to focus I don't mind." (A8) "But she's, she's struggling with it, And I didn't wanna just—I try not to just go for people with their hands up." (A14) "So I try my best to find opportunities [for him] to join in, 'cause actually he's stronger academically than you realise." (A17)
Unmerged 28	Type 2.13 Teacher Role and Influence	"Well that's…By trying to give other people opportunities to be able to answer questions…Um, as well as going back to [name] when, he wants to respond as well." (A1) "You can insist on them having their hands up, but, this is a mid to low ability class, I don't wanna stifle it, So if someone looks like they're trying to get involved, I'll probably encourage it, by looking at him as if 'come on, have a think'." (A8) "So when I look at them, I'm more communicating to them, like 'beware, I am watching ya.'" (A10)
Unmerged 29	Type 2.14 Teacher Action Taken	"This is me getting back on track. I'm looking at the board where my question is, so I was just looking at the board there. Just thinking, what's the question, yep question, then back on." (A8) "So here I'm silencing them." (A11) "Um, then I'm just there to change the powerpoint slightly and…So I can mode it [the task] for them." (A13)
Unmerged 30	Type 2.15 Teacher Does, Sees, Says Nothing	"I should've realised At that point, that [name] was in, and [same name] wasn't here yesterday either. And therefore Was looking very puzzled." (A5) "They [the boys] were cheesing me off, to be honest. Yeah, just uh… If I'd not got those [eye tracking] glasses on, I think they'd have been uh… dealt with a bit sooner. [laughing] I don't [normally] wear glasses…" (A9)
Unmerged 31	Type 2.16 Uncoded	
Cumulative Cognitive Processing (full-merge 4[a])		[Examples not possible: these codes were applied to the full transcript of each participant, as appropriate.]
Viewpoint (mid-merge code 11)		

Unmerged 39	Type 4.01 Viewpoint Single	
Unmerged 40	Type 4.02 Viewpoint Multiple	
Perspective (mid-merge 12)		
Unmerged 41	Type 4.03 Perspective Highly Integrated	
Unmerged 42	Type 4.04 Perspective Partially Integrated	
Unmerged 43	Type 4.05 Perspective Nonintegrated	
Scope (mid-merge 13)		
Unmerged 44	Type 4.06 Scope Continuous Time	
Unmerged 45	Type 4.07 Scope Discontinuous Time	
Certainty (mid-merge 14)		
Unmerged 46	Type 4.08 Certain	
Unmerged 47	Type 4.09 Uncertain	
Unmerged 48	Type 4.10 Uncoded	
Classroom Relationships (full-merge 5)		
Affect (mid-merge 15)		
Unmerged 50	Type 5.01 Relational Affect	[All utterances coded as Unmerged 50 and Unmerged 51 were also coded as Unmerged 50.]
Unmerged 51	Type 5.01.1 Negative	"Because, you know, it is hard, to have your name up there, They automatically think, I'm in trouble, and I'm just checking that their facial expressions—they should be used to it by now, 'cause that's what I do—but I still like to make sure that they're not feeling bad." (A5) "I just don't want people like certain students to feel uncomfortable, or that they're being scrutinised." (A6) "Students can quite easily get frustrated when they've got their hand up for ages [but they are not picked]." (A10)

Unmerged 52	Type 5.01.2 Positive	"But this one's improved loads recently: she's been coming to afterschool revision, she's been putting extra work in, she's got a level 7 on a test, so she's really pleased, So we're aiming really to try and keep that level, and not sort of rest on their laurels." (A6) "He [Nathan] likes encouragement." (A12) "Very proud that he'd done it as well, Which is nice." (A18)
Relational Links (mid-merge 16)		
Unmerged 53	Type 5.02 Relations between actors	[All utterances coded as Unmerged 54, 55 and 56 were also coded as Unmerged 53.]
Unmerged 54	Type 5.02.1 Student to Student	"These two students here, um, shouldn't really be sat next to each other." (A3) "And I addressed Josh there 'cause I could see he was talking to Dan… He was talking to Dan so that's why I was addressing him and that's why I looked at him there." (A4) "He's one of the really bright members of the class – they both are. They try and bounce off." (A8)
Unmerged 55	Type 5.02.2 Student(s) to Group of Students	"So I'm sort of glancing in between Tamsyn and The rest of the class just to make sure that they're actually listening to what they're saying." (A2) "There's less distraction there, they're also thinking as a class. Everyone's building on it. It allowed me to control it a lot more easily as well 'cause I could see everyone was focused in on the discussion." (A8) "People disagreeing was exactly what I wanted, really, There was some really good discussion, so they're not just thinking about um, what he might include, or what you might not." (A14)
Unmerged 56	Type 5.02.3 Teacher to Student(s)	"I've seen uh, Lucy later on and I talk to Lucy, kind of walking towards…Lucy a minute ago, and part of the reason for that is, if she…Is very bright student who does need a little bit of encouragement, um, every now and again." (A1) "Right ok I'm just trying to get everyone motivated, so they're like reading the Board, doing the task that I want them to do." (A10) "And then Ellie was late in, which was why I'm looking over that side, making sure she's doing what she should be." (A16)
Unmerged 57	Type 5.03 Uncoded	
Unmerged 58	General Uncoded	