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Capturing teacher priorities: Using real-world eye-tracking to investigate expert teacher priorities across two cultures.

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Abstract

Classroom teaching is complex. In the classroom, teachers must readily attend to disruptions and successfully convey new tasks and information. Outside the classroom, teachers must organise their priorities that are important for successful student learning. In fact, differing gaze patterns can reveal the varying priorities that teachers have. Teacher priorities are likely to vary with classroom expertise and can conceivably change with culture too. Therefore, the present study investigated expertise related and cultural teacher priorities by analysing their gaze proportions. To obtain this data, 40 secondary school teachers wore eye-tracking glasses during class time, with 20 teachers (10 expert; 10 novice) from the UK and 20 teachers (10 expert; 10 novice) from Hong Kong. We analysed gaze proportions during teachers' attentional (i.e., information-seeking, e.g., teacher questioning students) and communicative (i.e., information-giving, e.g., teacher lecturing students) gaze. Regardless of culture, expert teachers' gaze proportions revealed prioritisation of students, whereas novice teachers gave priority to non-instructional (i.e., *not* students, teacher materials, or student materials) classroom regions. Hong Kong teachers prioritised teacher materials (e.g., whiteboard) during communicative gaze whereas UK teachers prioritised non-instructional regions. Regarding culture-specific expertise, with Hong Kong experts prioritised teacher materials more than UK experts who, in turn, did so more than UK novices. We thus demonstrate the role of implicit teacher gaze measures as *micro*-level indicators of *macro*-level and explicit aspects of instruction, namely teacher priority.

Keywords: Eye-tracking, expertise, cross-cultural comparisons, teaching, gaze proportions

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Classroom teaching is complex. An effective teacher monitors student engagement and detects student disengagement. An effective teacher also gives clear instructions and explanations. Thus, successful teaching requires effective information-processing and information-giving. The complexity of teaching can be grasped by investigating it in ‘slow motion’: one way of capturing all the things that teachers do is through process-tracing techniques such as eye-tracking. Indeed, experts are well documented to use gaze patterns distinct from those used by non-experts (or novices, Reingold & Sheridan, 2011). Expert gaze is likely to differ, too, depending on the cultural setting (Berliner, 2001; Sternberg, 2014).

The present article builds on analyses of a study that has been reported elsewhere [PRESENT AUTHORS]. In those earlier analyses, teachers’ gaze durations were analysed in accordance with eye-tracking conventions, to compare expert with novice knowledge, but also with other facets of teacher expertise, namely efficiency, flexibility and strategic consistency. In yet another paper (under review), this data was analysed sequentially, to see whether the order of teacher gaze differ across expertise groupings and cultural settings [PRESENT AUTHORS]. Thus, our analyses have so far revealed when teachers exercise changeability to their advantage, according to their expertise and culture. However, these previous analyses only considered ‘in-the-moment’ and micro-level aspects of teacher gaze. The present article employs a new approach to this dataset by using what ordinarily is implicit, intensive, micro-level data that is eye-tracking to analyse explicit, long-term, macro-level aspects of teaching, namely teacher *priorities.* In doing so, we ask how exactly do experts operate differently from novices? In what ways are experts’ teaching attitude and outlook distinct from those of novices? What priorities do experts have that novices have yet to develop? By using gaze proportions as outcome variables, the present analysis reveals ongoing, deliberate, explicit priorities that experts have which permeate to the implicit level, that is where they look.

Together, the present article further reports on a study that builds on existing literature by comparing teachers across expertise and cultures. As the value of verbal data is widely acknowledged among vision (van Gog et al., 2005) and expertise (e.g., Ericsson & Simon, 1980; Ericsson, 1984), we also used verbal data by following the approach of nonverbal behavioural scholars to classify teacher gaze using with teachers' speech that is simultaneously uttered with teachers' gaze (cf. McNeill, 1992, 2005). Using gaze proportions, the present analyses extend existing literature *and* our prior analyses on culture-specific expertise in teaching by exploring teacher priorities: that is, what teachers consistently give importance to and which they deliberately centre their teaching around. This paper additionally extends vision research by accessing the priority-related insight available from gaze data and it extends the decision-making field by going beyond the laboratory to analyse gaze proportions derived from the real-world.

1.1. Teachers' Attentional *and* Communicative Gaze

Teacher gaze does more than processing information: it also signals information (Risko, Richardson & Kingstone, 2016). During instruction, teachers perform two main tasks: teachers ask questions (as in *attentional gaze*) and they talk (as in *communicative gaze*; McIntyre & Klassen, 2016). Although attentional gaze is indispensable to teaching, not least for classroom management (Wolff, Jarodzka, van den Bogert & Boshuizen, 2016), teaching has even been defined as a communicative (i.e., information-giving) profession that is centred on imparting knowledge to learners (Leinhardt, 1987; Livingston & Borko, 1989). Effective communication is so integral to the profession that communication skills are part of established frameworks of teaching (Seidel & Shavelson, 2007) and students consider it to be essential to their own academic achievement (Waxman & Eash, 1983).

Yet, the vision literature is surprisingly limited in its focus on the communicative aspects of professional gaze for attention (Kahneman, 1973; Peterson & Posner, 2012) as well as for communication (Argyle, 1990; Mehrabian, 1970). Until recently, eye-tracking research has largely been confined to the laboratory, a context which largely limits vision research to attentional gaze and leaves communicative gaze unaddressed (see also Risko et al., 2016). The prevalent use of visual scenes in the eye-tracking literature, resulting in the role focus on attentional gaze (for a review of such studies, see Reingold & Sheridan, 2011). Teacher gaze research shares this issue (e.g., Cortinaet el., 2015; van den Bogert, van Bruggen, Kostons & Jochems, 2014).

The arrival of realistic mobile eye-tracking technology makes it possible to investigate teacher gaze in the real-world. Not only does attentional gaze in the real-world differ from that in the laboratory, but opportunities to explore communicative gaze are much more available in the real-world (Foulsham, Walker & Kingstone, 2011; Risko, Laidlaw, Freeth, Foulsham & Kingstone, 2012). To distinguish between attentional and communicative gaze, the present research adopted an established approach to nonverbal behaviour (Kendon, 1967; McNeill, 2005): we used the teachers' speech that co-occurred with their gaze to identify the intention—attentional or communication—that was underlying teacher gaze. Thus, the present study used teacher speech to categorise teacher attentional gaze separately from teacher communicative gaze to enable the separate analysis of two distinct gaze types.

1.2. Teacher Priorities

Teacher priorities are instructors' goals that endure over time, regardless of situational change. Regardless of domains, experts' exceptional knowledge and experience in their professional domain (Bédard & Chi, 1992; Ericsson & Kintsch, 1995), priorities are likely to differ between experts and novices. It is this contrast in knowledge that distinguishes between expert and novice chess performances, since greater knowledge makes available a more extensive menu of strategies (Chassy & Gobet, 2011), with chess experts appear to use significantly more search-and-evaluate and pattern recognition than novices (Campitelli & Gobet, 2004). Expert teachers have likewise shown themselves to be more knowledge-driven (Berliner, 2001), more reflective (Allen & Casbergue, 1997; Clarridge & Berliner, 2001) and more systematic (Livingston & Borko, 1989) approach to their profession. Novices are also guided by strategy—but these are not experience-based, revealing inflexibility and are typically ineffective (Berliner, 2004). Thus, experts are more guided by strategy and therefore differ from novices in their priorities.

It seems that priorities and decision-making strategies can differ with culture too. Typically individualistic, Western populations rely on analytic reasoning in which linear deduction dominates, resulting in more extreme choices (or priorities). In contrast, East Asian populations are typically collectivist, which means that decision-making tends to be based more on holistic reasoning in which a 'middle way' is pursued as a compromise between opposing views, resulting in less extreme choices (Briley et al., 2005; Nisbett, Peng, Choi & Norenzayan, 2001; Willner, Gati & Guan, 2015). Cultural differences in pedagogical priorities certainly exist, as shown by teachers' long-term approaches to and goals for classroom instruction. Hofstede (1986) has underscored that way Western, individualistic classrooms prioritise the learning process ("learn how to learn", p. 312), whereas East Asian, collectivistic classrooms prioritise the learning outcome ("learn how to do", p. 312). Indeed, both the format (Correa, Perry, Sims, Miller & Fang, 2008; Leung, 1995) and students' preferences (Zhang, Huang & Zhang, 2005) of classroom learning differ across cultures. Even the importance given to teacher education and teacher confidence diverges between East and West (Blömeke et al., 2016). In spite of the recognised cultural differences in teaching priorities, research on cultural differences in teacher *gaze* is limited to date. The present article addresses an important gap in the literature.

1.3. Gaze Proportions as Indicators of Teacher Priority

The present article capitalises on the value of gaze proportion measures in exploring teacher expertise. A gaze proportion is how much a person looks at one region relative to alternative regions. Specifically, we used gaze proportions with the expectation that they would address particular aspects of expert patterns in each, attentional and communicative, teacher gaze: namely, the deliberate policies and decision-making priorities of the teacher.

Decision-making research has consistently found the proportion measure reflective of ongoing priorities. For example, when participants were asked to indicate their preference out of two options, proportion measures have revealed that people typically use an integrated approach to develop priorities as choice proportions are higher for options associated with multiple information sources that contain congruent (or the same) information (Hochman, Ayal & Glöckner, 2010) and because higher choice proportions are found for options of consistently high economic value when compared with those with only inconsistently high economic value (Ayal & Hochman, 2009). Choice proportions have also shown that risk-aversion is a priority in decision-making, as options less likely to be chosen when they are linked with increasing chances of loss (Erev, Ert & Yechiam, 2008) and with negative arousal (Glöckner & Hochman, 2011). Choice proportions have revealed the deliberate (i.e., priority-based) nature of justice-related decisions too, as unpressured (i.e., deliberate) decision-making conditions yielded lower choice proportions for unfair options than time-pressured (i.e., instinctive) conditions (Hochman, Ayal & Ariely, 2015). Thus, choice proportions have been effective in revealing the priorities that people have in decision-making.

Gaze proportions are now being used to investigate the decision-making, with the regions receiving higher gaze proportions interpreted as more weighted (i.e., prioritised or important) than those receiving lower gaze proportions. Gaze proportions are thus being used as an especially direct, internally valid measure of how information is prioritised during choice-making (Glöckner & Herbold, 2011). In one study, deliberate thinking was prompted by asking participants to balance potential reasons for each option before making their response; intuitive thinking was triggered by asking participants to make fast and spontaneous decisions. Deliberate (i.e., priority-based) thinking co-occurred with higher gaze proportions whereas intuitive thinking related to lower gaze proportions (Horstmann, Ahlgrimm & Glöckner, 2009). Similarly, higher proportion of gaze was directed towards the subsequently chosen option, demonstrating the value of gaze proportion in reflecting priorities in the face of several alternatives (Fiedler & Glöckner, 2012). In another such study, participants used a significantly larger proportion of gaze towards unlikely events when the value of options was presented all at once, in comparison with when the value of options was systematically presented one at a time: unlikely events have greater priority in pressured decision-making, such as in the first condition (Glöckner, Fiedler, Hochman, Ayal & Hilbig, 2012). Gaze proportions particularly highlight the way people make decisions: specifically, gaze proportions highlight whether the gaze region (in this case option in decision-making) is over-weighted or under-weighted in importance, in the context of its economic (or objective) value (Glöckner et al., 2012) or the decision-making priority for the participant (preference vs. recency, Glaholt & Reingold, 2009). Gaze proportions have also been found to reveal priorities in social scenarios, which tend to be more complex than laboratory scenarios involving solely monetary factors for decision-making. In particular, higher gaze proportions related to greater benefit for others in a social situation (Fiedler, Glöckner, Nicklisch & Dickert, 2013).

Teacher priority can likewise be investigated through teachers' gaze proportions. It seems particularly interesting to explore what *expert* teachers prioritise. Some research has commenced in this respect, with experts demonstrating greater equity in their gaze at each student (Cortina et al., 2015). Already, expert teachers have been shown to give equal priority to every student, which resonates with the general consensus that student-centredness characterises effective teaching (e.g., Pianta et al., 2012; Reeve, 2009). However, only attentional teacher gaze was examined, with communicative teacher gaze yet to be investigated. The role of *culture* in teacher gaze proportions is another budding research area. The integral role that mothers play in infants' learning makes research involving mother–child dyads relevant. Collectivist (e.g., East Asian) mothers have shown higher proportions of gaze to be directed away from their infant, in contrast to the higher proportion of gaze directed *at* infants among individualistic (e.g., Western European) mothers (Kärtner, Keller & Yovsi, 2010). Expert teachers in classrooms could therefore be expected to display culture-specific priorities through their gaze proportions.

1.4. The Present Article

It is likely that teacher gaze not only reveals what a teacher is trying to find out (as in attention) or say (as in communication), but also reveals the teacher's *priority* underlying both attentional and communicative episodes. Through gaze proportions derived from real-world eye-tracking of classroom teachers, the present research analyses how teachers' priorities differ according to their expertise and culture, making this the first extension of a decision-making analytic approach (e.g., Glöckner & Herbold, 2011) to educational psychology. It also employs direct, real-world, quantitative metrics (i.e., gaze measures) to supplement recent qualitative insight into teacher priorities obtained from the laboratory (Wolff et al., 2016). Thus, macro-level conclusions are drawn for the first time from eye-tracking data: specifically, to teacher research and to real-world, mobile eye-tracking data. Accordingly, our hypotheses were as follows.

Hypothesis 1: Expertise was expected to yield differential priorities, given that it has done so in past vision literature (e.g., Reingold et al., 2001). Specifically, experts would direct a greater proportion of their gaze—attentional and communicative—towards important areas such as students (Reeve, 2009), whereas novices' gaze proportions should reveal that student-centredness is yet to become a priority. That is, novices will prioritise teacher materials, student materials and non-instructional classroom regions more than students themselves.

Hypothesis 2: Culture was expected to yield differential priorities. Specifically, East Asian teaching has demonstrated a content-driven focus, in contrast to the Western European emphasis on student progress and experience (e.g., Leung, 1995). Therefore, East Asian teachers were expected to use lower proportion of gaze towards students, and more gaze proportions towards teacher and students' learning materials, than Western European teachers.

Hypothesis 3: Expert teacher priority was expected to be culture-specific. Together, Hypotheses 1 and 2 entail that experts in both East Asia and Western Europe will prioritise student experiences. However, the East Asian priority of content-based learning and progress means that East Asian experts can be expected to use slightly lower proportions of student gaze than Western European experts. East Asian experts should also use higher proportions gaze towards teacher and student learning material, due to their greater importance in East Asia than in Western Europe.

2. Method

2.1. Participants

Participants consisted of 20 Hong Kong Chinese (henceforth East Asian) and 20 White Caucasian UK (henceforth Western European) secondary school teachers of various subjects. Schools were selected on the condition that they followed their respective national curricula and that they consisted of students from the first to fifth years of secondary education. Cultural groupings in the present study were based on geographical location (i.e., in Hong Kong vs. in the UK). Expert teachers were defined using the guidelines given by Palmer et al. (2005), which consisted of (a) having at least six years' experience, (b) social recognition as an expert in teaching (selected by the school leadership), (c) professional or social group memberships within the field of teaching, and (d) performance ratings (based on in-school classroom observations). Performance ratings in both Hong Kong and UK schools were scored out of four, with 1 being Inadequate and 4 being Outstanding. Both systems are derived from the Ofsted (2016) who provide standardised protocols for assessing classroom quality. There was a significant difference between experts (M = 1.40, SD = .68) and novices (M = 2.40, SD = .88) in their performance ratings, $t(38) = 4.01$, $p < .001$, $d = 1.26$. See Table 1 for detailed teacher demographics.

2.2. Apparatus

The Tobii 1.0 glasses eye-tracker was used to record teacher gaze. This eye-tracker was monocular, with a sampling rate of 30Hz and calibrated using nine gaze points. The eye-tracker yielded a 640 by 480 px video, capturing 56 degrees horizontally and 40 degrees vertically. The eye-tracker also yielded audio recordings. Two approaches were used to secure quality of data analysis: each participant was asked to confirm the location of the gaze cursor during cued retrospective reporting (Van Gog et al., 2005); when the gaze cursor disappeared, we applied the code, *Unsampled*.

2.3. Design

The teachers wore eye-tracking glasses during their usual timetabled lesson ($M_{Class\ size}$ = 27.56, s.d. = 8.20), so that each participant taught differing content. Students sitting in rows and the teacher standing at the front and centre. Eye-tracking took place for one ten-minute ‘teacher-centred’ episode[1]. Teacher-centred activity was chosen due to the fact it takes place in all lessons, regardless of subject. Teacher-centred sessions are also the richest in teacher data (the focus of this article), with the highest sampling rate of teacher behaviour compared with more student-led activities such as pair work. These episodes best control for extraneous variables too, by minimising the likelihood of unforeseen events (e.g., student walkabouts) that occur more frequently during student-led activity. Moreover, reactivity is unlikely to be a problem, since the demanding nature of classroom teaching will be sufficient to ‘distract’ participant attention from their eye-tracked status. Similar observational research designs have also been found to prompt minimal reactivity (Praetorius, McIntyre & Klassen, 2017), making the present data comparable to teacher-centred sessions without eye-tracker presence. Thus, a balance was made between collecting authentic, true-to-life teacher gaze data—by not imposing teaching material onto participants but taking what they already planned—and maximising research control, by choosing teacher-centred activity rather than another form of classroom activity (e.g. group work).

2.4. Procedure

2.4.1. Data collection

[1] Ten minutes was deemed ample due to the intensive nature of eye movements, as shown by pilot studies in which this recording duration yielded approximately 1000 data points per participant.

The eye-tracking glasses were calibrated by the researcher just before recordings took place. In order to preserve the individual calibration, participants were instructed not to move the glasses until recording was over. Once ten minutes of teacher-centred learning was recorded, the researcher waited for a considerate moment to remove the eye-tracking equipment from the teacher. Once the eye-trackers were removed, the researcher administered a questionnaire to both students and the teacher (not reported in this article), then left the room. Cued retrospective reporting (Van Gog et al., 2005) was then conducted with each participating teacher (not reported in this article).

2.4.2. Coding

We systematically coded teacher gaze and simultaneous verbalisations (i.e., cognition, see below). Both the teacher gaze and simultaneous verbalisations were coded from the start to the end of analysed periods of eye-tracking.

2.4.2.1. Gaze codes

Gaze behaviour was coded by the researcher by slowing the playback to one eighth of real-time speed and manually applying the gaze behaviour codes. The gaze behaviours coded were *student gaze, student material, teacher material, non-instructional* (or 'other' targets; e.g., door, window, light, wall) and *unsampled* gaze. *Student gaze* were comparable with fixations towards students: this code was applied when the gaze cursor overlaid students for more than four frames (cf. Franchak, Kretch, Soska & Adolph, 2011; Hanley et al., 2015). Unsampled gaze was coded when the gaze cursor disappeared from gaze replay. Through both the pilot and official coding process, these gaze codes proved adequate in that, together, they comprehensively addressed all possible gaze behaviours.

2.4.2.2. Cognitive codes

Simultaneous verbal data was coded manually while playing the video in real-time (i.e., full playback speed) to generate teacher cognition codes. The simultaneous verbal data from eye-tracking recordings was divided into two teaching behaviours: information-seeking (or questioning; to measure *attentional gaze*) and information-giving (or lecturing; to measure *communicative gaze*). Information-seeking consisted of question-asking by the teacher: these are periods when teachers asked students questions and chaired the whole-class dialogue until students offered the necessary response. Information-seeking thus included classroom silence as the teacher waited for students to answer their question; it also included periods when students spoke instead of the teacher. Information-giving included straight talk and rhetorical questioning by the teacher.

2.5. Measures

2.5.1. Gaze events

Each gaze code was aligned cognitive codes on one spreadsheet, according to recording timestamps, for data synchronisation. The gaze event was identified according to the cognitive code that each gaze code aligned with. This involved ensuring every gaze behaviour coded was adjacent to the cognition taking place at the time (i.e., attention *or* communication). Thus, each gaze behaviour that was coded always took place during one cognition or the other, yielding gaze events, namely *attentional gaze* or *communicative gaze,* throughout the teacher gaze data.

2.5.2. Gaze proportions

In addition to the value of gaze proportions, we confirmed that the present analysis also needed such relativized measures due to uneven occurrences of each gaze event. Untransformed gaze *frequencies* (i.e., count, not durations) of each, attentional and communicative, gaze were compared across the present cultural groups. East Asian teachers emerged to display more communicative gaze overall than their Western European counterparts; Western Europeans used more attentional gaze. We therefore computed gaze proportions as relativized measures of gaze frequency for each individual participant. For example, *student gaze proportion* was calculated through dividing the participant's focused gaze towards students by the total count of all gaze behaviours (i.e., student + student material + teacher material + non-instructional) by the same participant. It was gaze proportions that we analysed for expertise, culture and interaction effects. Altogether, eight possible gaze proportions were analysed: attentional *student*, *student material*, *teacher material* and *non-instructional* gaze, as well as communicative *student*, *student material*, *teacher material* and *non-instructional* gaze.

2.6. Analysis

To inspect reliability, two members of each sub-group (e.g., Western novices) were selected for re-coding. Among these participants, the first two out of ten minutes of their gaze recording were re-coded. For a close inspection of reliability, duration rather than proportion measures were used. *Intra*-rater reliability showed excellent consistency in the main coder (ICC[3] = .92, 95% CI[.84, .96]), while *inter*-rater reliability showed satisfactory consistency in the coding system (ICC[2] = .65, 95% CI[.33, .81]). The same system was used for verbal re-coding, except only intra-observer reliability was used due to the limited availability of bilingual researchers. Our coder showed strong consistency in the verbal coding (ICC[3] = .86, 95% CI[.57, .95]).

For statistical analyses of proportion measures, we employed beta regression analyses. Beta regression allows for proportion measures to be interpreted in terms of what they originally represented. Additionally, beta distributions possess the flexibility to cater for the typically asymmetric—non-normal—distribution of proportions. Moreover, rather than presenting a problem, the heteroskedastic nature of proportions is incorporated into beta regression analysis (Ferrari & Cribari-Neto, 2004). The gamlss package (Rigby & Stasinopoulos, 2001, 2005) in R (Ihaka & Gentleman, 1996) was used to run beta regression analysis. Beta-distributed dependent variables (i.e., student gaze and non-instructional gaze) were analysed using the standard BE family; zero-inflated (i.e., containing zeros) dependent variables (i.e., teacher material and student material gaze) were analysed using the BEZI family (Ospina, 2006; Ospina & Ferrari, 2010). The logit link default for both BE and BEZI models meant absent heteroscedasticity was not a problem.

For each DV, we ran one main effects beta regression model with expertise and culture as two main effects as well as their interaction term, expertise $\times$ culture. We considered running class size as a covariate, to control for its potential confounding influence on either main effect. Although class size met the homogeneity of regression slopes as well as the independence from IV assumptions, class size was not correlated with the DVs (i.e., gaze proportions; r=.10 to .19), suggesting a limited role of class size as a covariate. Conclusions regarding main effects did not alter, either, by adding class size as a co-variate; neither were the model fits (i.e., AIC) notably improved. We therefore ran analyses with no covariates, focusing entirely on expertise and culture as predictors of teacher gaze.

3. Results

Results are organised in order of hypotheses. For each hypothesis, results for attentional gaze are reported before those for communicative gaze. Before results from statistical analyses, the summary statistics of teachers' gaze proportions are presented below (Table 2). Outcomes from statistical analyses are then shown in tables, first for attentional gaze (Table 3) then for communicative gaze (Table 4): these are referred to in the text that follow, as each hypothesis is addressed.

The first hypothesis predicted teacher expertise to play a significant role in gaze proportions, as a measure of teacher priorities. To identify the gaze targets that are most prioritised by experts in both cultures, we analysed the proportions of where teachers looked during attentional gaze. Experts were compared with novices. Beta regression analyses found expertise to significantly predict *attentional student gaze*, $B= 1.07$, s.e. = .37, $t = 2.89$, $p = .007$, and *attentional non-instructional gaze,* $B= -1.11$, s.e. = .56, $t = 2.00$, $p = .05$, with experts using significantly more *student gaze* and less *non-instructional gaze* than novices. Expertise did not predict *attentional student material gaze* ($p = .30$) or *attentional teacher material gaze* ($p = .12$). Figure 1 shows line graphs for the attentional gaze proportions of each participant group. Beta regression analyses found expertise to significantly predict *communicative student gaze*, $B= .89$, s.e. = .40, $t = 2.22$, $p = .03$, and *communicative non-instructional gaze,* $B = -1.14$, s.e. = .55, $t = -2.08$, $p = .05$. Expertise did not predict *communicative student material gaze* ($p = .80$) or *communicative teacher material gaze* ($p = .23$). As in attentional gaze, expert teacher gaze in communicative gaze involves higher proportions of *student gaze* and lower proportions of *non-instructional gaze*. Figure 2 shows line graphs for the communicative gaze proportions of each participant group.

The second hypothesis anticipated teacher culture to play a significant role in gaze proportions, as a measure of teacher priorities. To identify what teachers in each cultural group—Hong Kong and the UK—look at, the proportions of teacher gaze directed towards differing classroom regions were analysed using beta regression. Culture did not predict any attentional gaze proportions at all (Table 3; all $p > .05$); neither did culture play a significant role in predicting any communicative *student gaze* or *student material gaze* (Table 4; $p = .60$ to .64). Culture, however, did predict *communicative teacher material gaze* to statistical significance, B= -1.47, s.e. = .71, t = -2.08, p = .05, with Hong Kong teachers (coded culture = 1) looking more at teacher materials than UK teachers (coded culture = 2). Culture also predicted *communicative non-instructional gaze* to near-significance, B= 1.10, s.e. = .56, t = 1.98, p = .06, with UK teachers (coded culture = 2) looking more at *non-instructional* areas than Hong Kong teachers (coded culture = 1). Thus, whereas culture does not have an effect in attentional gaze proportions, it does in communicative gaze proportions.

The third hypothesis related to whether culture-specific expertise played a significant role in teachers' gaze proportions, that is their priorities. To do this, the expertise × culture interaction term was included in the beta regression model. The interaction term did not significantly predict any attentional gaze proportions (Table 3; all p > .05), but it did significantly predict communicative *teacher material gaze,* B= .88, s.e. = .42, t = 2.08, p = .05, and communicative *non-instructional gaze,* B= .79, s.e. = .35, t = 2.25, p = .03 (Figure 2). Given the significant expertise × culture interaction, we conducted sub-group analysis to probe the combined role of expertise and culture in predicting communicative *teacher material* and *non-instructional gaze* proportions. In sub-group analysis, expertise significantly predicted *teacher material gaze* proportions among UK teachers, B= .94, s.e. = .34, t = 2.78, p = .01, but not in Hong Kong (p = .70). Culture neared significance in prediction of *teacher material gaze* among experts, B = -.61, s.e. = .31, t = -1.99, p = .07, but was not significant among novices (p = .33). Expertise was not a significant predictor of *non-instructional gaze* among Hong Kong (p = .11) or UK (p = .15) teachers. Culture did not predict *non-instructional gaze* either among experts (p = .20), though it neared significance among novices, B = -.47, s.e. = .26, t = -1.83, p = .08. Together, UK experts used more *teacher material gaze* than UK novices, but Hong Kong experts exceeded UK experts in this gaze type. *Non-instructional gaze* was adopted significantly more among Hong Kong novices than their UK counterparts, suggesting that beginning teachers are more inclined to use *non-instructional gaze* in Hong Kong than in the UK.

4. Discussion

The current study makes a number of important contributions to the literature on teacher gaze. First, it extends the use of gaze proportion from decision-making psychology to educational science. Second, investigations of teacher gaze from laboratory studies into real-world classroom settings. Third, it considers expertise and cultural aspects of teacher priorities, as revealed in teacher gaze. Fourth, we have added teacher communicative gaze to conventional teacher attentional gaze analysis. Finally, we have demonstrated the value that different proportion measures have for investigating teacher gaze. By pioneering teacher research on these fronts, the present article is the first to use implicit measures to uncover explicit aspects of teaching, namely teacher priorities.

In doing so, expert teachers were found to prioritise students during both attentional and communicative periods of classroom instruction (Hypothesis 1). In contrast, the attentional and communicative gaze of novices suggest that it is non-instructional classroom regions that beginning teachers prioritise (Hypothesis 1). No cultural differences were found in attentional gaze, but Hong Kong teachers used more communicative teacher material gaze while UK teachers used more communicative non-instructional gaze (Hypothesis 2). Culture-specific expertise was also only found in teachers' communicative gaze, with Hong Kong experts using more teacher material gaze than UK experts who, in turn, used more teacher material gaze than UK novices (Hypothesis 3). Non-instructional gaze was used significantly more by Hong Kong novices than UK novices (Hypothesis 3).

Expert teachers in this study used higher proportions of student gaze than novices did. Thus, gaze proportion analysis showed expert teachers to give priority to students in the classroom during both attentional and communicative parts of instruction (Hypothesis 1), regardless of culture. The priority demonstrated by our sample of expert teachers echoes existing teacher effectiveness research: that is, effective teachers are likely to take a student-centred approach to teaching. Such a classroom priority maximises the chances of successful classroom outcomes, regardless of culture (Sang, Valcke, van Braak & Tondeur, 2009, cf. Tondeur, Devos, van Houtte, van Braak & Valcke, 2009). Indeed, teacher expertise is characterised by a concern for factoring student needs into curriculum delivery (Livingston & Borko, 1989) and during observations of colleagues' teaching (Wolff et al., 2016). During communicative sessions in particular, experts prioritise connection with students (Sidelinger & Booth-Butterfield, 2010; Turman & Schrodt, 2006), which they achieve through a variety of non-verbal, immediacy behaviours including eye contact. Our expert teachers certainly appeared to take greater advantage of the innate teaching 'resources' in natural pedagogy (Csibra & Gergely, 2009; Farroni, Massaccesi, Menon & Johnson, 2007).

Whereas experts focus on students' classroom experiences, novice teachers used higher proportions of gaze towards non-instructional classroom regions, suggesting that they prioritised these regions more than experts (Hypothesis 1). A number of possibilities account for the higher proportion of gaze that novices allocated to non-instructional regions of the classroom. One possibility is that what experts have come to prioritise in classroom instruction—students—have yet to become priorities among novices themselves. An alternative, or simultaneous, explanation for their high proportions of gaze towards non-instructional targets is that novices need more 'thinking time', due to the greater cognitive load that the profession demands from beginning teachers, which would explain novices' attentional gaze toward non-instructional region. That is, novices may be looking toward non-instructional regions for 'relief' from the processing required from task-relevant looking. Certainly, previous literature has demonstrated the 'thinking' role of averting gaze from others, regardless of culture (Doherty-Sneddon, Bruce, Bonner, Longbottom & Doyle, 2002; McCarthy, Lee, Itakura & Muir, 2006). Related, averted gaze is well documented among populations who characteristically fail to process key visual information during social interaction, such as those with autism for whom eye contact leads quickly to cognitive overload. For such individuals, averted gaze seems to bring mental relief (Doherty-Sneddon, Whittle & Riby, 2013). It seems mental relief may be a priority for novice teachers in a way that is not necessary among experts. Additionally, literature has previously suggested that looks towards areas not relevant to an immediate conversation is essential to human interaction, which would explain the high rate of beginning teachers' default looks towards non-instructional regions during communicative gaze.

Expertise differences in proportions of gaze towards student materials and teacher materials were not statistically significant. It could therefore be concluded that prioritisation of these two classroom regions does not mark out the expertise status of a teacher. Rather, it is the teacher's prioritisation of either students or non-instructional regions that give indication of a teacher's expertise. Notable, however, is the role of proportions of communicative gaze towards teacher materials in distinguishing between cultures which we discuss next. The prioritisation of teacher materials can thus be regarded as a mark of cultural disposition rather than professional expertise.

Cultural differences emerged in communicative gaze, with Hong Kong teachers using higher proportions of gaze toward—and therefore giving greater priority to—teacher materials and UK teachers to non-instructional regions (Hypothesis 2). The Hong Kong teachers in the present study reflect the way the subject pedagogical content knowledge of East Asian teachers exceed those of their Western counterparts, as found in preceding studies (König, Blömeke, Paine, Schidt & Hsieh, 2011; Zhou, Peverly & Xin, 2006). Since one typically excels in an area valued by one's setting, it is likely that East Asians value learning content more than their cultural counterparts. In support, Leung (2014) has suggested that it is the Confucian value of discipline and memorisation that drives East Asian teachers to excel in the content knowledge aspect of their profession. As for why non-instructional regions emerged to be a UK-specific priority, a number of possibilities come to mind. Firstly, UK teachers may have been ensuring that they are not triggering excessive arousal, or anxiety, in their students through averting their gaze from students and learning materials (Kendon, 1967). Through averting their gaze, UK teachers would have been reducing the sense of difficulty in the classroom discussion (Beattie, 1978). As seen in mothers' gaze changes during the first year of their child's life (Messer & Vietze, 1984), averted gaze also suggests that UK teachers see their capacity for independence, such that they can be trusted to lead the classroom learning for themselves. All three possibilities converge to reflect the student-led preferences in Western instruction in contrast to the teacher-led tendencies in East Asia (Bryan, Wang, Perry, Wong & Cai, 2007; Leung, 1995).

Teacher priorities were a function of culture-specific expertise, too, in communicative teacher gaze (Hypothesis 3). Through sub-group analysis of the expertise × culture interaction, UK experts directed higher proportions of gaze towards, or greater priority for, *teacher materials* than UK novices, but Hong Kong experts did so more than UK experts. Hong Kong expertise is apparently defined by this priority for teacher materials, echoing conjectures above that teacher gaze proportions have highlighted the importance of content knowledge in East Asian teaching. But UK experts give importance to content knowledge too which should not be surprising, given that knowledge is a universal indication of expertise in teaching (Berliner, 2001; Shulman, 1986) and in other domains (Sternberg, 2014).

A final comment is warranted regarding cultural differences. It was interesting that attentional gaze revealed no cultural differences in teacher priorities in culture-only analyses or in the culture-specific expertise analyses (i.e., expertise × culture). The purpose of the present article was to explore the role of teacher gaze proportions as indicators of teacher priority: it appears that gaze proportions reveal more about teacher priorities during communicative gaze than in attentional gaze. There is also a chance that culture simply matters more in communicative gaze than in attentional gaze, at least from the macro perspective taken in gaze proportion analysis. Regardless, these findings vindicate the authors' division between attentional and communicative gaze for priority analysis.

4.1. Limitations

A limitation in the present research is that the gaze proportion measure of teacher priority is not supplemented by a corresponding measure of teachers' priorities. To triangulate the proposed—novel and implicit—framework with another—established and explicit—approach to measuring teacher priority will be an invaluable next step for future research that use eye-tracking to investigate teacher priorities. Indeed, such an extension would further strengthen the methodological framework that is proposed in this article. Discussions relating to explicit, self-report measures of teacher priority (e.g., Rimm-Kaufman, Storm, Sawyer, Pianta & LaParo, 2006) and the importance of taking teacher priority into consideration (Borko & Shavelson, 1990; Munby, 1982) have already been taking place. The incorporation of these preceding explicit measures with our implicit measure (i.e., eye-tracking) of teacher priority would improve teacher decision-making research substantially.

Moreover, it should be noted that teacher priorities access teachers' cognitive habits: it is here that the capacity of gaze proportions ends. Teacher priorities must be distinguished from discussions of teacher personality since the latter goes beyond teacher cognition to concern behavioural, emotional as well as cognitive levels of teacher behaviour. Readers should be aware that the proposed analysis therefore does not offer an avenue for understanding teaching styles or personality as such. Rather, only teachers' decision-making priorities are available via gaze proportion measures.

4.2. Implications

Since experts demonstrated prioritisation of students during both attentional and communicative gaze, the central implication of this article is that teachers should prioritise students. Moreover, the importance of prioritising students transcends culture, since no cultural differences emerged whatsoever in this regard. Thus, unlike our previous analyses of this study's data [PRESENT AUTHORS] and unlike preceding cross-cultural studies in education (Leung, 2014; Nguyen, Elliott, Terlouw & Pilot, 2009; Zhou, Lam & Chan, 2012), the present article contends that student-centredness is one aspect of teacher cognition that deserves to be foundational universally, in both Western European and East Asian teacher training curricula. In support, some teacher effectiveness literature has already reported that some teaching priorities seem appreciated among students from varying cultures (e.g., Zhang et al., 2005). Additionally, prioritisation of students deepens students' understanding of their subject (Kinchin; 2003; Rimmer, 2015), students' emotional security ((Harslett, Godfrey, Harrison, Partington & Richer, 1999) and security with peers as well as students' interest in subject material (Barraket, 2005). Teachers who prioritise students are also those who are noted for effective classroom management (Brackett, Reyes, Rivers, Elbertson & Salovey, 2011), a positive classroom climate and students' subjective sense of integration into the class group (Opdenakker & van Damme, 2006). Even parental involvement is improved by teachers' prioritisation of students (Opdenakker & van Damme, 2006).

Methodologically, we have demonstrated the value of gaze proportions in tapping into higher-, macro-level processes of teacher expertise and have thus gone beyond typical moment-to-moment insights from duration-based measures of gaze. By reporting our gaze proportion analyses, we have also shown that it is possible to make use of gaze proportions in real-world studies, including those of professional expertise. In doing so, we make significant contributions to both the vision research literature and to decision-making psychology.

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Figures

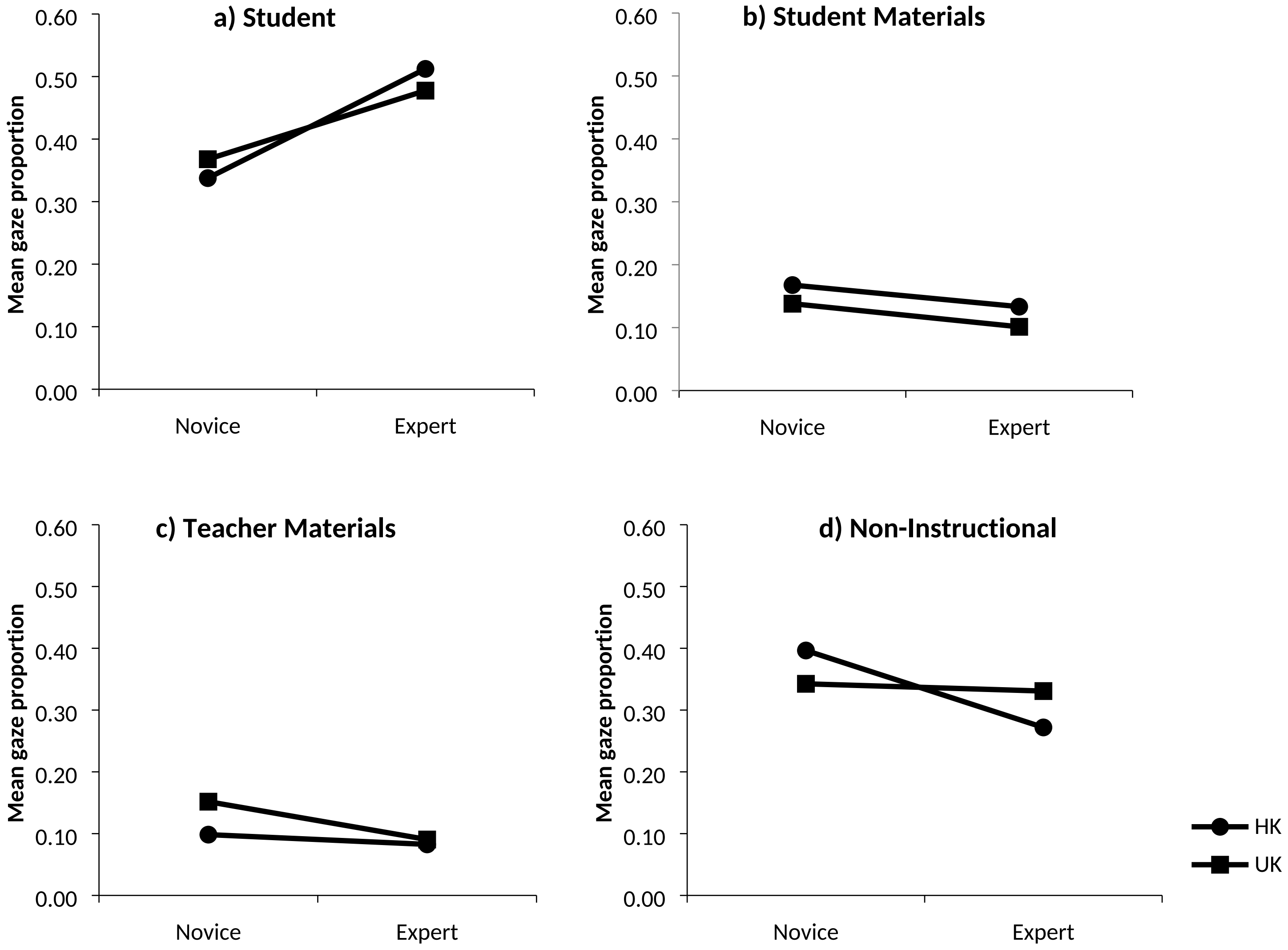
a) Student
b) Student Materials
c) Teacher Materials
d) Non-Instructional
Mean gaze proportion
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Novice
Expert
HK
UK

Figure 1. Line graphs with teacher *attentional gaze proportions* for each participant group: HK (i.e., Hong Kong) represented East Asians; UK represented Western Europeans. Expertise was the only significant predictor, which related only to *student gaze* and *teacher material gaze*.

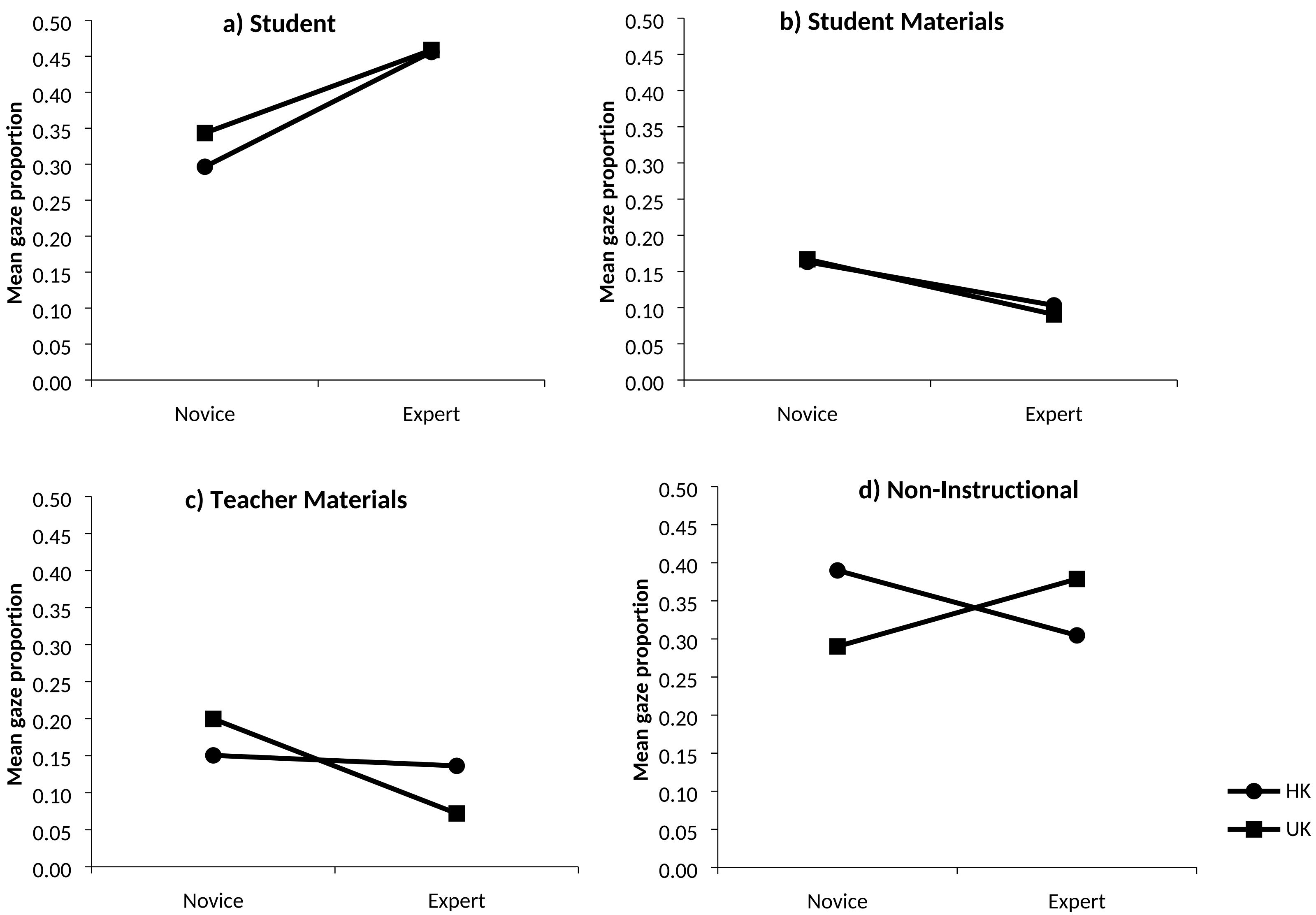
a) Student
b) Student Materials
c) Teacher Materials
d) Non-Instructional
Mean gaze proportion
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Novice
Expert
HK
UK

Figure 2. Line graphs with teacher *communicative gaze proportions* for each participant group. For significance levels, see in-text reporting.

Tables

Table 1

Teacher Demographics

		Class level				Subject, *N*				Teacher details									
										Age		Gender, *N*		Years of experience				Performance ratings	
Culture	Exper-tise	*M*	*SD*	Min	Max	Sci/ Maths	Native lang	Hum	Other	*M*	*SD*	M	F	*M*	*SD*	Min	Max	*M*	*SD*
	Expert	3.00	1.41	1	5	0	4	4	2	44.00	9.94	3	7	19.30	7.47	10	32	1.60	.84
East	Novice	2.30	1.77	1	5	2	1	4	3	26	3.16	3	7	4.60	3.24	1	10	2.70	.95
	Expert	2.20	1.23	1	4	2	0	7	1	35.00	8.16	4	6	11.00	7.36	3	28	1.20	.42
West	Novice	1.82	1.08	1	4	3	2	4	2	33.00	10.33	4	6	3.23	2.48	2	10	2.09	.70

Note. ‘Performance ratings’ are reverse-scored (1 being ‘Outstanding’; 4 being ‘Inadequate’); ‘Sci’ is an abbreviation for Science; Science included social sciences (e.g., Economics); ‘Native lang’ is an abbreviation for Native Language; ‘Hum’ is an abbreviation for Humanities.

Table 2

Descriptive statistics for teacher gaze proportions.

	Student		Student materials		Teacher materials		Non-Instructional	
	M	S.D.	*M*	S.D.	*M*	S.D.	*M*	S.D.
HK								
Expert	.48	.10	.12	.10	.11	.07	.29	.10
Novice	.32	.10	.17	.09	.12	.08	.39	.14
UK								
Expert	.47	.08	.10	.07	.08	.05	.35	.13
Novice	.36	.08	.15	.09	.18	.10	.32	.15

Note. The above statistics are untransformed, whereas the regression analyses below use transformed values.

Table 3

Beta regression outcomes for attentional gaze proportions

	R^2	Expertise				Culture				Expertise x Culture			
		B	s.e.	t	*p*	B	s.e.	t	*p*	B	s.e.	t	*p*
Student	.42	1.07	.37	2.89	.007	.45	.36	1.23	.23	.31	.23	1.33	.23
Student material	.07	-.07	.65	.12	.91	-.43	.68	-.64	.53	.10	.42	.24	.82
Teacher material	.18	.10	.55	.19	.85	-.21	.56	-.38	.71	.32	.34	.94	.35
Non-Instructional	.11	-1.11	.56	2.00	.05	.86	.56	1.54	.13	.55	.35	1.58	.12

Note. The R^2 in this analysis was a generalised R^2 relevant to beta regression, namely Cox-Snell R^2.

Table 4

Beta regression outcomes for communicative gaze proportions

		Expertise				Culture				Expertise x Culture			
	R^2	B	s.e.	t	*p*	B	s.e.	t	*p*	B	s.e.	t	*p*
Student	.37	.89	.40	2.22	.03	-.18	.40	-.47	.64	.20	.25	.78	.44
Student material	.14	-.18	.71	-.26	.80	-.41	.77	-.54	.60	.24	.46	.54	.60
Teacher material	.22	.78	.64	1.22	.23	-1.47	.71	-2.08	.05	.88	.42	2.08	.05
Non-Instructional	.12	-1.14	.55	-2.08	.05	1.10	.56	1.98	.06	.79	.35	2.25	.03

Note. The R^2 in this analysis was a generalised R^2 relevant to beta regression, namely Cox-Snell R^2.