Teach at first sight: Expert teacher gaze across two cultural settings

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Abstract

Teacher gaze is central to learning, yet research in this area has been limited to Western and laboratory settings. Moreover, within these contexts, only attentional (i.e., information-seeking) gaze has been investigated so far. The research presented in this thesis aimed to extend existing literature by identifying culture-specific (UK and Hong Kong) patterns of expert teacher gaze in real-world classrooms, and going beyond attentional gaze to communicative (i.e., information-giving) gaze. Participants were n= 40 secondary school teachers with 20 (10 expert; 10 novice) from the UK and 20 (10 expert; 10 novice) from Hong Kong. All consented to wearing eye tracking glasses while teaching a class. Gaze proportion, duration, efficiency, flexibility and sequences were measured and analysed. The strategic consistency of the way in which teachers used gaze was also assessed, as was the relationship between measures of gaze and teachers' interpersonal behaviour. In both cultures, expertise in teaching was demonstrated by giving students priority, that is, higher proportions and longer durations of teacher gaze directed towards students. Gaze flexibility was also a sign of expertise in both cultures, as was strategic consistency. Cultural differences also emerged in what constituted expert teacher gaze. Expertise specific to the UK was shown through teachers looking less at teacher materials and through strategic consistency. Expertise specific to Hong Kong was shown through looking less at non-instructional non-student targets and by gaze flexibility. Teacher interpersonal style (i.e., agency × communion) and teacher agency increased as non-student attentional gaze decreased and as non-student communicative gaze increased; and teacher communion was significantly related to attentional but not communicative gaze.

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Author's Declaration

I hereby declare that the work contained in this thesis is my own, except where otherwise referenced, and it is the result of study that has been conducted since the official commencement date of the degree. This work has not, in whole or in part, previously been published and never been submitted for any other degrees for the University of York or otherwise.

1. CHAPTER ONE: INTRODUCTION

As humans, we are born with an expectation to learn through the gaze of others (Csibra & Gergely, 2009). Although we find human faces intrinsically more interesting than non-facial stimuli, such as flowers (Taylor, Itier, Allison & Edmonds, 2001) or upturned faces (Tomalski, Csibra & Johnson, 2009), it is the eyes contained by faces that we are most interested in (Taylor et al., 2001)—so much that faces without eyes are of no interest to us (Tomalski et al., 2009). What do eyes have that give them such precedence?

It can be argued that eyes are the richest source of information available in the social world (e.g., classrooms, Baron-Cohen, 1995; Frith & Frith, 2012) and are therefore the choicest channel for *learning* about the world. In turn, effective use of one's eyes would best ensure successful *teaching* about the world. The failure or inability to relate with others through gaze has been associated with negative socio-emotional experiences (Bauminger & Kasari, 2000; Travis & Sigman, 1998) and life outcomes (Chen, Leader, Sung & Leahy, 2015; Wehman et al., 2014). The skilled use of gaze in social interaction earns trust (Einav & Hood, 2008), affection (Mason, Tatkow & Macrae, 2005) and eminence (Mason, Hood & Macrae, 2004). As such, teachers would be wise to give due importance to this aspect of classroom instruction.

Yet, research is limited regarding how gaze should be used by teachers (Gegenfurtner, Lehtinen & Säljö, 2011). To understand what effective teacher gaze involves, the present study made *expert–novice comparisons* with the expectation that this approach would make best practice clear. This study thus follows expertise research tradition which has, through expert–novice comparisons, consistently highlighted how exceptional members of varying professions behave (e.g., for radiologists, Lesgold et al., 1988; for physicists, Chi, Bassok, Lewis, Reimann & Glaser, 1989; for musicians, Brochard, Dufour & Despres, 2004). The present study goes further by making *cross-*

cultural comparisons as well, in order to identify the teacher gaze patterns that are effective in one culture but not another (Sternberg, 2014). This approach also identifies teacher gaze patterns that are effective regardless of geography, that thereby transcend culture. In doing so, the present research responds to calls for educational research to recognise the likely influence of culture on the effectiveness of teacher behaviour (e.g., Leung, 2013; Nguyen, Terlouw & Pilot, 2006) such as teacher gaze.

In spite of the importance of gaze as teachers' channel for conveying information (i.e., communicative gaze), existing expert–novice comparisons of teachers have focused entirely on gaze as teachers' channel for obtaining information (i.e., attentional gaze; e.g., van den Bogert et al., 2014; Wolff et al., in press.). The need for research to disentangle teachers' use of gaze for *attentional* purposes, to obtain information or responses they require, as distinct from *communicative* purposes, to give information to students that they require, is clear—not only because of the natural function of teacher gaze for human learning (e.g., Csibra & Gergely, 2009) but also because, at this time, vision researchers are frequently emphasising the dual direction of information transmission in social gaze (Jarick & Kingstone, 2015; Myllyneva & Hiertanen, 2015). The present research therefore acknowledges the dual nature of human gaze by analysing occasions of teachers' attentional gaze separately from occasions of teachers' communicative gaze, as identifiable through the simultaneous speech of teachers (McNeill, 1985, 2006).

Extant research into teacher and social gaze has also been largely limited to laboratory designs. Although laboratory research is invaluable to understanding core mechanisms in human behaviour, social gaze in the real-world is notably different from social gaze in the laboratory (Foulsham, Walker & Kingstone, 2011). As a form of social gaze, therefore, teacher gaze is better captured in the real-world. Moreover, while all professional expertise is best investigated in the field (Ericsson, 2014; Klein, 1993), teaching is an exceptionally complicated profession (Berliner, 2001) which needs even more to be investigated in the classroom setting in order for research on expert teacher gaze to be accurate (Rich, 1993). Accordingly, the present study was conducted in the *real-world*, in secondary school lessons that participants teach as part of their everyday life.

To make this real-world design possible, eye-tracking glasses were used. Because such mobile, real-world eye-tracking data is new, much of the present thesis was dedicated to exploring analytic techniques that are both feasible and insightful with regard to teacher expertise (Sternberg & Horvath, 1995). Three stages of gaze analysis are reported in this thesis: frequency, temporal and scanpath analyses. The present thesis innovated in its *frequency analysis*, by using proportion measures as indications of teachers' long-term strategies and priorities (e.g., Brändtstatter, Gigerenzer & Hertwig, 2006). Using state space grids (Hollenstein, 2013), this study's *temporal analysis* was also innovative because both static (i.e., conventional, aggregated) and dynamic (i.e., process-tracing, structural) approaches were taken to explore equally important aspects of teacher expertise (Sternberg & Horvath, 1995). This study was also the first to conduct *scanpath analysis* (Foulsham & Underwood, 2008) on mobile, non-geometric (position-based) eye-tracking data. All three approaches to analysing teachers' glasses eye-tracking data revealed statistically significant and conceptually insightful findings on expert teacher gaze. The present thesis thus makes valuable methodological contribution to educational eye-tracking research.

Finally, teachers' instructional behaviour is never separate from their interpersonal behaviour. Teachers may prioritise pedagogical goals, but their actions can never be extricated from the interpersonal dynamics in classroom interactions (Crétons, Wubbels & Hooymayers, 1993). The manner in which teachers seek (as in attentional gaze) and give (as in communicative gaze) information through their gaze will have interpersonal effects on their students, whether they are aware of this or not (Watzlawick, Beavin & Jackson, 1967). Given the importance of teacher–student relationships to students' classroom experiences and outcomes (Pianta et al., 2012), the present thesis explored the connection between teacher gaze and their 'interpersonal style' as reported by students (Wubbels et al., 2012) to initiate the study of *interpersonal gaze*. Using hierarchical multiple regression, teachers' expertise and culture were factored out in analysis to then identify the direct relationship between teachers' gaze and three aspects of their interpersonal style: teacher agency (i.e., leadership), communion (i.e., closeness with students) and overall interpersonal style (i.e., agency × communion).

In all, the present research sought to understand (1) expert teacher gaze (2) for communication as well as attention, (3) in two cultural settings, Hong Kong and the UK, and (4) to do these in the real-world. This thesis also demonstrates the contributions that (5) three analytic approaches can make to real-world teacher gaze research and makes headway into understanding (6) teacher interpersonal gaze by connecting teacher gaze with their interpersonal style.

2. CHAPTER TWO: GAZE AS NATURAL PEDAGOGY

Teacher gaze is not only used to obtain relevant information from the classroom: it also relays and supports teacher instruction as part of a communicative process. The giving and receiving of signals through eye contact and gaze direction has been repeatedly demonstrated through social gaze research. Most recently, Myllyneva has highlighted the impact of others' gaze, even when that 'observer' is not visible to the observee (Myllyneva & Hietanen, 2015), which highlights the communicative potential of human gaze: it gives as much as it receives. Accordingly, this thesis gives due recognition to the role of communicative gaze—gaze that gives, conveys and clarifies information—as distinct from that teacher attentional gaze—gaze that seeks, receives and processes information.

In particular, this chapter begins the literature review by focusing on the way in which *communicative* gaze is central to teaching. The chapter is organised in two halves. The first part of the chapter outlines the broader conceptual context of communicative gaze, namely social cognition. The two forms of social cognition are outlined, automatic and controlled. Within controlled social cognition in particular, intent is addressed which later relates to communicative intent that is shown through social signals. The second half of the chapter contends that human gaze is naturally pedagogical. The chapter then proceeds by outlining the pedagogical properties of human gaze, including its role in signalling communicative intent and redirecting audience attention. Together, the goal of this chapter is to underscore the likely importance of teacher gaze when investigating effective classroom instruction.

2.1. Social Cognition

Social cognition is "the sum of those processes that allow individuals of the same species to interact with one another" (Frith & Frith, 2007, p. 724). Social cognition is the way in which humans "interpret, analyse and remember information about their social world" (Pennington, 2000, p. 1) so that individuals in the same context are able to, as a network, achieve collective goals and maintain shared values. Indeed, social information is being exchanged at all times, even when the observee is not deliberately giving information to the observers and when the observee is unaware of being watched, such that all observable behaviour is public information as far as social cognition is concerned (Danchin, Giraldeau, Valone & Wagner, 2004). In fact, the observational mechanisms of social cognition are arguably essential to human learning, in order to avoid catastrophic mistakes in relation to specific locations, actions or another person (Frith & Frith, 2012). Given that social cognition is very much developed through the observation of others, the role of gaze—attentional and communicative—in message exchange is likely to be an important one.

Since collective goals are shared rules that govern group behaviours and priorities (Visscher, 2007), they are integral to social cognition. Accordingly, investigation of social cognition must take place in the *real-world,* where collective goals are in operation (Fiske & Taylor, 2013). Additionally, social cognition necessarily concerns *mentalism*; that is, the internal representation of a given concept—such as a person, his characteristics and the relationship between his characteristics (Fiske & Taylor, 2013; Onishi & Baillargeon, 2005; Wimmer & Perner, 1983). As we adjust to the needs of our context, a chain of cognitive responses take place (McGuire, 1969), such that *process* is another aspect of interest and process analysis becomes relevant (Fiske & Taylor, 2013). Additionally, to address collective goals in one's context, *multi-modal* input is made (Fiske & Taylor, 2013), of which visual data is of central interest in this thesis.

2.1.1. Automatic Social Cognition

Social cognition is both automatic and controlled. As part of automatic social cognition, Danchin refers to the publicly understood information that is channelled through social behaviours (Danchin, Giraldeau, Valone & Wagner, 2004). The movement of the observee is another indication of whether he or she is becoming a social agent (Frith & Frith, 2010; Johansson, 1973), or a potential partner for interaction.

Mentalism is also known as 'mind-reading' and involves the judgement of intentions based on observed movements (Castelli, Happe, Frith & Frith, 2000; Frith & Frith, 2010), trustworthiness based on past actions (Behrens, Hunt, Woolrich & Rushworth, 2008; Pelphrey, Morris & McCarthy, 2004) and knowledge based on past performance (Samson, Apperly, Braithwaite, Andrews & Bodley-Scott, 2010). Mentalism also involves judging emotional states, whereby humans are continually self-projecting, a major component of mentalism (Mitchell, 2009). During self-projection, individuals continually simulate for themselves a hypothetical set of mental states that seem appropriate for the experiences they are observing (Jenkins, Macrae & Mitchell, 2008; Mitchell, Cloutier, Banaji & Macrae, 2006; Mitchell, Banaji & Macrae, 2005). Meanwhile, the observer mentalises to track their own agency, through self-reflection for assessing one's control over a situation (Miele, Wager, Mitchell & Metcalfe, 2011)—a process that continues, as one remains in a context or as they move from one space to the next (Hampton, Bossaerts & O'Doherty, 2008).

Over time, humans form impressions about the 'regular' interlocutors in their lives to ease demands on cognitive load (Higgins, King & Mavin, 1982). These impressions are proceduralised (i.e., refined) over time (Smith & Branscombe, 1988), thereby refining the approach interactions with familiar individuals in well-established contexts.

2.1.2. Controlled Social Cognition

Controlled social cognition is actively determined by the present goal—"a mental representation of desired outcomes" (Fiske & Taylor, 2013, p. 38). Controlled social cognition can become automatic, or require deliberate control throughout the process. Habit is one example of controlled (i.e., goal-driven) yet automatic behaviour. Habits are behaviours that are enacted more efficiently than unhabituated behaviours required in order to meet a goal (Aarts & Dijksterhuis, 2000). Heuristics are another example of automatic behaviour with underlying controlled social cognition (i.e., goals). Heuristics are "strategies that ignore information to make decisions faster, more frugally and more accurately than complex methods" (Gigerenzer & Gaissmaier, 2011, p. 454). Effective use of heuristics will take into account, not only general features (Grether, 1992), but also the most recent efficacy of the strategy concerned (Sinkey, 2015). Goal-driven automaticity can be identified among teachers, in terms of their own pedagogical or interpersonal goals are at work. Identifying what these are and tapping into the teacher communication at a pre-conscious level can be an effective way of enhancing classroom practice.

Intent is social cognition that is controlled for the full duration, which involves "making the hard choice and [is] enacted by paying attention to implementing" the hard choice (Fiske & Taylor, 2013, p. 42). Since intent consists of making choices, it may be best understood by its distinction from ordinary bias (i.e., automatic social cognition). To illustrate intent, Wheeler and Fiske (2005) reported adults' amygdala to be significantly more activated than when they were asked to treat a face as a non-social object, during a non-social task (e.g., is there a dot in the photograph), compared with when participants were asked to treat the face as a social object in a social task (e.g., estimate person's age). Related is Phelps' distinction between the negative implicit, autonomic reactions in White participants to Black stimuli—and the absence of this in self-reported racial attitudes (Phelps et al., 2000). Thus, social goals drive humans to exercise intent—and counteract instinct—when making conscious decisions.

2.1.3. Social Cognition in Teacher Gaze

In summary, the present thesis lies within the field of social cognition: specifically, in the way humans use automatic and controlled mechanisms to make decisions about the nature of the interaction. What follows is the way teaching and learning takes place within one part of social cognition, namely controlled social cognition, specifically intent. Although I focus on this aspect of social cognition, I am conscious that other aspects of social cognition are active: I will therefore be referring back to relevant aspects of social cognition in subsequent chapters. Figure 2.1 depicts where teacher gaze—and this thesis—falls in the overall framework of social cognition. For now, let us focus on the controlled aspect of the inherent way in which humans learn, through natural pedagogy.

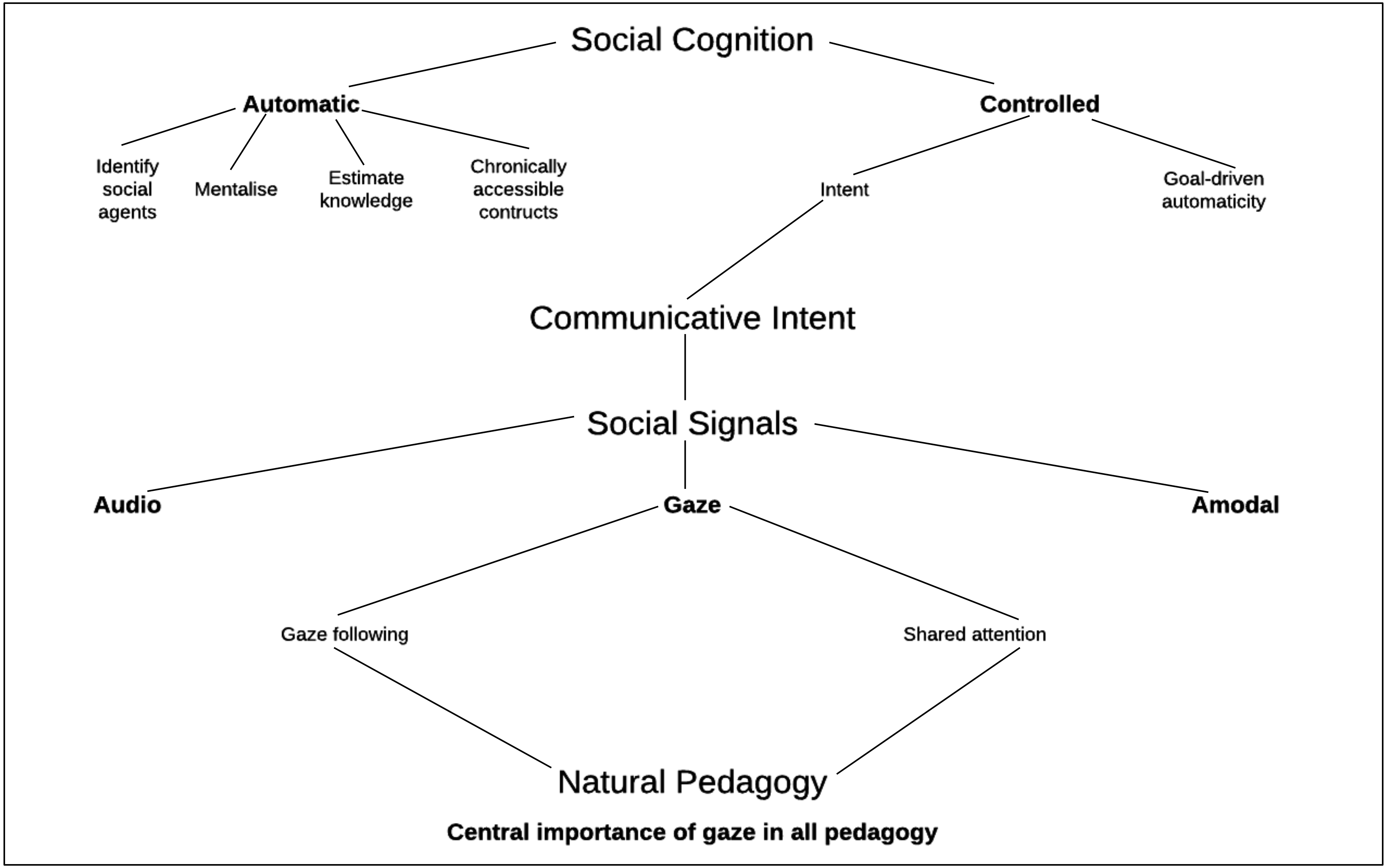


Figure 2.1. Concept map of where this thesis (especially teacher communicative gaze) resides in the wider framework of research.

2.2. Gaze is Naturally Pedagogical

Natural pedagogy is the communication system by which humans learn. The communication system is one “specifically adapted to allow the transmission of generic knowledge between individuals [and] enables fast and efficient social learning of cognitively opaque cultural knowledge that would be hard to acquire relying on purely observational learning mechanisms alone” (p.148, Csibra & Gergely, 2009). By ‘learning’, the theory refers to the permanently accessible knowledge that is generalised across contexts.

In the natural pedagogical process, adults, including teachers, are said to instinctively create learning opportunities (Vrijj, Fish, Mann & Leal, 2006), and to make these learning events explicit through social signals. Children, meanwhile, are predisposed to detect and segregate each learning event according to the signals used by the adult in question. Csibra (2010) outlines three channels for social signals. One is the auditory channel; sounds selected and produced with a target audience and response in mind, such as motherese (i.e., infant-directed speech). Another is the amodal channel; events that lead to a target response, such as contingent responsivity in the other. The visual channel is the channel presently of interest. In fact, direct gaze is central to natural pedagogy, being the most obvious example of social signals for learning and communication.

2.2.1. Adult Gaze Stands Out

The human eye is exceptionally well-suited as a tool for social signalling (Tatler, Kirtley, MacDonald, Mitchell & Savage, 2014). Our eyes possess in themselves a visual contrast that exceeds other animals’ through their significantly whiter scleras (Kobayashi & Kohshima, 2001). In particular, human sclera covers the largest proportion of the eye of all primates and is uniquely wide in shape. Together, it seems clear that the human eye is designed for communication by its high contrast design and for eyeball movements across the visual field by its wide scleratic space. Indeed, an image of an eye triggers stronger reflexes than drawn arrows (Ristic, Wright & Kingstone, 2007). Viewers even make neural responses to the whole eye, dedicating specific responses to each, the iris and each individual scleratic space (Langton, Watt & Bruce, 2000). Whereas primates' eyes are developed for camouflage and survival, humans' eyes are uniquely designed with social interaction in mind (Tomasello, Hare, Lehmann & Call, 2007).

The human eye grabs human attention from an early age. Indeed, Baron-Cohen (1995) refers to an eye detection device that operates in humans from earliest infancy. Evidence for the general impact of the human eye on babies is found in Farroni's demonstration that newborns look significantly longer at drawn images of direct gaze than those of averted gaze (Farroni, Csibra, Simion & Johnson, 2002; cf. Batki, Baron-Cohen, Wheelwright, Connellan & Ahluwalia, 2000). Furthermore, the attention of newborns is only grabbed when eyes are presented in forward-facing faces presented the right-way up (Farroni, Menon & Johnson, 2006)—an effect replicated among adults (Tomalski, Csibra & Johnson, 2009). In other words, a visual stimulus is intrinsically salient to humans when they are confident that the image is a human eye.

The *stare-in-the-crowd effect* demonstrates the impact of the human eye on others. From a 'crowd' of distractors, undergraduates detected 'stares' (i.e., direct gaze) in their peripheral vision significantly quicker than when they were required to locate averted gaze (Palanica & Itier, 2011). Senju and Johnson (2009) call this impact of direct gaze the *eye contact effect* in which "perceived eye contact modulates the concurrent and/or immediately following cognitive processing and/or behavioural response" (p. 127). Authors suggests reasons for the eye contact effect, based on neural correlates. Facial, task-dependent, social, communicative and emotional regions have all been found to activate in response to displays of eye contact (i.e., direct gaze). Of those, the classroom-related aspects of adult (and teacher) gaze will now be outlined.

2.2.2. Gaze Within a Wider Pedagogical Process

In the theory of natural pedagogy, adult gaze is part of a wider learning system, namely *shared attention* (Baron-Cohen, 1995). One would expect the same processes in the classroom with teacher gaze. Human children have been found to imitate only those actions that appear intentional, leaving accidental-looking actions out (Carpenter, Akhtar & Tomasello, 1998). To make *pedagogical intention* apparent, adults signal through gaze. Within pedagogical intention, Csibra (2010) distinguishes between informative intent and *communicative intent*. Informative intent is the inward goal to a specific impact on a specific audience. Communicative intent is the demonstration of this intent to the audience (cf. Sperber & Wilson, 1995). Social signals convey communicative intent (Frith & Frith, 2012) as well as the audience of the intended message (Csibra, 2010). Attention is thus captured through the most prominent social signal, usually direct gaze.

2.2.2.1.Pedagogical purpose I: Gaze informs

Communicative intent is expressed through social signals—visuo-motor movements that do not meet functional purposes. In gesture, hand movements for pointing take longer to reach their destination and are held for longer when people perform tasks to teach (or inform; Peeters, Chu, Holler, Özyürek & Hagoort, 2013). Thus, social signals possess distinctly salient properties for the purpose of conveying communicative intent (Committeri et al., 2015). Moreover, neural regions within the social cognition network (Committeri et al., 2015) are only activated in speakers who are teaching (or informing) others (Brunetti et al., 2014). Likewise, gaze has been highlighted to give this social, communicative dimension to body movements: adults looking at their addressee produce hand movements that are significantly closer to the addressee during a pointing task (de Langavant et al., 2011). Neural regions associated with other-awareness (i.e., heterocentricity) were also activated exclusively when participants pointed while looking at addressees. Thus body movements associated with communicative intent appear to be fundamentally different from body movements that do not similarly contain social meaning.

Once prominent social signals have successfully captured others' attention, they are then used to facilitate the process of message transmission. When speakers orient their body towards their addressees, neural regions for mentalising are more activated in the listeners than when speakers orient their body away from addressees (Nagels, Kircher, Steines & Straube, 2015). Similarly, hand gestures enhance listeners' comprehension (Driskell & Radtke, 2003) as well as lessening the cognitive load for the learner (Cook, Yip & Goldin-Meadow, 2012). Unlike gestures, gaze do not enhance the benefit of gestures as speakers talked. Gaze does, however, enhance listeners' understanding of the message (Holler, Schubotz et al., 2014). Moreover, neural regions (i.e., the right middle temporal gyrus) that were activated by combined speech and gesture messages were further activated when these messages were delivered alongside eye contact (Holler, Kokal, et al., 2014).

2.2.2.2.Pedagogical purpose II: Gaze Directs Attention

In natural pedagogy, adult gaze also functions within a "referential triangle" (Tomasello, 2000, p. 38), as the child naturally expects adult behaviour to relate to an object in their context (Csibra & Gergely, 2009). Humans have a particularly strong need for gaze cues in their earliest stages of development, since they are unable to use verbal cues, making gaze cues essential as supports for pointing (Csibra & Gergely, 2009) and head orientation (Bayliss, Pellegrino & Tipper, 2004). Gaze directs attention through direct gaze ensued by gaze shifts (Senju & Csibra, 2008) which in turn triggers *gaze following*. When an adult directs their gaze towards a child and then shifts their gaze to an object of interest the child's gaze follows allowing , the same object to be given simultaneous regard, or shared attention, by adult and child (Baron-Cohen, 1995).

To achieve shared attention, gaze following must take place. Since even newborns consistently display gaze following, it can be argued that humans have an innate inclination towards shared attention. Specifically, newborns looked away from drawn images of averted gaze more often than direct gaze (Farroni, Massaccesi, Pividori & Johnson, 2004). After viewing images of averted gaze, newborns looked more promptly at gaze targets located in the directions congruent with the image's gaze direction: participants also displayed gaze following more frequently in these scenarios.

Further laboratory evidence replicates newborns' awareness of adult averted gaze (Hains & Muir, 1996), with newborns consistently suppressing their smile whenever the adult looked away. Ten to twenty-eight month-old infants continue to give early demonstrations of gaze following (Hood, Willen & Driver, 1998). At this age, infants continue to look more quickly at targets in locations that are congruent with videos of real faces' gaze directions, compared with targets of incongruent locations. Likewise, 12 to 18 month-old infants made significantly more correct looks (i.e., towards the gaze target location) when adult gaze was unobscured compared with when the adult's eyes were closed or covered (Brooks & Meltzoff, 2002).

Humans continue to employ shared attention throughout development, as humans demonstrate gaze following even in adulthood (Böckler, van der Wel & Welsh, 2014). This means the process is relevant to education. Gaze following among university students were significantly more likely when preceded by direct rather than averted gaze.

That is, students correctly identified which of the two target letters were displayed among distractor letters when direct then averted gaze was displayed, compared with alternative gaze sequences. Neural regions associated with social attention were, accordingly, more activated when adults observed direct gaze preceding gaze shift (Böckler, Eskenazi, Sebanz & Rueschemeyer, 2015). The importance of eyes for directing attention is further demonstrated by the elimination of gaze following when schematic faces are inverted, so that the eyes no longer appear to be eyes, compared with when schematic faces are upright (Kingstone, Friesen & Gazzaniga, 2000). Thus, the mechanism by which shared attention takes place—observed direct gaze, observer gaze shift, observer gaze following—persists throughout human life and can be expected to take place in the classroom.

2.3. Chapter Two: Summary

Teacher (or adult) gaze is part of a network of processes into which humans are born to operate collectively. Some social processes are automatic such as mentalism. Others are deliberate and guided by top–down processes, such as the meeting of goals through heuristics. Goal-driven automaticity is then the combination of the automatic and deliberate aspects of social cognition. Echoes of all three levels of social cognition—automatic, deliberate and goal-driven automaticity—will be found in the subsequent chapters of the literature review. Within social cognition, processes exist by which natural pedagogy take place. At the centre of natural pedagogy is teacher (or adult) gaze acting as one major component of communicative intent, teacher–learner shared attention and gaze following. The present chapter has highlighted the ways in which, among humans, teacher (or adult) gaze has an important potential and role as a pedagogical resource (e.g., its salience, Kobayashi & Kohshima, 2001). Thus, the expectation that teacher gaze should be central to classroom teaching seems grounded in human instinct. It appeared logical therefore attempt a detailed understanding of the possibilities of teachers' use of gaze for instruction.

3. CHAPTER THREE: EXPERT TEACHER GAZE

3.1. Expertise

An expert has "special skills or knowledge representing mastery of a particular subject through experience and instruction" (Ericsson, 2014, p. 508). Expertise is domain-specific (Bédard & Chi, 1992). Experts have efficient yet comprehensive knowledge structures, enabling them to be flexible in their planning and automatic in their task performance (Glaser, 1990). Such individuals are invaluable to society.

Experts are often identified for imitation to increase cumulative effectiveness within a population (Dean, Vale, Laland, Flynn & Kendal, 2013). To illustrate, gamers with both visible and superior scores were more likely to be mimicked by neighbouring players (Wisdom & Goldstone, 2010). Experts, therefore, can make a distinctive impact that makes their behaviour worth particular attention. In the classroom context, novice teachers can learn from experts' classroom practice and training programmes can be adjusted to correspond with experts' approaches to the profession. The characteristics of expertise found across professions (i.e., 'prototypes', Sternberg & Horvath, 1995) will be outlined in the next section of this chapter: namely, knowledge, efficiency, intuition, flexibility and strategic consistency.

3.1.1. General Expertise Feature 1: Knowledge

Expert knowledge is obtained and organised more effectively than novice knowledge. A major contribution to experts' superior knowledge is their memory system. According to Ericsson's Long-Term Working Memory theory, stronger connections between working and long-term memory enable experts to access relevant memories more effectively (Ericsson & Kintsch, 1995). Experts' knowledge structures are also more advanced so that abstract information is better integrated. Medical experts, for example, can recall relevant information more quickly and categorise patients more optimally, and therefore have lower rates of detrimental decisions (Norman, Brooks & Allen, 1989). Similarly, chess experts have been found able to recall chess moves that had been spoken to them at the rate of one move per two seconds, in contrast to novices who could not recall any moves (Saariluoma, 1991). Expert memories appear to be organised in a qualitatively different way to novices', that is, their memories are protected against disturbances that experience has revealed to be typical in the profession.

Expert knowledge is also more expansive than novice knowledge, leading to more complex and effective manoeuvres. Chassy and Gobet (2011) compared expert chess players with novices, dividing participants by their Elo (1978) ratings, by which chess players qualify as experts if they have 2000 points or more. The expert group was further divided into 'candidate masters' and 'masters'; and the novice group into class B (lower Elo range) and class A (higher Elo range). The study thus had four levels of expertise to compare. The study found that, the more expert the chess player was, the more complex their opening move would be. Chassy suggested that experts had undertaken more deliberate practice and therefore had accumulated a greater volume of stored templates for chess moves prior to the chess games in this study. Correspondingly, expert physicists have been found to recognise deeper structures of physics problems, whereas novices are more likely to be absorbed with surface characteristics (Chi, 1978).

3.1.2. General Expertise Feature 2: Efficiency

As a result of their superior knowledge and experience, experts are generally more efficient in their decision-making and appear to perform many tasks automatically (Sternberg & Horvath, 1995). In other words, experts operate in a less resource-consuming way (Anderson, 1982). It seems that, the more professionals perform their duties, the more they adapt their strategies to comprehensively suit the requirements of their jobs. These strategic changes increase the efficiency with which the individual performs their task. Such efficiency development has been demonstrated through studies using the Alphabet Verification Task. For instance, Haider and Frensch (1996) presented undergraduate students with letter–digit combination strings that all conformed with a consistent set of rules. Participants were given correct details on the way in which strings could be incorrect (i.e., the informed group) before being tasked to verify whether subsequent strings followed the same rules (i.e., correct) or not (i.e., incorrect) . Informed students had significantly faster reaction times and made a larger number of correct decisions than mis-informed students. Compared with mis-informed participants, informed students also showed a notably reduced learning curve, suggesting that the rate at which informed students reached expertise was improved by the correct background knowledge that they were given. Thus, expert behaviour can be simulated when viewers are given correct theories to operate by.

3.1.3. General Expertise Feature 3: Intuition

Intuition (i.e., flow or tacit knowledge) typifies experts . Human skill development can be understood as an adaptive system (Simon, 1992) in which we continually optimise our problem-solving processes as our experiences accumulate over time. Through this process, skilled intuition is an advanced recognition system, whereby situational cues trigger, in experts, memories of relevant information and associated solutions. Intuitive knowledge relates to practical problems which can have multiple candidate solutions and arise in everyday, real-world scenarios. Intuition is thus a resource that can support experts in performing their tasks more quickly and smoothly than novices.

Experts have demonstrated more extensive use of intuitive knowledge during problem-solving. For example, final year undergraduate Physics students were more likely to apply more than one intuition (or general principles) to problems than Physics students from earlier stages in their degree (Sherin, 2006). Correspondingly, customers approaching service providers for advice on problems report a greater likelihood of ‘easy solutions’ (i.e., direct yet accessible) from experienced assistants compared with newly employed assistants (Koskinen, 2000). Fadde (2007) emphasises that recognition among experts occurs more quickly than among novices, which in turn enables decisions and action to follow more quickly. In fact, Fadde argues that the chances of expert performance can be increased by developing recognition during ordinary, or recurrent (Van Merrienboer, Clark & de Croock, 2002), tasks. Experts in the military (Hedlund et al., 2003), in nursing (Meerabeau, 2006), in academia and in business (Wagner & Sternberg, 1985) all scored higher in intuition (i.e., tacit knowledge) than novices: that is, experts performed higher in self- and other-management, knowledge for short- and long-term contexts, and in their understanding of the ideal compared with the practical reality (Wagner ,1987). It is important, however, to distinguish between subjective confidence and experience-based intuition (Kahneman & Klein, 2009): the expert’s intuition is one that relates to a genuinely predictable environment and extensive deliberate practice in that environment.

3.1.4. General Expertise Feature 4: Flexibility

Since the development of expertise is comparable to skill acquisition, the broad processes of skill acquisition are relevant to this thesis. Skill acquisition is defined as the progression from “slow, deliberate processing to fast, automated processing” (p. 424, Taatgen, 2005). Experts possess established unconscious strategies for handling routine tasks, while top-down control is reserved only for the most novel and complex (Taatgen, 2005). Indeed, Taatgen argues that humans continually modify task performance systems, to ensure that only the most minimal control is needed and the maximum flexibility is enjoyed.

Expertise is thus also characterised by flexibility in handling task constraints. The more deliberate practice pianists had undertaken, the less safety goggles impaired their sight-reading performance (Lehmann & Ericsson, 1996). Likewise, not only did mathematics experts demonstrate awareness of more options for problem-solving strategies, but they also discussed these in terms of aiming to minimise errors and maximise efficiency in the process (Star & Newton, 2009), demonstrating flexibility-orientation within expertise. Indeed, the Einstellung effect—where experience is documented to result in mal-adapted and sub-optimal decisions (Frensch & Sternberg, 1991; Luchins, 1942)—disappears among the strongest chess experts (Bilalić, McLeod & Gobet, 2008). Thus, the most advanced experts remain dissatisfied until the most optimal solution is reached, one that takes into account all aspects of the scenario.

Strategy shifts are consistently documented among experts. Through the Alphabet Verification Task, Haider, Frensch and Joram (2005) demonstrated that experts—who previously demonstrated strategy shift during training when they received error feedback—were more likely to exercise strategy shift when they received no feedback. Experts (i.e., those who used strategy shifts) were also more able to verbalise errors contained within string stimuli. Moreover, experts dispensed of existing strategies that no longer prove relevant to their task. Thus, experts suppress strategies, even when they have been consistently useful, when they cease to be comprehensively applicable to their task.

3.1.5. General Expertise Feature 4: Strategic Consistency

Experts often use consistent strategies that have proven effective over time. A case study with one man, SF, with an exceptional memory capacity revealed a consistent memorisation strategy. Being an avid runner, SF only maintained his exceptional memory of numbers when they could be encoded as running times (Chase & Ericsson, 1982). Consistent processes that expert chess players have repeatedly been found to adopt consist of familiarising themselves with the board, identifying salient and distinctive areas, contemplating potential lines of attack and defence, considering potential consequences, revising and re-evaluating manoeuvres, all with a view to identifying the single move with the best prospects (de Groot, 1978). Expert designers likewise demonstrate a consistent practice—across and within individuals—of extensive 'problem scoping' potential solutions before undertaking one design (Lloyd & Scott, 1994). Ericsson (2006) cites further examples of experts in many professions that demonstrate the same exceptional level of consideration and caution, supported by a comprehensive representation of their field. These professions included athletes (French et al., 1996), doctors (Simpson & Gilhooly, 1997) and accountancy (Johnson, Jamal & Berryman, 1991).

3.2. Teacher Expertise

Expertise in teaching brings both effectiveness and relief. Classrooms are comparable with "nuclear power plants, medical emergency rooms [and] air traffic control" (Berliner, 2001, p. 478). As such, teachers can be seen as operating within a high-pressure context, in which superior knowledge (e.g., Saariluoma, 1991), complex yet efficacious manoeuvres (e.g., Chassy & Gobet, 2011) and fast decision-making (e.g., Haider, Frensch & Joram, 2005, below), all characteristics of expert performance, are a real advantage. Sternberg and Horvath (1995) take the 'prototype view' of teacher expertise, arguing that hallmarks of expertise in other professions can be used to explore expertise in teaching. In support, the development of teacher expertise (Berliner, 2004; cf. Brekelmans, Wubbels & van Tartwijk, 2005; Huberman, 1989; Maskit, 2011) can be closely compared with general professional expertise (Dreyfus, 2004). Moreover, children begin seeking out experts beyond their parents by the age of ten (Henrich & Broesch, 2011) and student perceptions of teacher expertise (i.e., understanding) significantly increase teacher credibility (Schrodt & Finn, 2011), mediate the learning benefits of teacher prosocial behaviours (Schrodt et al., 2009) and increase the likelihood of learner motivation (Frymier & Thompson, 1992) and persistence (Wheeless, Witt, Maresh, Bryand & Schrodt, 2011). Indeed, children become conscious by the age of five that teachers should have authority through superior knowledge and skill (Ziv & Frye, 2004). Taken together, children seem more disposed towards learning from teachers who display signs of expertise. Accordingly, ‘prototypic’ characteristics of expertise (i.e., knowledge, efficiency, intuition, flexibility, strategic consistency; Sternberg & Horvath, 1995) can be anticipated among expert teachers.

3.2.1. Expertise Traits in Teaching

3.2.1.1.Teacher Expertise Feature 1: Knowledge

Since the “explanation can be seen as a critical component of instruction,” (Leinhardt, 1987, p. 280), pedagogical knowledge is likely to be critical to teacher expertise. Meanwhile, deliberate practice (cf. Ericsson & Kintsch, 1995) is carried by expert teachers through revision and reflection on how to improve on lesson plans with the same learning objectives (Berliner, 2001; Lin, 1997). It seems that teacher knowledge and depth of reflection both increase with teacher expertise (Allen & Casbergue, 1997; Clarridge & Berliner, 2001).

In teaching, experts possess more complex knowledge (Dunkin & Precians, 1992) and thus exceed novices in their ability to improvise in response to classroom problems and in the frequency of their professional reflection (Borko & Livingston, 1989). Expert teaching is also more driven by the overarching direction of the students’ curriculum as well as students’ individual learning needs (Livingston & Borko, 1989)—especially with students’ progress and mastery of each subject matter (Schempp, Tan, Manross & Fincher, 1998). When asked to teach an unfamiliar subject, experts were concerned with mastering the subject matter before delivering a lesson on it (Schemp et al., 1998). Novices, rather, were preoccupied with identifying tasks that students could do during the given lesson time, so that they were more activity-driven and less focused on the subject matter or the students themselves. In lessons themselves, experts operate according to their pedagogical knowledge and convictions (Schemp et al., 1998).

Experts' knowledge of their students also exceeds novices', as expert teachers have been found to express ongoing awareness of each class' range in student ability and their continued assessment of student progress in their subject. In contrast, novices tend to have a narrow view of student ability, inclined to expect students to know something rather than nothing about the subject they are responsible for teaching (Schemp et al., 1998). In sum, teachers appear to possess knowledge structures that differ according to expertise: experts manifest stronger pedagogical knowledge by highlighting key concepts and subject-related strategies; experts also recognise subject-specific opportunities in certain classroom activities, such as the review lesson for problem-solving demonstrations in maths (Livingston & Borko, 1990).

Shulman (1986) emphasises the importance of considering the expansiveness of teachers' knowledge for a true judgement of their expertise. Shulman argues that classroom expertise necessarily involves subject content knowledge, general pedagogical knowledge, and pedagogical content knowledge, among others. Subject content knowledge is the teacher's awareness of what the students need to learn, according to the curriculum; subject content knowledge also includes general awareness of the wider academic field. However, expert teachers' subject knowledge will be specific to their own fields, which itself is sizeable owing to the large bank of past experience that they can call upon (Berliner, 2001). Pedagogical content knowledge is the teacher's conceptual understanding of theories on teaching, as a specific profession. General pedagogical knowledge is the teacher's practical grasp of classroom management *principles* which can in fact be applied to any organisational task across professions. To Shulman (1987), "teaching is essentially a learned profession" (p. 9). Indeed, subject content knowledge and pedagogical content knowledge appear to be the most striking differences between expert and novice teachers (Meyer, 1994).

3.2.1.2.Teacher Expertise Feature 2: Efficiency

As in other professions, expert teachers demonstrate greater efficiency with their cognitive resources (e.g., Anderson, 1982). Cognitive overload takes place when external demands outweigh the internal resources available (Sweller, 1989). Expert teachers demonstrate the optimal balance between automaticity (i.e., flow) and adaptivity (Feldon, 2007). Expert teachers benefit from having automaticity in simple and recurrent classroom tasks; they also have adaptivity for complex and non-recurrent tasks such as interaction with students, where individually tailored judgements and decisions are required (cf. van Merrienboer et al., 2002). Automaticity thus lowers cognitive load for recurrent tasks among experts, who incorporate automatized decisions to ensure that non-recurrent aspects of the teacher's task are performed with due consideration. Qualitative observations of expert and novice teachers also found this contrast of efficiency in-class and out-of-class, with experts displaying more efficient planning before lessons and readier improvised responses (Borko & Livingston, 1989). Together, the typical characteristics of expertise mean the expert teacher experiences reduced demands on their cognitive load.

3.2.1.3.Teacher Expertise Feature 3: Intuition

As teachers grow in expertise, they become "intuitive" (Berliner, 2004, p. 207). That is, expert teachers have the ability to make connections between separate events in a way that novices would not be able to. Berliner argued that this holistic processing and understanding equips teachers to reliably predict classroom events. Rubin (1989) adds that the expert teacher is not only effective at transmitting subject content knowing using standard pedagogical content knowledge, but has a well-developed instinct for integrating contextual cues into their classroom practice. Expert teachers' past experience has thus formed tacit knowledge which they use to generate appropriate solutions to each immediate scenario. As a result of their intuition, expert teachers are more analytical and decisive compared with novice teachers. This expert–novice difference in intuition is found across professions, with instructors (i.e., expert 'teachers') demonstrating greater intuition through higher scores in tacit knowledge of pedagogical principles than non-instructors (i.e., novice 'teachers'; McLeod, Maegher, Steinert, Schuwirth & McLeod, 2004).

Expert teachers demonstrate greater intuition through their ability to 'sense' increasing levels of boredom, likelihood of disruption, or learner experiences of confusion (Berliner, 2004; Dunkin & Precians, 1992). In PE teaching, experts are able to recall and apply the same solution that they used in badminton lessons to a student struggling with the volleyball serve. Expert teachers are monitoring the classroom situation almost subliminally until events occur that require their attention—a scenario also detected through expert intuition (Bell, 1997). Expert teachers further demonstrate greater intuition through their capacity to identify socially unskilled and insensitive classroom scenarios compared with novices (Elliott, Stemler, Sternberg, Grigorenko & Hoffman, 2011).

3.2.1.4.Teacher Expertise Feature 4: Flexibility

Like experts in other professions, expert teachers display flexibility and adaptability regardless of classroom events. Novices would be thrown by unanticipated questions, whereas experts could maintain their steer of the lesson towards the objectives of the day in spite of unforeseen events (Livingston & Borko, 1989). In fact, experts are able to integrate student-triggered events, as they happen, into their lesson plans. In their observations, Livingston and Borko recorded the way novices employed micro-level planning and planned until the last moment before their lesson began, whereas experts showed a work–life balance in which they had time for home life while giving due time and effort to preparing their next lessons. The range of instructional approaches that expert teachers are comfortable with is greater than that of the novice teacher (Castejón & Martínez, 2001). Expert teachers are more open to and interested in formal systematic procedures put forward to them, whereas novices are reluctant to take unfamiliar systems on (Dunkin & Precians, 1992). Berliner (2001) has emphasised the adaptability of expert teachers in applying relevant pedagogical knowledge across contexts and according to specific student needs. Expert teachers veer from the precise activities planned in the face of pending classroom problems, whereas novices proceed as planned (Byra, 1993). The ability of expert teachers to be flexible and to adapt planned lesson activities is said to be due to their greater knowledge (Leinhardt & Greeno, 1986; Verloop, an Driel & Meijer, 2001).

3.2.1.5.Teacher Expertise Feature 5: Strategic Consistency

Consistency has long been recognised as a major component of effective teaching and school practice (Mortimore, Sammons, Stoll, Lewis & Ecob, 1988). Sub-categories of levels on which teachers should exercise consistency have also been identified, namely in educational (e.g., classroom instruction of one topic), organisational (e.g., behaviour management systems), timings (e.g., rules on how classroom time is used) and opportunities (e.g., school curriculum) that every individual student receive (Creemers & Reezigt, 1996).

Indeed, expert teachers operate under a singular, consistent personal philosophy from day to day (Brickhouse, 1990). This philosophical consistency filtered down to consistent in-class actions that themselves are congruent with each teacher's personal beliefs. In contrast, novices' educational philosophies are vague and their classroom practice variable. Compared with novices, experts thus maintain consistency with specific aspects of classroom practice. One consistent practice among expert teachers was that they highlight concepts relating to the broader subject curriculum readily (Leinhardt, 1987; Livingston & Borko, 1990). For example, one expert maths teacher highlight substitution as the specific concept that was central to the lesson. As another example, an expert geometry teacher highlighted the specific concept of the relationship between the ellipse and the hyperbola throughout her review lesson (Livingston & Borko, 1990). Expert teachers' classroom practice are consistent in a number of other ways (Leinhardt, 1989). First, experts can be observed to use consistent sequences of activity types across multiple lessons, suggesting that they have, with experience, developed a 'best practice' package that can be applied to all classes. Expert teachers thus have routines that students soon come to expect from their lessons, which in turn lessens demand on students' cognitive load. Second, experts carry out classroom management in consistent ways, using one system that students can rely on. Third, experts use consistent practice in over the course of a curriculum, such that lessons cohere with each other with one consistent overarching goal. For example, one maths expert would repeatedly ask a question within and across lessons that prompts students to reflect on their own progress (Leinhardt, 1987).

3.3. Expert Teacher Attention

3.3.1. Attentional Expertise

Attentional expertise research has addressed two of the five prototypic aspects of expertise (i.e., knowledge, efficiency, intuition, flexibility, strategic consistency): namely, knowledge and efficiency.

3.3.1.1. Attentional Expertise Feature 1: Knowledge

In keeping with their superior knowledge capacity, experts are documented to have greater long-term working memory capacities (e.g., Ericsson & Kintsch, 1995). Since they have stronger connections between knowledge elements, experts take less time to process visual stimuli. Experts' refined memory systems yield a more advanced attentional system, namely perceptual chunking (de Groot, 1966). To demonstrate, Gilbert, Boucher and Jemel (2014) presented participants with a target lexeme—their target perceptual chunk. Subsequently, participants were categorised on the basis of whether audio utterances contained the target lexeme or not. Event-related potential in neural regions associated with semantic integration were more activated when the target lexeme was larger and when the onset time was delayed, demonstrating the influence of complexity in perceptual chunks. Gilbert thus demonstrated perceptual chunking in action.

Perceptual chunking is also found in gaze, with experts possessing larger perceptual chunks. Other than demonstrating a stronger memory of the target chess board, chess experts also required significantly less viewing time during the 'perception' phase of their task (Chase & Simon, 1973). Experts ceased to perform better than novices, however, when the target chessboard was set up in an unconventional way. When interviewed, the chess expert reported being troubled by the apparently illogical set-up of the board, which highlights the importance of perceptual chunks on the chessboard in the way chess experts operate. Furthermore, experts' perceptual chunk were significantly larger, as shown by experts requiring fewer and shorter viewing times at the chessboard during the perception phase.

Correspondingly, Sheridan and Reingold (2014) found chess experts to yield significantly shorter first dwell durations and total times than novices when asked to decide the best move for a chessboard. Experts also detected the coherence of a chessboard more quickly than novices: that is, their first dwell arrived at the critical piece sooner and their total gaze at critical areas (relating to chessboard coherence) was longer than novices'. Experts thus demonstrated more effective perceptual chunking, who had better rehearsed and more extensive 'templates' (Gobet & Simon, 2000) which in turn sped their comprehension of a chessboard in a way not possible for novices.

3.3.1.2.Attentional Expertise Feature 2: Efficiency

Experts are more efficient in their information-processing in general than novices (Haider & Frensch, 1996). Correspondingly, experts use more relevant and fewer irrelevant eye movements compared with novices (Gegenfurtner et al., 2011). Furthermore, the total area that experts gaze at is also significantly smaller than novices'.

One mechanism accounting for experts' greater speed is their theory- and experience-driven approach to visual attention, which is not possible among novices who have yet to develop theories and accumulate experience (Haider et al., 2005). Accordingly, experts perform prevalent and familiar—more difficult—tasks with greater ease than less prevalent but simpler tasks (Rehder & Hoffman, 2004). Meanwhile, participants' gaze was directed at a range of targets during initial stages, reflecting theory-testing. At later stages, participants' gaze was concentrated on the regions that were most relevant to their task. In shape-based tasks, gaze focused on shape features; in size-based tasks, gaze focused on size-related features. Likewise, as paediatricians increase in diagnostic accuracy, so their gaze is directed towards relevant areas for longer (Balslev et al., 2012). Surgeons demonstrate the same trajectory: as surgeons increased in expertise, operation-relevant gaze also increased, alongside decreasing measures of cognitive load (Tien et al., 2015). The same superior gaze rate towards task-relevant areas has been found among experts in air traffic control (van Meeuwen et al., 2014), mammogram-readers (Kundel, Nodine, Conant & Weinstein, 2007), drivers (Petzoldt, Weiβ, Franke, Krems & Bannert, 2013) and fish experts (Jarodzka, Scheiter, Gerjets & van Gog, 2010). Thus, as theories proved redundant, they were dispensed of, and gaze direction increasingly focused on the theory-driven—relevant—areas of stimuli.

Related is the holistic (i.e., comprehensive) perception that expert gaze often demonstrates, due to experts' efficient theory-driven information-processing. Specific gaze patterns that demonstrate experts' holistic approach to perception include fixations remaining on target regions for planned actions (e.g., empty squares on chess board, Charness, Reingold, Pomplun & Stampe, 2001) and fewer gaze transitions (Charness et al., 2001; Reingold et al., 2001). These gaze patterns suggest expert recruitment of both central and peripheral vision, whereas novices seem able to only process visual information where they are looking. Using cued retrospective reporting, Jarodzka demonstrated the strategy-driven nature of expertise through expert reports of knowledge- and experience-based shortcuts. Cued retrospective reporting also revealed experts' multiple internal consideration during single fixations at single gaze targets, demonstrating the richness of cognitive processes taking place in less time and fewer eye movements among experts compared with novices (Jarodzka et al., 2010).

3.3.2. Expert Teacher Attention

Only a limited number of studies have been conducted on teacher attention, one major rationale for the present thesis. However, the studies that have been carried out so far will now be outlined and research hypotheses formulated accordingly.

3.3.2.1.Teacher Attentional Expertise Feature 1: Knowledge

Related to perceptual chunking is the value of reducing cognitive load, or mental effort applied to non-automatic task performance. In his review, Feldon (2007) called for teacher professional development to make automaticity the trajectory of all teaching practice. To do this, Feldon refers to van Merriënboer's (1997) distinction between two types of skills in task performance: recurrent and non-recurrent skills. Non-recurrent skills are required for situations that do not take place often; recurrent skills are those that are repeatedly required in a profession. Feldon used this framework as the basis for understanding the expert–novice differences found among teachers, with experts being those who have identified and become well-versed with recurrent skills in teaching. Feldon cites Ericsson's research on chess expertise and the advantage experts displayed in their capacity of each memory 'chunk', drawing parallels between chess and classroom expertise to highlight the gains teachers could make in their adaptability to unforeseen challenges. Feldon (2007) argued that teachers would default back to ineffective practice less often and instead adopt effective and beneficial behaviours. Working memory space would also be more available for making spontaneous decisions when required as well as giving students due attention. Overall, a case has been made that teachers become more 'expert' by having greater "functional" (p. 129) memory capacity to recognise and address relevant aspects of the classroom, unlike novices whose attention is allocated in a less informed manner.

Sabers, Cushing and Berliner (1991) demonstrated the advantage that expert teachers have over novices in their memory capacity for relevant classroom events.

Authors asked expert and novice teachers to watch videos of lessons and describe both instructional and classroom management techniques they could see. They then showed participants the videos a second time and asked participants to concurrently think aloud, identifying things they could see as well as the thoughts they had as the videos went on. Questions were then asked of participants about their life as teachers, followed by yes-or-no questions testing their memory of the classroom events that took place in the videos. Sabers et al. found expert reports on the videoed lessons to be better integrated and richer with interpretive detail. They also pointed out that the training for all teachers was comparable, leaving experience to be the only factor that can yield experts' more comprehensive and efficient visual processing of the classroom videos they observed.

3.3.2.2.Teacher Attentional Expertise Feature 2: Efficiency

Van den Bogert conducted a recent eye-tracking study with teachers using video stimuli (van den Bogert, van Bruggen, Kostons & Jochems, 2014). Expert teachers (Palmer, Stough, Burdenski & Gonzales, 2005) were compared with novices who were teacher-trainees. Teachers were shown videos of real-world lessons that genuinely took place; videos were made from the teacher's perspective. As they viewed the videos, teachers were asked to identify classroom management related events by pressing a designated keyboard button. Using gaze visits, van den Bogert found that experts noticed significantly more events within the same time period than novices. Analysis also found experts looking at salient classroom problems (e.g., student walking across the classroom) for shorter durations than novices, suggesting that they required less time to process this problem.

Strategy differences across expertise in non-educational settings have now been replicated in educational contexts (Dogusoy-Taylan & Cagiltay, 2014). In fact, Dogusoy-Taylan found expert science teachers not to differ from novices in the strategies they used during concept mapping development. Nonetheless, gaze patterns were different across expertise during concept map development. Specifically, experts used fewer but longer fixations, longer fixations at linking areas (between concept map regions), and longer fixations during the checking and reasoning parts of the development process. Novices, meanwhile, used a higher number of fixations throughout the process, suggesting an unguided, trial-and-error approach to their gaze.

3.3.2.3. Other Teacher Attentional Expertise Features

No known research has documented teacher attentional intuition. In terms of flexibility, expert teachers seem to move on from salient classroom regions more easily—flexibly—than novices. For example, experts' gaze towards salient classroom problems is shorter in duration, but more frequent (van den Bogert et al., 2014).

More discussion exists on teacher gaze consistency. Other than being more consistent among themselves than novices (van den Bogert et al., 2014), experts also use their gaze in consistent ways across pupils. Van den Bogert demonstrated this through heatmaps for various areas of interest, with expert gaze being more evenly distributed in the whole duration of gaze recording compared with novices'. The linear nature of experts' gaze distribution in contrast to the quadratic distribution of novices' gaze distribution supported this interpretation of expertise differences in teacher gaze distribution (van den Bogert et al., 2014).

Expert–novice differences in teacher gaze distribution have been shown through the GINI Index (Gini, 1921). Cortina recorded one lesson being taught by one out of each of 12 teacher pairs, which consisted of an expert teacher (mentor) and a student teacher (their mentee; Cortina, Miller, McKenzie & Epstein, 2014). For each lesson recorded, every student in the class was given a number, which was then used to code the teacher's gaze toward them. As in van den Bogert et al. (2014), Cortina found expert teachers to distribute their gaze more evenly across all students. Thus, for experts, authors found a positive association with visual monitoring of the classroom and for novices, a negative association between the two variables.

3.4. Expert Teacher Communication

3.4.1. Teacher Communicative Expertise

'Expert' teacher communication can also be seen in patterns of effective classroom communication. One characteristic of effective teacher communication is in the greater use of subject-specific terms. For example, in Science classrooms, higher frequencies of science-related terms—smells, acidity, solubility, flame colour—will be used by experts than novices (Lundqvist, Almqvist & Östman, 2009). In Maths classrooms, experts repeat subject- and curriculum-related terms more than novices (Livingston & Borko, 1990). Experts also refer to the big picture more often than novices (Livingston & Borko, 1990). Explanations of learning materials by experts are significantly richer than those by novices (Leinhardt, 1989). In fact, much of teacher communicative expertise is shown through the way experts make their lesson structure clear over the academic year and in their lesson planning generally (see 3.2.1.1. Teacher Expertise Feature 1: Knowledge). Effective (or expert) teacher communication is characterised by student responsiveness, results in student control, explicit and systematic explanations, and enabling students to reach full understanding through hooks and sequencing that they can follow (Duffy, Roehler, Meloth & Vavrus, 1986).

Teacher clarity is measured by observable characteristics (Bush, Kennedy & Cruickshank, 1977) and is achieved when exposition of new material is fluent, resulting in student comprehension (Chesebro, 1999). For true teacher clarity, the teacher must structure their lessons effectively, including previews of the main ideas before the start of the lesson, clear lesson objectives, frequent summary stops, and a general use of reviews throughout each lesson (Chesebro, 2003; Chesebro & McCroskey, 1998). Teachers also sustain students' awareness of the lesson goal, referring regularly back to them and consistently use instructional phrases that relate to the lesson's goals (Seidel, Rimmele & Prenzel, 2005). A teacher achieves clarity when he or she minimises hesitation utterances (e.g., 'uh'), stays focused on the key content and uses examples students can relate to (Chesebro, 2003) and explains concepts at a pace which is appropriate to the learners (Bush et al., 1977). Clear teacher communication is thus accomplished by taking time to explain concepts to students, stressing more challenging points and explaining new words (Bush et al., 1977). Throughout, the clear (expert) teacher is more concerned that students understand the lesson than the unclear (novice) teacher (Hines, 1981; Kennedy, Cruickshank, Bush & Myers, 1978).

Measures of effective teaching (i.e., teacher expertise) increase with teacher clarity. Other than students' own ability, students themselves believe that it is teachers' effectiveness in communication that contributes the most to their ultimate academic achievement (Waxman & Eash, 1983). Learning, as measured by recall, learner apprehension and affect towards the teacher and the subject matter all improved with teacher clarity (Chesebro, 2003; Chesebro & McCroskey, 1998, 2001). The same advantage has been found when learning was measured by conceptual understanding tests (Metcalf, 1992) and correlates with student satisfaction (Hines, Cruickshank & Kennedy, 1985). Students' perceptions of their own learning progress is also positively predicted by teacher clarity (Finn & Schrodt, 2012; French-Lazovik, 1974). When teachers conveyed lesson goals clearly, it was more likely that students would demonstrate growing competence and interest in the subject area (Seidel et al., 2005).

Aspects in which teachers differ on the basis of expertise include their *non-verbal* behaviour: that is, their bodily (Cooks & Le Besco, 2006), hand (Singer & Goldin-Meadow, 2005), and head movements (Campos, Shiota, Keltner, Gonzaga & Goetz, 2013).

3.4.2. Expert Teacher Communicative Gaze

One part of teacher expertise in non-verbal communication is teacher gaze. What constitutes ‘expertise’ in communicative gaze is evidenced by examples of effective use of gaze during communication outside of education. Information is more effectively transmitted when eye contact is used compared with when it is absent. In emergency medical settings, for example, handovers between paramedics and nurses are shorter and more efficient when colleagues maintain eye contact (Dean, 2012), suggesting that information is more accurately exchanged through eye contact. In support, eyewitness research has demonstrated that more information about the speaker is betrayed when interviewees are required to maintain eye contact compared with when they are not required to sustain eye contact (Vrijj, Mann, Leal & Fisher, 2010). Additionally, expert witnesses have greater credibility when they maintain eye contact with their audience in the courtroom (Neal & Brodsky, 2008). Likewise, eye contact among unacquainted women results in successful negotiations (Swaab & Swaab, 2009). In particular, women agree on more aspects of the shared decision when acting as film advertising agency representatives, namely the budget, film, genre, director and time, when they exchange eye contact during discussions compared with when they do not. Women are also more likely to gain what was most important to themselves, following negotiations sustained by eye contact. Men, on the other hand, experienced the opposite effect of eye contact. Used effectively however—that is, among women—communicative gaze demonstrates expertise in scenarios involving negotiation.

At the most basic level, direct gaze is central to human processes of natural pedagogy (Csibra & Gergely, 2009): the information-giving (i.e., communicative intent) is most clearly signalled through direct gaze (Frith & Frith, 2012). Teachers' gaze at students also predicts students' perceptions of teacher expertise (Turman & Schrodt, 2006). Yet, notable is the singular focus on attentional gaze in expert teacher gaze research so far—and much of vision research in general. Social gaze researchers have recently begun highlighting the importance of considering communicative gaze in understanding human interaction (e.g., Myllyneva and Hietanen, 2015). Others have, unfortunately, conflated attentional gaze with communicative gaze (Montague & Asan, 2014). Others still explore the assumption that gaze gives communicative signals: these researchers investigate differential messages from the same gaze direction, as determined by the social setting (see Chapter Four). In classroom research, however, the focus on teachers' communicative gaze has been embedded in teacher immediacy research (e.g., Frymier & Houser, 2000), which explores interpersonal (i.e., relational) signals in teacher gaze (see Chapter Five).

3.5. Chapter Three: Summary

Expert teaching is domain-specific and invaluable both to the development of other teachers and to students themselves. Expertise is particularly beneficial in the classroom because of the credibility students attribute to and, in turn, the attention they give to their teacher (Dean et al., 2014; Wisdom & Goldstone, 2010). Just as experts outside the classroom display the prototypes of expertise (Sternberg & Horvath, 1995), namely exceptional knowledge (e.g., Ericsson & Kintsch, 1995), efficiency (e.g., Haider & Frensch, 1996), intuition (Simon, 1992), flexibility (Taatgen, 2005), and strategic consistency (e.g., Chase & Ericsson, 1982), so have experts in the classroom demonstrated their exceptional skill in their profession (e.g., Leinhardt, 1987, for knowledge; Feldon, 2007, for efficiency; Rubin, 1989, for intuition; Livingston & Borko, 1989, for flexibility; Mortimore et al., for strategic consistency). Likewise, vision research has demonstrated some prototypes of expertise outside teaching (e.g., Sheridan & Reingold, 2011, for knowledge; Haider et al., 2005, for efficiency) and inside the teaching profession—especially in teacher attentional gaze (e.g., Sabers et al., 1991, for knowledge; van den Bogert et al., 2014, for efficiency; Cortina et al., 2015, for strategic consistency). While no known vision research has addressed teacher communicative gaze, both communication (e.g., Dean, 2012; Neal & Brodsky, 2008; Vrijj et al., 2010) and human gaze (e.g., Csibra & Gergely, 2009) research suggest that it should play a significant role in the teacher's effectiveness and success in the classroom. Given that experts in any field have greater command of their professional vision than novices do, the present thesis is grounded on a strong basis for exploring the distinct ways in which expert teachers use their gaze.

4. CHAPTER FOUR: EXPERT TEACHER GAZE ACROSS CULTURES

4.1. Culture Shapes Expertise

Culture is “the set of attitudes, values, beliefs and behaviours shared by a group of people” (Sternberg, 2004, p. 325). Cultural groups differ in social orientation—that is, the way people view the ‘self’. Triandis (1989) distinguished between the individualistic self—an identity shaped in isolation from others—and the collectivist self—an identity shaped in relation to others. In his cultural task analysis model, Kitayama proposed that the social orientation imposed by a culture not only affects one’s behaviour within a sociocultural environment. Rather, the influence of social orientation permeates down to internal psychological processes, including attention, emotion, self-representation and attributions (Kitayama, Park, Sevincer, Karasawa & Uskul, 2009). Western populations have long been identified as individualistic on the whole, while East Asian populations are documented as collectivist (e.g., Hofstede & Bond, 1988; Kitayama & Imada, 2010). Accordingly, much evidence on the role of social orientation has used East–West comparisons.

General cognitive style is shaped by social orientation (Varnum, Grossmann, Kitayama & Nisbett, 2010). Self-representation differs depending on the social orientation of one’s cultural setting. In one study, Western college students demonstrated independent self-representations by describing their childhood memories in terms of their internal experiences and emotions. East Asian college students, by contrast, demonstrated inter-dependent self-representations by describing their own childhood in terms of family routines and activities (Wang, 2001). European Americans have been found, on average, to value self-expression more than their East Asian (or Asian American) counterparts. They are also more invested (i.e., better memory) in their choices as individuals (i.e., the pen they most favoured) and placed greater value on self-expression (i.e., reporting personal evaluations of writing pens) than their East Asian counterparts (Kim & Sherman, 2007).

Attribution is another example of social orientation at work. Bi-cultural adults can be primed to give either collectivist or individualist reasons for observed behaviour. For example, following Chinese primes, Hong Kong Chinese participants were more found confident in situational (i.e., collectivist) explanations for behaviour of a fish seen in a video, whereas American primes resulted in greater confidence in dispositional (i.e., individualistic) reasons (Hong, Morris, Chiu & Benet-Martínez, 2000). Likewise, when Peng and Knowles (2003) primed American Chinese to identify with their Chinese heritage, participants attributed physical movement to situational factors; American identity primes resulted in dispositional attributions.

Beyond attributional shifts, social orientation primes have also triggered shifts in worldview (Oyserman & Lee, 2008). In this study, individualistic or collectivist values were activated in participants—regardless of cultural context—through primes including pronoun circling, scrambled sentences and I- or we-personalised prose. Varnum et al.'s review (2010) demonstrates that social orientation divides populations in terms of cognitive style both, across and within cultures, such that social orientation can by no means be expected between East and West, but from other geographical comparisons too, such as within Europe itself (i.e., East Asian vs. Western Europe).

Given that cognitive style appears to be shaped by cultural dispositions such as social orientation, 'expertise' will be defined in different ways, depending on the cultural setting in which a teacher is based. Indeed, social orientation impinges not only on personalities (Triandis, 2001), but also on the way in which a workplace operates (Gelfand, Erez & Aycan, 2007). In teaching, cultural dimensions likewise influence the conceptualisation and expression of expertise (Sternberg, 2004). Whereas one culture might emphasise skills in social interaction, another culture might value cognitive ability more (Sternberg, 2001). Likewise, cultural differences can be anticipated in the teacher gaze patterns different cultures consider to be ‘expert’ in each cultural setting.

4.2. Culture Shapes Teacher Expertise

Expertise is likely to be culturally defined (Sternberg, 2004, 2014). Teacher expertise, likewise, is formed in accordance with context (Berliner, 2001). If national and school policies shape community beliefs on best practice in education (Berliner, 2001), the social orientation of a whole cultural setting (Triandis, 1989) is even more likely to impinge on shared ideas of quality classroom instruction. While cross-cultural variations in within-subject teaching techniques have been attributed to linguistic differences (Ng & Rao, 2010), educational research has focused on pedagogical differences that are related to the social orientation that dominates a culture. Hofstede (1986) has outlined the way learning ideals differ when comparing collectivist and individualistic settings. Whereas individualistic classrooms emphasise the learning process (“learn how to learn”, p. 312), collectivistic classrooms emphasise the learning outcome (“learn how to do”, p. 312). Whereas individualistic populations encourage learners to speak up and even voice disagreement, collectivistic populations discourage destabilisation of whole-class harmony so limit discussions to smaller student groups (Hofstede, 1986). As contended in the situated cognition approach to pedagogy, if teachers are to successfully build student cognition and capacities, students’ context must be taken into account—along with the cultural ideals (Brown, Collins & Duguid, 1989).

Indeed, cross-cultural differences in the way classroom instruction takes place are marked. Chinese lessons are observably more structured than British lessons, with more instances of whole-class instruction (cf. Stigler & Perry, 1988) and fewer instances of group work among students (Leung, 1995). Among teachers, North Americans have emphasised the need to make mathematical learning kinaesthetic, whereas the Chinese have endorsed applying mathematical learning to everyday life at the first opportunity (Correa, Perry, Sims, Miller & Fang, 2008). East Asian teachers give wider-ranging tasks to students (Stevenson & Lee, 1995) and continue in the same stream of mathematical skill—but increasing task complexity at a greater rate in one sitting than American counterparts (Perry, 2000). East Asian students also typically learn through silent reflection than their Western peers (Kennedy, 2002; Park, 1997; Wozniaková, 2016), with evidence of East Asian students employing non-verbal mechanisms to process learning material (Kim, 2002).

Teachers' conceptions of effective teaching have also been noted to vary with culture. Teachers in Western regions believe student-led activities to be more effective, which contrasts with the teacher-led preferences that Chinese teachers have. Additionally, Western teachers emphasise active engagement by students whereas Chinese teachers seem to limit student engagement to verbal exchanges—if that. Correspondingly, American teachers value peer discussions and group work more than their Chinese counterparts. Meanwhile, Chinese teachers emphasise the need for a carefully structured lesson by the teachers, whereas Western counterparts make little mention of this teacher responsibility (Bryan, Wang, Perry, Wong & Cai, 2007). Moreover, Chinese teachers more often encourage students to take a holistic, multi-unit approach to subject understanding which diverges from American teachers' endorsement for students to take an analytic (i.e., individualised, isolate) approach to viewing different parts of the subject (Yang & Cobb, 1995).

Not only do teachers' conceptions of effective teaching differ across cultures, but teachers' performance in specific aspects of classroom expertise seem culture-specific as well. Cultural comparisons on Shulman's (1986) dimensions of teacher expertise show

Chinese teachers outperforming their American counterparts in subject and pedagogical content knowledge, whereas American teachers exceeded Chinese teachers in general pedagogical knowledge (König, Blömeke, Paine, Schidt & Hsieh, 2011; Zhou, Peverly & Xin, 2006). König attributed the American expertise in general pedagogy to a greater cultural focus on the student's classroom experience, driving teachers to excel in general pedagogical knowledge. Huang, Li and He (2010) have demonstrated that, in China—as in the West, experts focus on deeper learning processes of students, rather than on the external and superficial features of classroom experiences. Specifically, Huang found experts in mainland China to make a larger number of questionnaire responses pertaining to students' coherent knowledge development, participation, and higher order thinking, as well as teachers' mathematical knowledge compared with novices. In contrast, novices made more mentions of in-class activities (or homework) and students' self-exploration. Meanwhile, Leung (2014) highlights the role that Confucian tradition plays in the East Asian emphasis on memorisation and achievement, which requires teachers to excel in subject and pedagogical content knowledge.

Students' definitions of effective teaching differ across culture too. When preferred teaching styles were compared between university students in Hong Kong and the US, American students wanted significantly greater creative cognitive complexity and norm-based task-performance involving low cognitive complexity. Hong Kong students preferred to be task-driven in their priorities significantly more than their US counterparts (Zhang, Huang & Zhang, 2005). Correspondingly, student outcomes differ with differing learning activities across cultures: whereas students in China benefit more from the relevance of teaching content to real life, American students learn more successfully through experiential and individualised learning styles (Correa et al., 2008).

4.3. Culture Shapes Attentional Gaze

Cultural differences in social orientation not only shape social values and ideals, but have also been found to predict attentional style. Typically collectivist, East Asian populations have usually shown a holistic approach to visual attention; typically individualist, Western populations have been characterised by an analytic approach to attention (Nisbett & Miyamoto, 2005). As collectivists, East Asians' holistic attention has been attributed to their relationship-oriented cognition; as individualists, the Western analytic attention has been linked with their rule-based cognition (Norenzayan, Smith, Kim & Nisbett, 2002). East Asian holistic attention has been demonstrated by the way they identify visual stimuli such as in Rorschach Tests (Abel & Hsu, 1949) by taking them as a whole, in contrast to their Western counterparts who make judgements on the same visual stimuli using its isolated parts.

Correspondingly, East Asians have shown greater context-sensitivity than Westerners when viewing the same scene, with East Asians detecting changes in peripheral regions of a scene more readily than Westerners, who were likely to detect centrally located scene changes only (Masuda & Nisbett, 2006). At other times, East Asians have been unable to ignore contextual information to the detriment of their judgement. When presented with a frame containing a slanted rod, East Asians more errors in estimating the rod length their Western counterparts; when the frame contained an upright rod, error rates were comparable between the two cultural groups (Ji, Peng & Nisbett, 2000). It seems that East Asian populations prefer relative judgements (e.g., line length in relation to a square) and Western participants perform better in absolute judgements (e.g., estimating the precise length of a line; Kitayama, Duffy, Kawamura & Larsen, 2003).

This cultural contrast in attentional orientation seems to be a deep-rooted one, as cultural differences occur as early as at the age of five. When asked how cards with images should be grouped together, children in rural China made significantly different choices to rural North American children. Chinese children stated that babies belong with their mother, showing relationship-based reasoning, whereas American children chose to group cards together based on shared features, such as adult with adult and children with children (Chiu, 1972).

Cultural differences in attentional style have neurological evidence too. When passively viewing faces or houses, Western participants displayed greater selectivity in the left fusiform face area (FFA) when viewing faces compared to when viewing houses, while East Asian participants exhibited greater reactivity in the right FFA. Greater activation in the left hemisphere among Western participants corresponds with logical—individualistic and analytic—processing to be expected from this cultural group. Correspondingly, greater activation in the right hemisphere among East Asian participants corresponds with the expected relational—collectivistic—processing (Goh et al., 2010). In support, Hedden reported greater activation of attentional control regions when participants were required to make judgements incongruent with their own culture (e.g., East Asians during absolute judgement tasks; Hedden, Ketay, Aron, Markus & Gabrieli, 2008). Further neurological support is in the heightened activation of lateral occipital brain regions exclusively among East Asians, when participants were shown backgrounds incongruent with the central object in an image (Jenkins, Yang, Goh, Hong & Park, 2010).

Eye movement evidence also exists in relation to the social orientation basis of attention. During free-viewing of the same images, East Asian graduate students looked more at the image background, whereas their Western counterparts looked more at the centre of each image. East Asians also used more scanning gaze (i.e., saccades) in contrast to Western participants who used more focused gaze (i.e., fixations; Chua, Boland & Nisbett, 2005). Eye movement studies have also replicated the cultural difference in context-sensitivity. When presented with a central face expressing one basic emotion, Western participants used an analytic, compare-and-contrast approach to viewing the whole visual stimulus before identifying the emotion of the central face. Oppositely, East Asian participants did not display such gaze transitions between the central and surrounding faces; East Asians also looked more at surrounding faces than the central face than the Western participants did. Together, these holistic gaze patterns in less accurate emotion identification overall in this study (Stanley, Zhang, Fun & Isaacowitz, 2013). Images containing one face at a time have also elicited holistic attention among East Asians and analytic attention among Westerners. That is, East Asians have tended to gaze at central facial regions suggesting holistic attention through the use of peripheral vision, whereas Western gaze scatters across the face with a preference for the eye regions suggesting an analytic attentional style (Blais, Jack, Scheepers, Fiset & Caldara, 2008). Even in restricted vision, the actual information extracted and recalled later by East Asians concentrates in the central (i.e., nose) region, while Western Caucasians mainly extracted information from the eye region (Miellet, Vizioli, He, Zhou & Caldara, 2013) and the same cultural differences have been found for images of non-human faces (Kelly, Miellet & Caldara, 2010).

4.3.1. Culture Shapes *Teacher* Attentional Gaze

In one study, Dutch teachers were shown videos of real-world and asked to identify events relating to classroom management. Within the same time period, experts noticed significantly more relevant events than novices. In contrast, novices looked longer at salient—but not necessarily relevant—classroom events than experts did (van den Bogert, van Bruggen, Kostons & Jochems, 2014). Authors suggested that expert teachers required less time to process salient problems. Expertise differences, however, were not found in a comparable study conducted in East Asian settings (Yamamoto & Imai-Matsumura, 2013). Yet, others have commented that the definition for classroom management issues (e.g., an closed textbook) were problematic in Yamamoto's study (Wolff, Jarodzka, van den Bogert & Boshuizen, 2016). Moreover, it is presently added that Yamamoto's distinction between experts and novices was less clear than parallel studies. Other than using teaching experience as the sole criterion for teacher expertise (cf. expertise criteria in van den Bogert et al., 2014), Yamamoto also used an inadequate expert–novice difference in teachers' experience for their expertise comparisons: a notable contrast to van den Bogert et al.'s and expert–novice difference in years' experience (i.e., 20 years). The nature of the expert–novice difference among East Asian teachers is therefore worth further examination, with greater care taken to the distinction of expert teachers from novices.

4.4. Culture Shapes Communicative Gaze

4.4.1. Cultural Differences in Non-Verbal Signals

Culture shapes communication. Edward Hall (1976) distinguished between high- and low-context communication. In high-context communication, social roles are prioritised over verbal content and characteristics, along with non-verbal aspects of the interaction. The physical environment and social positions take precedent when trying to understand a speaker's message, above and beyond the message content. In fact, little is made explicit among high-context populations to avoid over-informing the listener and the verbal message is abbreviated. Moreover, the listener is expected to be aware of the context in which they receive the message, such that both the speaker and the listener have responsibility for correctly decoding a message. Hesitation characterises high-context messages (Okabe, 1983) and camouflage of the speaker's full opinion, giving greater priority to harmony with the listener (Gudykunst, Matsumoto, Ting-Toomey, Nishida, Kim & Heyman, 1996). In contrast, low-context communication involves thorough verbal expression of one's meaning (Hall, 1976). Verbal content takes precedent over non-verbal characteristics esteemed in high-context settings.

Gudykunst and colleagues demonstrated that collectivists are likely to employ high-context communication and individualists low-context communication (Gudykunst et al., 1996). Specifically, Gudykunst showed that East Asians (i.e., Japanese and Korean) were significantly more likely to score highly on collectivism and high-context communication than Westerners. Correspondingly, Western participants (i.e., American and Australian) scored lower on collectivism *and* showed greater low-context communication. Likewise, using different measures of high-/low-context communication, Kim, Pan and Park (1998) found East Asians reported greater high-context tendencies and American participants showed a greater low-context inclination (cf. Richardson & Smith, 2007). More support still for high-context communication among East Asians is in their communicative apprehension compared with North American counterparts (Morishima, 1981; Zhang, Butler & Pryor, 1996). In keeping with their high-context patterns, East Asian participants found it harder to ignore vocal tones—a non-verbal feature—during a Stroop Effect task, whereas Western participants, being low-context, found it harder to ignore verbalised content (Ishii, Reyes & Kitayama, 2003). East Asians are also well documented to have a strong preference for disagreeing indirectly, whereas their Western counterparts do not have a stronger preference for direct *or* indirect disagreements (Afifi & Lee, 2000; Goldenberg, Ginexi, Sigelman & Poppen, 1999). The use of silence has also revealed cultural differences, as Americans use smaller quantities of silence than their Japanese counterparts. However, when they do use silence, American silence is significantly more likely to be strategic than Japanese (Hasegawa & Gudykunst, 1998).

Since culture has been related to high- or low-context communication style, I likewise expected expert teachers to differ in rates high-/low-context communication according to their cultural context.

The same non-verbal behaviour, or gesture, can be diverse in cultural meaning (Archer, 1997). "Just as there is no reason to expect an English word to be recognized internationally, there is no reason to expect an American hand gesture to be recognized" (p. 80). For example, the thumbs-up signals good wishes in the West, but is obscene and hostile in the Middle East. Archer goes on to list ten further examples of orthogonal meanings for the same culturally emblematic hand movements. Even at a broad and superficial level, then, the same non-verbal behaviours send fundamentally different signals to different cultural audiences.

Thus, gestures differ across cultures in meanings, spatial cognition, linguistics, and pragmatics (Kita, 2009). Relevant to this thesis are differences in the meaning and pragmatics carried by gestures across cultures. In terms of meaning differences, gestures function as culture-specific 'emblems' (cf. Ekman & Friesen, 1969). That is, the same hand movement around the globe carries culturally defined messages. By forming a ring with the thumb and index finger, one is signalling 'OK' in most of Europe, but referring to a more intimate (perhaps obscene) body part in Mediterranean areas such as Greece and Turkey (Morris, Collett, Marsh & O'Shaughnessy, 1979). Kita cites, as well, the cultural diversity in the pointing gesture. Contrasting meanings are found within some cultures, such as among Napolini Italians, depending on the angle of the finger-pointing gesture (Kendon & Versante, 2003). Within other cultures, such as East Africa and Central Australia, lip-pointing is also used differentially for different messages and is reserved for transmitting more private messages in a public space (Enfield, 2001).

Cultures also differ in gesture pragmatics—that is, the communication system of gesture (Kita, 2009). Kita gives politeness as an example for the way cultures differ in their interpretation of shared gestures. The same gesture, in one culture, represents the utmost courtesy and, in another culture, the greatest offence. Gestural taboos are salient illustrations. For instance, the left hand is perfectly acceptable and inoffensive in most cultural settings, but is regarded unhygienic in South Asian and West African regions (e.g., Meyer-Rochow, 2009). Giving, receiving, eating and drinking are therefore constrained from the left hand. Kita highlights the compensation that results, with the right hand and the rest of the body. Meanwhile, there is a "respect position" (p. 158) for the left hand: hidden behind one's back, away from the addressee. When the left hand becomes necessary during communication, its movement is minimised, so that the most movement involves a flick of the wrist.

4.4.2. Cultural Differences in Communicative Gaze

Like gesture, gaze consists of cultural complexities. Even in the same cultural context, individuals with different personality profiles experience direct gaze in contrasting ways. Roelofs et al. (2010) compared the eye contact experiences of individuals with high social anxiety with those characterised by low social anxiety. Authors found that individuals with high social anxiety were significantly faster at avoiding angry faces that are simultaneously displaying direct gaze; they also avoided happy faces significantly more than individuals did who were low in social anxiety, regardless of gaze direction. When culture is brought into the equation, we can expect whole populations to differ from each other according to the social meanings transmitted in one context that would be contradicted in another. Using skin conductance measures, Wieser, Pauli, Alpers and Mülhlberger (2009) added demonstrations that direct gaze is threatening to socially anxious individuals. Wieser et al., however, did not find the gaze avoidance shown in Roelofs et al. (2009). Thus, just as individual differences (Chen, Minson, Schöne & Heinrichs, 2013) and social settings (Wu, Bischof & Kingstone, 2013) *within* a culture shape the meaning of gaze signals, so gaze can also be expected to signal different messages *across* cultural settings.

Just as personality profiles can shape the interpretation of gaze (Brooks, Church & Fraser, 1986; Larsen & Shackelford, 1996; Wu, Bischof, Anderson, Jakobsen & Kingstone, 2014), so too can cultural profiles. Argyle and Cook (1976) focus on the cultural complexities of mutual gaze (or eye contact) in particular. Indeed, the eye is a hothouse of cultural obsessions (cf. 'the evil eye', Elworthy, 2003). They review the way cultural differences exist in the meanings underlying mutual gaze. Watson (1970), for example, documented the contrast between 'contact' and 'non-contact' cultures. Asians (including East Asians) live in a non-contact culture, in which members touched and looked less at each other, faced each other less directly and stood further apart. Watson noted how, as a non-contact culture, East Asian populations considered extended eye contact to signal arrogance, threat and disrespect. Conversely, to contact cultures, which include Latin Americans and the Middle East, limited gaze conveys dishonesty, insincerity and non-confidence. Culturally, mutual gaze (or eye contact) is required for politeness in the West, but must be used with caution in the East to avoid conveying confrontation. In non-contact cultures, then, eye contact can be expected to be minimised in the same way as the gesture taboos that Kita (2009) describes. Just as the left hand is suppressed to the flick of a wrist in West African culture, so is eye contact reduced to the most fleeting moments whenever it is used in the East.

The East Asian avoidance of eye contact is additionally supported through research using video stimuli. Senju and colleagues presented Japanese and British adults with videos of faces that turned toward or away from participants (Senju et al., 2013). Japanese participants showed a greater sensitivity to others' gaze by looking at the avatar's eyes for longer and by shifting their own gaze more promptly when the avatar moved their gaze away from the participant (cf. Jack, Garrod, Yu, Caldara & Schyns, 2012). Throughout, Japanese participants gazed longer at the eye further away from themselves compared with their British counterparts. The heightened sensitivity towards others' eyes among East Asians demonstrates the greater complexity in gaze signals that is specific to East Asian culture.

It appears that eye contact is associated with stronger emotions among East Asians than it is within Western populations. Akechi presented images of emotionally neutral faces to Japanese and Finnish individuals (Akechi et al., 2013). Images either displayed direct or averted gaze. Japanese participants interpreted negative emotion in both gaze conditions (i.e., anger), but negative emotion increased when they were shown direct gaze (i.e., anger combined with sadness), whereas their Finnish counterparts did not interpret anger in either gaze condition. Cultural differences in gaze signals might also explained by where emotional information is obtained. Interpretations of emotional intensity are increased with gaze shifts among East Asians, whereas Western Caucasians use eyebrow and mouth movements as their primary source of emotional information (Jack et al., 2012). Moreover, the two cultural groups have contrasting ideas (i.e., internal representations) of each basic emotion (Ekman, 1994): unlike their Western counterparts, East Asians are more dispersed in their ideas of each emotion, with features overlapping across emotions (Jack et al., 2012). In all, the eye region is significantly more likely to signal negativity among East Asians than Western Europeans. This potential for direct gaze to signal confrontation in East Asian settings was expected to play a role in my East Asian classrooms.

For the same cognition, different gaze directions have been used by different cultural groups (McCarthy, Lee, Itakura & Muir, 2006). For ‘knowing’, eye contact was sustained the longest by Trinidadians, followed by Canadians, with Japanese individuals sustaining eye contact for the shortest duration of time. For ‘thinking’, Japanese individuals looked downwards, whereas Trinidadians and Canadians looked up. When observed by others, Canadians looked downwards during thinking, but upwards when unobserved. In contrast, Japanese individuals looked down regardless of having an audience (McCarthy, Lee, Itakura & Muir, 2008). With downward gaze being more useful for signalling non eye contact, it seems that East Asians may have an aversion to prolonged mutual gaze.

No known research has investigated the communicative gaze of expert teachers compared with novice teachers. However, given that the same gaze direction can signal contrasting messages across cultures, teachers can be expected to use different gaze patterns in accordance with culture-specific meanings behind gaze.

4.5. Universal Expert Teacher Gaze

There is evidence that some pedagogical persuasions exist which transcend culture. Just as Chinese teachers reported mixtures of constructivist (i.e., student-centred) and traditional (i.e., teacher-centred; content-oriented; Sang, Valcke, van Braak & Tondeur, 2009), so Belgian teachers also reported the same mixture (Tondeur, Devos, van Houtte, van Braak & Valcke, 2009). Teachers share certain ideals across cultures. For example, teachers of maths have cross-cultural agreement on the practical, real-life importance of the subject, on the importance of teaching maths as a ‘language’, on the value of developing abstract thinking in students and on the centrality of deliberate practice among students to make real progress in maths (Bryan et al., 2007). Moreover, teachers across cultures all value subject knowledge, pedagogical (i.e., instructional or explanatory) skill, connection with students and classroom management as dimensions of teacher expertise. Another example of universal teacher expertise is in novices' reports of the challenge they face (Morey, Nakazawa & Colvin, 1997). Both Japanese (i.e., East Asian) and American beginning teachers described their struggles in terms of mastering the numerosity of simultaneous tasks in teaching, their relationships with students and the apparent chaos of school life. The challenges of teaching, therefore, are comparable across cultures to some degree.

When considering eye contact regardless of the classroom context, both East Asian and Western European adults look more at the interlocutor's eyes when receiving direct gaze, in contrast to when experiencing averted gaze (Senju et al., 2013). Similarly, though McCarthy et al. (2006) found significant cultural differences in the specific directions to which gaze averted during thinking, gaze aversion during thinking (regardless of direction) transcended culture as all participants ceased eye contact for reflection. While Akechi et al. (2013) found differences in the interpretations of eye contact, the *impact* of eye contact was equally significant across participants from the East and the West. Recipients of direct gaze paralleled in heart rate deceleration, shorter gaze durations and higher ratings given by both groups of participants. From the deceleration of heart rate by direct gaze, Akechi pointed out the salience of direct gaze. From participant ratings of emotions, the intensification effect of direct gaze is universal: cultural differences are, rather, in the degree of intensification. The role of direct gaze in communication (i.e., communicative intent; Csibra, 2010) is therefore likely to be universal, as mechanisms for natural pedagogy (see Chapter Two) pervades across cultures. Altogether, some aspects of expert teacher gaze were expected apply to both cultural settings, while others would be found relevant to one culture but not the other.

4.4. Chapter Four: Summary

As human cognitive style changes with culture (Varnum et al., 2010), so too does the definition of expertise. As differing cultural groups vary in what they value (Triandis, 2001), they will accordingly vary in what they view to be expert (or skilled) behaviour (Sternberg, 2004). Indeed, definitions of expert teacher behaviour are context-dependent (Berliner, 2001) and culturally distinct (Hofstede, 1986). For example, Chinese classrooms give importance to a holistic and comprehensive understanding of their subject whereas North Americans value analytic, isolated and in-depth knowledge of individual components of their subject (Yang & Cobb, 1995). Correspondingly, cultures vary in their attentional gaze, according to the social orientation hypothesis (Nisbett & Miyamoto, 2005), and their communicative gaze, in accordance with cultural differences in high- versus low-context communication (Hall, 1976) and culture-specific signals conveyed by universally shared gestures (Kita, 2009). Meanwhile, the present thesis acknowledges the likelihood that universal definitions of expert (or effective) teaching exist (Bryan et al., 2007) which, in turn, would bring about universally valued teacher gaze patterns (e.g., McCarthy et al., 2006).

5. CHAPTER FIVE: TEACHER INTERPERSONAL GAZE

Gaze patterns can be expected to contribute to the overall perception students have of their teacher. Not only do teachers reveal the direction of information that they are conveying (i.e., output made through communicative gaze; input through attentional gaze), but teachers also build a picture of themselves for students to relate to. Teachers thus send emotional signals about themselves and their relationship with students through the way in which they organise their classroom gaze. This chapter discusses the importance of student motivation, highlighting the place that teacher interpersonal behaviour has in that. A theory for analysing teacher interpersonal styles is then introduced. Finally, the relationship between gaze and student motivation is outlined, before expectations are set out, that culture will shape expert teachers' interpersonal gaze in accordance with culturally different values given to classroom experiences.

5.1. The Importance of Student Motivation

Motivation is the internal process that instigates and sustains goal-directed behaviour (Schunk, 2000); it is to be "moved" to do something (Ryan & Deci, 2000a). In education, academic motivation can be defined as having "perceived reasons for engaging in a given activity" (Vallerand et al., 1992, p. 1016), including mastery-oriented enjoyment of school (Gottfried, 1990) and "voluntary use of high-level… learning strategies" (Turner, 1995, p. 413). With intrinsic motivation being that which is "inherently interesting or enjoyable" and extrinsic motivation being that which "leads to a separable outcome" (Ryan & Deci, 2000a, p. 55), it is valuable to identify factors which contribute to academic motivation in order to go beyond extrinsic motivation and begin tapping into intrinsic motivation, since primary, unlearned—intrinsic—reinforcers have been significantly more effective than secondary—extrinsic—reinforcers, which must be learned.

Ryan and Deci (2000a) distinguish between intrinsic and extrinsic motivation, as well as amotivation. Amotivation is the absence of any drive towards carrying out a task. Intrinsic motivation is internally driven, while extrinsic motivation consists of experiences with varying loci of causality. Specifically, external regulation uses rewards and punishments, introjection uses approval of others; identification is one's deliberate attribution of value to an activity, and integration is the synthesis of the activity of oneself with one's own personal goals (congruence). The process of moving from the most extrinsically motivated (i.e., external regulation) to the least (i.e., integration) and into intrinsic motivation is called internalisation, which authors describe as increasing persistence and engagement. Once a learner becomes intrinsically motivated, they are carrying out their task with a full sense of congruence and control: that is, they are acting out of self-determination. Ryan and Deci argue that this is the optimal state for sustained and fruitful task engagement.

While a number of mini-theories exist for how self-determination is attained, the present thesis will focus on the broader structure and the value of fostering intrinsic motivation. According to Ryan and Deci (2000b), the process of achieving intrinsic motivation involves three basic psychological needs. Relatedness is the sense of belonging with others; competence is the sense of efficacy with the task at hand; autonomy is the space for learners to bring the task into their own personal goals and values—making the task 'their own'. It is autonomy that authors have identified to be the critical component of internalisation. Thus, autonomy-supportive structures are much researched and promoted in the academic motivation literature (e.g., Diseth & Samdal, 2014; Reeve, Jang, Carrell, Jeon & Barch 2004).

Intrinsic motivation is shown through learners' engagement. Effort, enthusiasm, strategic thinking and proactive contribution are levels of behavioural, emotional, cognitive and agentic engagement respectively (Bandura, 1997). As such, research has often measured engagement as a major expression of intrinsic motivation (e.g., Pantziara & Philippou, 2013; Schraw & Lehman, 2001; Skinner, Furrer, Marchand & Kindermann, 2008). Accordingly, the discussion of motivation in this chapter will be dominated by references to engagement. Furthermore, I will restrict the region of learner engagement to the classroom alone in order to focus on educational setting from which I derive my data.

Motivation is therefore distinguished from intention. Intentional action is driven by forces from social interaction or some uninternalised beliefs. In contrast, motivated action is wholly inspired by one's sense of who one is (Deci, Vallerand, Pelletier & Ryan, 1991): that is, self-determined. Thus, though motivated and intentional behaviour are both consciously exercised by an individual, the regulatory processes bring the two forms of behaviour at odds with each other.

It is intrinsically motivated behaviour, in particular, that most benefits learners now and in the long run. The value of intrinsic motivation to learners centres on the long-term, sustainable processes it coincides with. Intrinsically motivated learners have a stronger sense of self, such that learning processes engage the learner as a whole, through multiple modalities (Deci et al., 1991). Such learners are more effective in self-regulation. Intrinsically motivated students use deeper learning approaches and display greater persistence. When self-determined, learners act, not out of compliance, but conviction.

With intrinsic motivation comes self-regulation. In self-regulation, the learner monitors, actively manages and controls him or herself to meet their learning goals (Burman, Green & Shanker, 2015). In relating intrinsic value, cognitive strategies and self-regulation with each other, Pintrich found secondary school students to be significantly more self-regulated when they also found intrinsic value in learning activities (Pintrich, Roeser & De Groot, 1994). Likewise, Sungur (2007) also found self-regulation to be both, directly associated with intrinsic motivation, and indirectly associated—through meta-cognitive strategy use. Even the focus of self-regulation processes are enhanced by intrinsic motivation. For example, intrinsically motivated medial students demonstrated patient-centred thoughts of self-regulation (Williams & Deci, 1996). Specifically, these medical students considered holistic, psychosocial aspects, in addition to biotechnical aspects, during their decision-making about the patient care.

Intrinsic motivation also coincides with deeper learning. For example, critical thinking is more prevalent among intrinsically motivated college students (Garcia & Pintrich, 1992). Specifically, science students who engaged in learning tasks with an intrinsic—mastery-oriented, interest-driven—mindset were significantly more likely to report a general approach that applies previous knowledge and rigorous evaluation to materials they presently face. Intrinsically motivated student teachers are also more inclined towards self-development, or mastery, in each given task (Ciani, Sheldon, Hilpert & Easter, 2011). For instance, the mastery-oriented student teacher will aim to completely understand a subject area that they are about to bring to their class. Vansteenkiste either presented intrinsically oriented goals to college students, that is, goals tapping into the relational, communal aspects students' lives, or extrinsically-framed goals, which tapped into monetary aspects of life (Vansteenkiste, Simons, Soenens & Lens, 2004). Intrinsically oriented students reported higher rates of deep learning as opposed to superficial learning, by existing knowledge to bear on the new information and pursuing the meanings that underlay the text (cf. Vansteenkiste, Simons, Lens, Soenens & Matos, 2005). Thus, deeper engagement with classroom materials can be triggered by appealing to intrinsic-level desires (Vansteenkiste, Lens & Deci, 2006).

Persistence is a third benefit of intrinsic motivation. Intrinsically motivated junior college students were significantly less likely to drop out of a French course compared with amotivated students (Vallerand & Bissonette, 1992). College students were, similarly, more likely to remain enrolled one year into their program if they had an intrinsic motivational profile as learners (Ratelle, Guay, Vallerand, Larose & Senécal, 2007). Swimmers were also more likely to continue attending swimming training 10 months and 22 months into the training season, if they demonstrated intrinsic motivation at the start of the competitive season (Pelletier, Fortier, Vallerand & Briere, 2001). While the intention to drop out of the educational system was more probable among high school and college students who simultaneously worked more than seven hours per week in part-time employment, this intention is curtailed when their employers fostered intrinsic motivation in these learners through autonomy-supportive attitude (Taylor, Lekes, Gagnon, Kwan & Koestner, 2012). Future goals among intrinsically motivated learners are shaped by mastery orientation, relating to family and society (Lee, McInerney, Liem & Ortiga, 2010).

5.2. Teacher Interpersonal Behaviour for Student Motivation

Of particular focus in the present thesis is the learner's psychological need for relatedness: specifically, teacher–student relatedness. Deci et al. (1991) endorsed an "interpersonal ambience" (p. 336) from teachers in order to reduce students' experiences of being controlled and pressured into performing an action. They distinguished between controlling, extrinsic language (e.g., 'should' or 'must') and intrinsic language (i.e., conveying student choice). Reeve (2009) reviewed the benefits of a teaching style that fosters intrinsic motivation (i.e., autonomy-supportive). When teachers adopt behaviours that encourage intrinsic motivation, students are more engaged, happy, persist, engage in deep learning and perform academically. Correspondingly, Assor and colleagues highlighted the ability in students to distinguish between opposing—autonomy-supportive versus autonomy-suppressive—teaching styles (Assor, Kaplan & Roth, 2002). Students are, accordingly, sensitive to teacher behaviour from the early stages of secondary schooling. The way in which teachers relate to students is obvious to students, with important consequences for their learning experiences and outcomes.

Adolescents have been said to “live for their social relationships” (p. 369; Pianta, Hamre & Allen, 2012). Pianta has argued that classroom relationships are fundamental support structures for adolescents. Lawson and Lawson (2013) agreed, emphasising that students do not go about school life on auto pilot. Rather, their attachments have a real impact on their academic motivation and, when strong, can prevent disruptive tendencies. Effective teacher behaviour centres on a balance between scaffolding and autonomous discovery, according to Pianta and colleagues (Pianta, Mashburn, Downer, Hamre & Justice, 2008). Eccles also underscores the importance of balanced teacher behaviour during adolescence, due to a heightened sensitivity to controlling teacher styles during pubertal transitions (Eccles et al., 1993). With attendance at secondary school comes a sharp increase in factors including unsupervised relationships, school size, range of beliefs encountered, secual readiness and parental anxiety. As a result, adolescents need teachers to interact in a balanced way more than ever before.

Substantial support exists for the role of teacher interpersonal style in students’ intrinsic motivation. As student perceptions of teachers’ control increase and perceptions of their knowledge decrease, intrinsic motivation also decreases in learners (Noels, Clément & Peletier, 1999). When students felt secure with a teacher and feel able to approach them during emotionally salient periods, the same students report stronger in-school functioning, as a measure of intrinsic motivation (Ryan, Stiller & Lynch, 1994). Correspondingly, increased social support from teachers correlated with measures of intrinsic motivation, namely higher school compliance, school identification and reduced subjective ratings of task value (Wang & Eccles, 2012). Path analyses have revealed that students' perceptions of teacher interpersonal behaviour (i.e., involvement and autonomy-support) predicted student engagement, as student- and teacher-reported academic engagement (Skinner & Belmont, 1993). Structural equation modelling has, likewise, demonstrated the benefits of teacher affective support in students' academic engagement, via academic enjoyment (Sakiz, 2012). Interventions to train PE teachers in autonomy-supportive behaviour resulted in significantly higher rates of intrinsic motivation in PE students, in comparison student motivation associated with untrained teachers (Cheon & Reeve, 2015). Also in PE, Tessier replicated the impact of teacher interventions in improving their interpersonal style and, in turn, students' PE motivation (Tessier, Sarrazin & Ntoumanis, 2010).

5.3. The Model for Interpersonal Teacher Behaviour (MITB)

The present thesis adopts the Model for Interpersonal Teacher Behaviour (MITB) as the theoretical framework for analysing teacher–student relationships. In short, the MITB views teacher interpersonal behaviour to consist of two dimensions, agency and communion, and that interpersonal behaviour is consistent within each person such that each teacher has their 'interpersonal style'. The assumptions of the MITB regarding classroom interaction are based on Watzlawick's communication systems theory on all interactions (Watzlawick, Beavin & Jackson, 1967). The structure of the MITB is derived from Leary's interpersonal theory (Leary, 1957). These will be outlined now.

5.3.1. Communication Systems theory

The MITB is based on communications systems theory which makes three assumptions (Watzlawick et al., 1967). The first assumption is that human interaction takes place in a system: content is therefore not the only aspect that matters, but the process (i.e., "relationship", p. 121) matters just as much. Accordingly, it is not sufficient for teachers to state what learning objectives are. The activities students engage in must then correspond with these stated objectives. For example, technical understanding of a mathematical procedure may be the stated focus of a lesson, but if students are required to complete an excessive number of tasks then the teacher undermines their own lesson goal by leading students, instead, to focus on efficient task-completion rather than gaining a deep, conceptual grasp of technicalities (Doyle, 1983). Each communicative act therefore has two levels: the report, what is said, and the command, how it was said. A teacher can verbalise friendly content in a hostile way. Here, Créton distinguishes between the way in which experts address disruptive behaviour from the approach taken by novices: whereas novices might address disruption immediately, experts are more likely to push on with subject-learning in spite of disruptive behaviour, thereby avoiding the command-level message that students can win teacher (and whole-class) attention through misbehaviour (Créton, Wubbels & Hooymayers, 1993).

The second assumption is that each interactional system is an open system, such that each dyadic interaction is affected by—and only fully understood—in the context of the participants' other interactional systems. As such, each interaction "does not behave as a simple of independent elements, but coherently and as an inseparable whole" (p. 123, Watzlawick et al. 1967).

The third assumption states that interactional systems are complex in nature, which means that each system cannot be understood in reductionistic and summarised terms; nor can interactions be understood purely through linear and causal analyses. Rather, each communication system involves circularity, the mutual influence from all participants (Créton, et al., 1993). Moreover, a ripple-effect takes place with every change, so that every action triggers more than one immediate effect (Créton et al., 1993). Créton continues, highlighting the complementary or symmetrical tendencies individuals in interactional behaviour (Créton et al., 1993). The ripple-effect of change among individuals disposed towards symmetry involves interlocutors mirroring each others' aggressive behaviour; rippled changes among those disposed towards complementarity can be seen in imbalanced power structures, where one person becomes over-dominant and others unthinkingly acquiesce. Accordingly, Créton and colleagues re-define 'withit-ness' (Kounin, 1970), not only to comprise awareness of goings-on in the classroom, but in terms of awareness and the ability to balance classroom dynamics, to yield an optimal learning communication system. That is, a 'withit' teacher will not only manage their classroom effectively, but they will also attend to emotional dimensions successfully.

5.3.2. Interpersonal Theory

"Behaviour which is related overtly, consciously, ethically or symbolically to another human being (real, collective or imagined) is interpersonal" (p. 4, Leary, 1957). According to the Interpersonal Theory, each individual's personality is best understood through that person's interactions with others. The social dimension, then, is the centre of human experience. Each person also has a preferred interpersonal style, or communication system. Every interpersonal style is, however, can be understood in terms of two dimensions: agency and communion.

In line with Pianta's claim that adolescents live for their relationships (Pianta et al., 2012), Baumeister and Leary (1995) contend for the human need to belong. In support is the human disposition towards forming social bonds. Infants have been observed to form strong bonds from a very young age (Bowlby, 1969), young children develop in-groups almost immediately after meeting strangers (Sherif, Harvey, White, Hood & Sherif, 1961), adults form strong relationships after sharing spending extended time together regardless of prior prejudice against the other (Wilder & Thompson, 1980). Human cognition provides further support for the human need to belong. Social information is categorised in terms of interpersonal relationship and in status-driven depth (Sedikides, Olsen & Reis, 1993). Our judgements of those with whom we have strong interpersonal bonds accord the attributional biases (Fincham, Beach & Baucom, 1987) and outlook (Perloff & Fetzer, 1986) that we have for ourselves. Interpersonal-level experience is the strongest mechanism by which people make causal attributions for events (Anderson, 1991). Human emotion also demonstrates the fundamental nature of belonging. The absence of belonging is linked to unhappiness (e.g., Myers, 1992), threats to existing connections associated with anxiety (Baumeister & Tice, 1990) and the increased emotional impact on oneself with increasing relational proximity with another who is suffering (Tesser, 1991). In his sociometer theory, Leary relates sadness to social loss, shame to dysfunctional social relationships, and social anxiety to anticipated rejection (Leary, Koch & Hechenbleikner, 2001).

5.3.3. Model for Interpersonal Teacher Behaviour (MITB)

The Model for Interpersonal Teacher Behaviour (MITB) consists of two dimensions based on Leary's Interpersonal Theory (1957): agency and communion (Wubbels et al., 2012). The *agency* dimension relates to dominant, controlling, influential behaviour that suggests control; the *communion* dimension relates to the opposite to agency: that is, sociable, loving, friendliness, cooperation, enthusiasm and warmth (Gurtman, 2009; Wubbels et al., 2014). Accordingly, the dimensions themselves should be orthogonal and uncorrelated with each other (Khine & Fisher, 2002). Amidst the two dimensions, the MITB is a circumplex model with eight octants evenly distributed around the circular structure: directing, helping, understanding, acquiescing, hesitating, objecting, confronting, imposing (see Figure 5.1; Wubbels, Brekelmans, Mainhard, den Brok & van Tartwijk, 2016). The octants adjacent to each other should be highly correlated (Khine & Fisher, 2002). In the MITB, Wubbels et al. (1993) differentiated between communication 'behaviours' and communication 'styles'. Communication behaviours are those that can be observed and may change in each moment; communication styles become evident over time as an individual's communication behaviours are observed. It is teachers' interpersonal (i.e., communication) style that the MITB is concerned with.

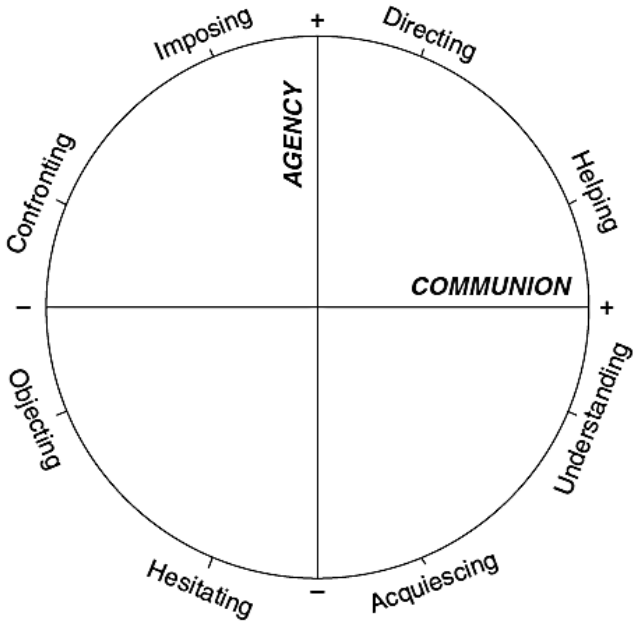


Figure 5.1. The Model for Interpersonal Teacher Behaviour, better known as the Questionnaire on Teacher Interaction model (QTI), now renamed as the Teacher Interpersonal Circle. (Permission for use granted by Tim Mainhard.)

In support for its longstanding relevance, others had also applied Interpersonal Theory to educational settings before the MITB was formulated. Slater (1962) asked university students to complete questionnaires relating to their own parents, regarding their parenting roles (Parental Role Patterns; Slater, 1955) and their personalities (Minnesota Multiphasic Personality Inventory; Hathaway & McKinley, 1943). From participants' responses to the two scales, Slater found that parenting roles and personalities fell into an eight-category, circumplex model with two dimensions—much like Leary's Interpersonal Theory. Slater's model had 'ego strength' as one dimension and 'extraversion' as the other. Citing the example of the Flanders Interaction Analysis

Category (Flanders, 1970), Dunkin and Biddle (1974) likewise contended that agency and communion had been conflated into one factor before applying the Interpersonal Theory to education. According to Dunkin, Flanders' scale corresponds only to teacher communion (or warmth), which accounts for the then-reported irrelevance of teacher interaction to students' learning outcomes.

A teacher's interpersonal style is measured using the Questionnaire on Teacher Interaction (QTI, Wubbels et al., 1993). The importance of teacher interpersonal style—as measured by the QTI—has been demonstrated with regard to student motivation. Brekelmans (1989) administered the QTI alongside a questionnaire targeting intrinsic motivation levels, which addressed 15-year-old students' appreciation of Physics lessons, how instructive and structured the lessons were, and how interested students felt in Physics specifically. Students were more intrinsically motivated when teachers displayed high levels of agency and very high levels of communion on the whole (see Figure 5.2). In Indonesia, secondary school students' perceptions of teacher agency and communion are related to intrinsic motivation, with teacher agency being especially important for student motivation (Maulana, Opdenakker, den Brok & Bosker, 2011). In Dutch secondary school settings, longitudinal benefits to intrinsic motivation are also associated with high rates of teacher agency and communion (Opdenakker, Maulana & den Brok, 2012). Teacher agency and communion decline over the academic year, as does student intrinsic motivation decreases in the meantime. However, at each time point, teacher agency and communion accounts for 60 and 25 per cent of the whole-class and individual's intrinsic motivation respectively.

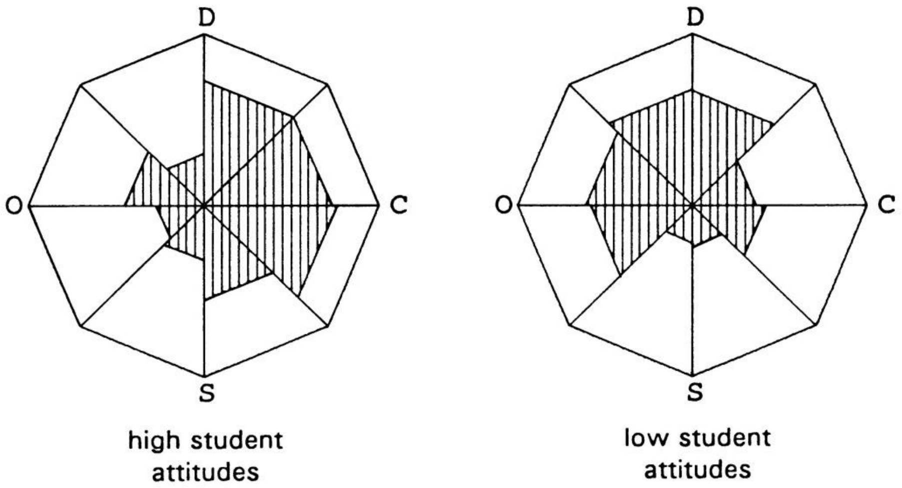


Figure 5.2. The teacher interpersonal profiles associated with high versus low student attitudes to learning (Brekelmans, 1989). These diagrams relate to the original Dutch language QTI, with the DS axis representing agency and the OC axis representing communion. These diagrams show the differing teacher interpersonal styles that relate to differing student attitudes.

5.4. Teacher Gaze and Teacher Interpersonal Style

Gaze patterns reveals something about an individual's interpersonal style. Evidence for the interpersonal role of gaze has been found in its motivational connotations, relational connotations and neuro-physiological correlates.

5.4.1. Motivational Connotations of Gaze

Emotions are accentuated by gaze. Greater amygdalic activation is triggered when emotional expressions are accompanied by direct, rather than averted, gaze (Sato, Kochiyama, Uono & Yoshikawa, 2010). Moreover, autonomic measures (i.e., EEG and SCR) revealed only recipients of direct gaze to preserve implicit memories of the emotional experience (Hietanen, Leppänen, Peltola, Linna-Aho & Ruuhiala, 2008).

Gaze has also been correlated neurologically with intrinsic motivation. Different gaze directions trigger different directions of motivation (Adams & Kleck, 2005). When using the approach–avoidance paradigm to measure motivation, Adams found undergraduates more likely to perceive approach-related emotions (e.g., anger and happiness) when faces showed direct gaze. Avoidance-related emotions (e.g., sadness and fear) were perceived when faces showed averted gaze (cf. Bindemann, Burton & Langton, 2008). As such, approach-related emotions appear to be enhanced by direct gaze; avoidance-related emotions are enhanced by averted gaze. It is direct gaze, however, that triggers a stronger response in the approach–avoidance system at the neurological (i.e., EEG) and physiological (i.e., SCR) level (Hietanen et al., 2008).

5.4.2. Relational Connotations of Gaze

Gaze shapes person perception. Importantly, adult gaze has moderated student perceptions of trustworthiness (Einav & Hood, 2008). Einav showed six and nine year olds videos of adults answering interview questions; these adults either used direct or averted gaze towards the interviewer. Both when the interview speech was audible and inaudible, both six and nine year olds attributed deceit to interviewees significantly more who displayed averted gaze compared with direct gaze. Gaze predicted attribution of deceit significantly more among nine than six year olds; however the gaze effect was strengthened among six year olds when videos were muted.

Person likeability is similarly enhanced by direct gaze (Mason, Tatkow & Macrae, 2005). Accordingly, neural regions associated with visual analysis (i.e., posterior superior temporal sulcus for ‘where is he/she looking’) were activated at gaze onset (Kuzmanovic et al., 2009). As gaze continued, regions associated with deeper cognitive processes (i.e., medial prefrontal cortex for evaluation; ‘do I like this person’) activated.

Perceived gender is shaped, too, by gaze direction (Macrae, Hood, Milne, Rowe & Mason, 2002). Specifically, direct gaze increases gender-stereotypic perceptions. Undergraduates gaze quicker reactions times in a gender-unrelated task when facial images displayed direct gaze than averted gaze. Direct gaze resulted in even faster responses when the task stimulus (i.e., scrambled words) were gender-stereotypic.

Other than gender, gaze also affects person memorability (Mason, Hood & Macrae. 2004). Facial stimuli were more often recognised by undergraduates when they displayed direct gaze compared with averted gaze (cf. Vuilleumier, George, Lister, Armony & Driver, 2005). In support, greater activation in the hippocampus (for self-relevant memory) takes place when facial stimuli displayed anger accompanied with direct gaze (Conty & Grèzes, 2012). Alternative social cues (i.e., anger on its own, or accompanied with pointing) resulted in significant changes in hippocampal activation.

Gaze also affects others' sense of connectedness (Wirth, Sacco, Hugenberg & Williams, 2010). Wirth's participants viewed short movies of an actor displaying either direct or averted gaze at another actor. Averted gaze participants felt more ostracised, lower mood, stronger rejection-related emotions and lower self-esteem. Negative beliefs also increased about the actor displaying averted gaze, namely that he was deliberately trying to ostracise, held a low opinion of others and unpleasant as a person.

5.5. Teacher Expertise and Teacher Interpersonal Gaze

5.5.1. Expert Interpersonal Style

There is contention as to whether teachers' interpersonal style improves with experience (e.g., de Jong, van Tartwijk, Verloop, Veldman & Wubbels, 2012; Ertesvåg, 2011). Therefore, the current research will explore whether a fuller definition of teacher expertise (Palmer et al., 2005)—beyond experience—could predict interpersonal styles that are more effective and conducive to students' intrinsic motivation.

Expert teachers usually adopt a more "liberal-minded and child-centred" approach to classroom teaching (p. 121, Castejón & Martínez, 2001). The lack of experimentation among novices inversely shows the freedom experts have in their methods. Enthusiasm also characterises expert teachers, as well as their attention to individual learners' differences. In contrast, novices tend to adopt a more controlling approach to classroom discipline—an approach that has been found detrimental to learner motivation (e.g., Reeve, 2009). Even in their reflection, experts are student-centred and context-driven as evidenced by their continually balancing students' with curriculum needs (Livingston & Borko, 1989). In fact, it seems experts deliberately plan on responding to students as a core component of what happens in the lesson. In contrast, novices are preoccupied with student misbehaviour, as shown by their reflections (Livingston & Borko, 1989) and often refer to the authority that they as teachers have for how they delivered a lesson (Schemp et al., 1998).

This child- or student-centredness is associated with facets of effective teaching. Student-centred teaching style positively predicts deeper understanding among students (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). Learner-centred teaching style has been correlated with effective classroom management (cf. 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 has been significantly predicted by teachers' interpersonal style (Opdenakker & van Damme, 2006). Indeed, teachers' growth in experience and expertise is correlated with growth in both teacher and student perceptions of teacher interpersonal agency (Brekelmans et al., 2005), due to teachers' growing ability to deal with problems that arise in a natural and convincing way (cf. Berliner, 2004). Moreover, both students' enjoyment of (Telli, den Brok & Çakiroglu, 2010) and achievement in (Sivan & Chan, 2013; Wei, Zhou, Barber & den Brok, 2015) a subject increases with ratings of teachers' interpersonal style. Teachers' student-centred pedagogical beliefs also increase with experience (Luft, 2001), a change which can be explained by the established knowledge among experts to enable the more complex and challenging practice of student-centredness, compared with the simpler task of teacher-centred, and highly controlled classroom. Indeed, student-centred teaching style is commended by both teachers (Abbott-Chapman, Hughes & Williamson, 2001; Harslett, Harrison, Godfrey, Partington & Richer, 2000; Michalski & Baker, 2009) and students (Çakmak, 2011; Tischler & Vialle, 2009; Zhang, Huang & Zhang, 2005).

Interpersonal awareness, including student-centred thinking, among expert teachers has also been highlighted by Wolff. By making qualitative comparisons of teachers' cued retrospective reporting on their own gaze recording, Wolff et al. (2014) compared expert teacher cognition with novices'. Using grounded theory, Wolff developed a coding scheme for teachers' verbalisations in collaboration with other experienced educational researchers. Three broad categories of teacher speech were derived: perceptions and interpretations of events, the main theme expressed, temporality and the cumulative cognition expressed over the course of the cued retrospective reporting (CRR). Wolff found experts to concentrate on the learning experiences of students, while novices were preoccupied with discipline and behavioural norms among students. Specifically, experts reported more perceptions and interpretations of the classroom events compared with novices. They also made more mentions on a greater range of themes, except student discipline—which novices mentioned significantly more than experts. An expert–novice contrast was found in the cumulative cognitive processing described, with experts describing multiple viewpoints on the gaze replay, while novices expressing single viewpoints. Experts also spoke in an open-ended way, whereas novices made dead-ended statements. Experts adopted an integrated perspective too, while novices only expressed their perspective in isolated, exclusive terms. Wolff thus demonstrated considerations teachers have at a deeper level, giving context to the differing visual attention displayed.

5.5.2. Expert Interpersonal Gaze

Teacher gaze research also endorses a greater inclination towards child-centredness among experts. Specifically, expert teacher gaze focuses on student learning (i.e., intrinsic processes), as shown by their gaze at salient classroom areas around, rather than at, disruptive students. Meanwhile, novices focused on controlling (i.e., extrinsic processes), as indicated by their fixations on student behaviour (van den Bogert et al., 2014). Van den Bogert demonstrated this when experts gazed. It seems likely that expert teacher gaze will relate to more adaptive interpersonal styles, whereas novice teacher gaze will coincide with less optimal interpersonal styles that are associated with extrinsic motivation.

5.5.2.1.Teacher Immediacy

Teacher immediacy research provides guidance on what we can expect in terms of teacher interpersonal gaze. Teacher immediacy is rooted in the approach–avoidance theory, which treats approach behaviour as an indicator of approval and preference, whereas avoidance behaviour is taken to indicate disapproval and disinclination (Mehrabian, 1981). As teachers' gaze at students is one channel of non-verbal immediacy (Mehrabian, 1981; Richmond, Gorham & McCroskey, 1987), there is as much research documenting the interpersonal (i.e., teacher–student connection) potential of teacher gaze as there is teacher non-verbal immediacy. For example, as part of teacher non-verbal immediacy, teacher gaze has been observed to predict teacher authority (Richmond, 1990; Turman & Schrodt, 2006) and credibility (Johnson & Miller, 2002). Likewise, as teacher–student eye contact increases, students increasingly like their teachers (Chesebro, 2003; Witt & Wheeless, 2001) and perceive teachers to be validating (Kerssen-Griep & Witt, 2012).

Moreover, teacher immediacy predicts effective teaching outcomes (i.e., expertise). Student interest, in- and out-of-class involvement, peer connectedness increase as teacher immediacy increases (Sidelinger & Booth-Butterfield, 2010). Student achievement (Witt, Wheeless & Allen, 2004) and teacher evaluations (McCroskey, Richmond, Sallinen, Fayer & Barraclough, 1995) also improve with teacher immediacy. Student motivation (Frymier, 1993) and adaptive student affect (Ellis, 1995) are also improved with increasing teacher immediacy (Chesebro & McCroskey, 2001). Indeed, teacher non-verbal immediacy—such as gaze—is so efficacious that it can compensate for and repair verbal non-immediacy (Teven & Hanson, 2004; Thweatt & McCroskey, 1998) as well as over-writing potential setbacks from students' lesser unpreferred learning formats (Messman & Jones-Corley, 2001). Students are also more likely to persist when teachers communicate effectively (Wheeless et al., 2011).

Teacher immediacy research also provides direct indications in support of the present expectation that experts achieve immediacy more often than novices. Expert teachers use fewer but more relevant non-verbal immediacy behaviours (Castañer, Camerino, Anguerra & Jonsson, 2013). Experts tend to score higher (who perform better) than novices, too, in their overall non-verbal immediacy, as rated by classroom observers (McCroskey et al., 1995) and by students themselves (Schrodt & Witt, 2006).

5.6. Culture-Specific Expert Interpersonal Gaze

5.6.1. Cultural Interpersonal Style

Optimal teacher immediacy seems to be culturally defined. In East Asian settings, teacher gaze also enhances teacher immediacy and in turn effectiveness. However, immediacy behaviours—such as teacher gaze—are used at a significantly lower rate in non-Western settings (McCroskey, Sallinen, Fayer Richmond & Barraclough, 1996). In fact, many proximal behaviours widely promoted in Western settings are regarded as inappropriate in East Asian classrooms (Cheng & Borzi, 1997; Hofstede, 1986), even offensive in social settings (Alston & He, 1997).

East Asian instructors use more subject-centred feedback and fewer immediacy behaviours including gaze, which corresponds with East Asian students' preferences (Myers, Zhong & Guan, 1998). While East Asian classrooms are documented to have lower levels of teacher immediacy, the experience of teacher immediacy is still beneficial and valued by students (Myers et al., 1998). Elsewhere, measures of non-verbal immediacy have correlated both with East Asian students' attitudes towards and their achievement in a subject (She & Fisher, 2002). Yet, although teacher immediacy is appreciated, the absence of it is not regarded as particularly detrimental by East Asian learners (Neuliep, 1997). In fact, even though the Chinese participants reported higher verbal immediacy of their teachers, Zhang (2005) showed that Chinese students experience significantly greater classroom communication anxiety than their American counterparts. Zhang highlighted that it was power distance—rather than teacher immediacy—significantly predicted classroom anxiety, demonstrating the role power distance plays in Chinese contexts. The positive yet moderate agency of teacher immediacy and the power distance unique to East Asian classrooms (rather than American, or Western, counterparts; Zhang, 2005) together demonstrate that the value of teacher immediacy is recognised in East Asian classrooms—alongside an additional dynamic that is only an issue in collectivist classrooms, such as Chinese settings (Hofstede, 1986). Meanwhile, getting non-verbal immediacy right—including gaze—has a greater impact in East Asian than in Western classrooms (i.e., in learner outcomes, Neuliep, 1997). This East Asian sensitivity to teacher non-verbal immediacy is likely to be due to the greater importance, culturally, of non-verbal compared with verbal cues, in this high-context (non-verbal) context.

Emotional expression has also revealed cultural differences. In relation to teacher–student relationships, Markus and Kitayama (1991) highlighted Matsumoto, Kudoh, Scherer and Wallbott's (1988) study demonstrating Americans to experience emotions more intensely, for longer periods and with greater need to be addressed in comparison with Japanese participants. Averill, Chon and Hahn (2001) highlighted this to be a well-recognised East–West pattern, with East Asians being more reserved and Westerners more expressive. Uchida and Kitayama (2009) replicated the East–West comparison of emotional intensity by finding American participants describing more features of both happiness and unhappiness than the Japanese did. Americans also rated happiness and unhappiness more desirable and less desirable respectively, in comparison with the Japanese participants. The finding was thus repeated that the West gives more attention and importance to emotional experiences. The engrained importance of emotional expression found in the West and its absence of value in East Asia was further demonstrated by Soto, Perez, Kim, Lee and Minnick's (2011) self-report study: impairments to psychological wellbeing brought about by emotional suppression was only found among European American participants and not in East Asian participants. Markus and Kitayama (1991) reasoned that the more moderate experience of emotions among East Asians was documented due to collectivist cultures giving greater importance to the group experience as a whole, while the Western emotional experience gives importance to the individual’s experience. Meanwhile, during film-viewing, collectivist (cf. East Asian) populations have shown themselves to mask their true emotions to an extent that individualistic viewers do not—even when self-reported experiences of the films were the same across cultures (Matsumoto & Kupperbusch, 2001). Matsumoto proposed that emotion-masking is part of the interpersonal harmony that is prioritised in East Asian regions; it may also be rooted in the prioritisation of others’ experiences over one’s own, as characteristic of collectivist values. “These findings suggest that [collectivists] learn to decouple their expressions from their feelings in some social situations, whereas this may not be as true for [individualists]” (Matsumoto & Kupperbusch, 2001, p. 127).

Teachers relate to students and foster goals differently depending on the culture in which they are based. Li (2005) proposed an East–West contrast in learning styles that is rooted in Socratic (for the West) or Confucian (in the East) thinking. Westerners (i.e., Eastern Americans in her sample) prioritise mind over virtue, whereas East Asians prioritise virtue over mind (cf. Cheng, 1996). Western learners emphasise mind over virtue through their pursuit of their individual development—intrinsic enjoyment, focus on thinking, and value for communicating knowledge; East Asians emphasise virtue over mind by viewing themselves in relation to society (Li, 2002, 2003). For that, East Asians focus on their own character and the perpetual striving to go beyond each milestone and achievement—as an exercise of humility. Chinese learners are therefore documented to have greater persistence—since learning is a process that they expect to be challenging—and to have greater openness to authority figures than their Western counterparts (Pratt, Kelly & Wong, 1999). The importance of humility before and respect for authority combined with the power distance more prevalent in East Asia have also been related to the silence that characterises East Asian classrooms more (e.g., Park & Kim, 2008). As such, Chinese parents are dissatisfied with teachers’ reports of their child achieving more than their peers; rather, they express a concern that their child continues in self-improvement (Ran, 2001). Correspondingly, Chinese teachers emphasise their roles not only in subject-specific knowledge transmission, but also their responsibility for the moral development of their students (Gao & Watkins, 2001). Likewise, Kitayama, Mesquita and Karasawa (2006, in Kitayama et al., 2009) noted cultural differences in emotional responses to achievements, where Western adults were more likely to experience happiness in response to personal achievement, whereas Eastern adults rejoiced in agreeable relationships.

Culture also relates to the educational community. Markus and Kitayama (1991) how described the role of others in an individual’s life can become significantly more influential in collectivist cultures, as relationships are not only part of the process for meeting goals but ends in themselves. Authors continued that the individuals would need to monitor the needs and preferences of others more consistently in order to achieve the relational goals one desires – all the while with this involving cooperating in meeting the other’s goals. Markus and Kitayama distinguish between all others – the indiscriminate category all those other than oneself – and ingroup others – those who have been selectively given regard by the individual. Triandis (1989) related this concept of ingroup to Tajfel’s (1978) social identity theory, while Markus and Kitayama (1991) pointed out that the ingroup for a collectivist is likely to be much narrower than the ingroup for an individualist.

The intensity of emotional experiences is also rooted in cultural disposition, that is individualism and collectivism. Individualists have a broader range of potential ‘in-group’ members, which can include teachers, whereas in-groups among collectivists are restricted to family and closest friends. In application to classroom relationships, the large number of hours a child spends in the classroom is likely to qualify the teacher for students’ ingroup emotionally. Pianta, Hamre and Allen (2012) argued accordingly, stating that classrooms are “one of the most proximal and potentially powerful settings for influencing children”. It stands to reason, then, that the emotional experiences of the classroom are likely to reflect the deep-seated cultural responses that can be expected from students from each setting. Furthermore, with increased hierarchy, decreased emotional intensity is reported (Matsumoto, 1989). Clearly, there is a concern for the negative effect of one’s emotional expression when in a hierarchical context. With greater regard for hierarchy corresponding more with collectivist cultures, a lower intensity of emotions can be expected among Eastern students. Taking the in-group and hierarchy effect together, the greater intensity with which Western students experience relationships can be expected in the present thesis, as can the more suppressed, other-centred experience of relationships in the Eastern students. Specifically, cross-cultural differences is expected in the outcome measures for teacher–student relationships, with stronger ratings expected from English pupils and a greater likelihood of negative experiences being expressed. To support this prediction, Matsumoto et al. (1988) showed that Japanese participants to never to display anger unless it is towards strangers, suggesting a disposition among Eastern individuals against negative emotion in relation to their in-group—which their teachers are expected to be members of.

5.6.2. Culture and Teacher–Student Relationships

East–West differences might also be found in reported teacher–student relationships. This possibility relates to the differential quality of relationships reported by each cultural group. Triandis, Bontempo, Villareal, Asai, and Lucca (1988) highlighted that American participants reported themselves to be lonely more often than their Japanese and Puerto Rican counterparts. Correspondingly, Japanese and Puerto Rican participants reported having better quality social support than the American participants. It stands to reason that if the current thesis finds cross-cultural diversity, differing ratings of teacher–student relationships are likely to be due to the differential relational experiences that each cultural group of participants have. Furthermore, Western students hold more negative beliefs about teachers than East Asians, yet believe students can be as close with teachers as they can be with teachers—a comparison that East Asians are less likely to draw (Fryberg & Markus, 2007). Fryberg also found East Asians for have significant more inter-dependent representations of their educational community than Western students did. Li (2002) made a successful East–West comparison of connectedness between China and Canada. Differences were found in the levels of connectedness, depending on the category of relationship: family-connectedness was significantly greater in the East, while friend-connectedness was comparable between the two regions.

Given the importance of teacher–student relationship in children's academic experiences and outcome, it would be logical to explore whether there is a notable East–West difference in teacher–student connectedness. If so, a valid correlation could be made with any cross-cultural gaze differences among expert teachers. MITB research has provided interpersonal profiles of what teachers thought characterised ideal teaching and the profiles of teachers whom students considered to be their best teacher. Ideal teacher profiles were essentially extreme versions of the best teachers' profiles. Both ideal and best teacher profiles consisted of very high levels of octants one (steering), two (friendly) and three (understanding), moderate levels of octants four (accommodating) and eight (enforcing), and low levels of six (dissatisfied) and seven (reprimanding) and very low levels of octant five (uncertain) (Figure 5.3). Créton and Wubbels (1984) noted that students respond more to the communion dimension than to teachers' agency—even though the best teachers will have high ratings on both.

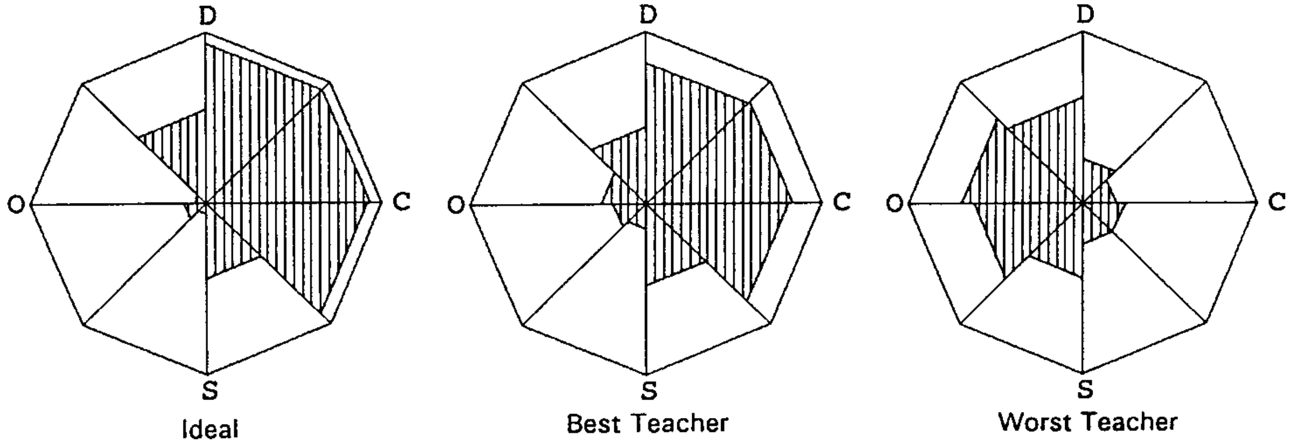


Figure 5.3. Early teacher interpersonal style profiles on students' perspectives on how the ideal, best and worst teachers behave (Créton & Wubbels, 1984).

In comparing Brunei, Singapore and Australia, den Brok found the East Asian teachers to be less communing and more influential (i.e., authoritative) than their Western counterpart, Australia (den Brok, Fisher, Wubbels, Brekelmans & Rickards, 2006). Likewise, Wei also discussed East–West comparisons to find greater agency and less communion among Chinese teachers than Australia (Wei, den Brok & Zhou, 2009; Wei. Zhou, Barber & den Brok, 2015). Additionally, since Chinese students' ratings for 'ideal' teacher agency was even higher than the actual rating, East Asian students apparently prefer more teacher authority than their Western counterparts (Wei et al., 2015).

In spite of the many cultural factors in teacher interpersonal style, some teacher behaviour are beneficial regardless of culture. While cultural differences have been found in specific dimensions within each teaching type explored by Zhang et al. (2005), ten out of the thirteen preference dimensions (within all three teaching types together) were the same across Hong Kong and US university students. Additionally, Zhang (2006) highlighted shared preferences among Hong Kong, mainland China and the US: namely the mutual inclination against norm-conforming teaching styles and preference for creativity-generating teaching styles as well as those that foster student collaboration.

5.7. Chapter Five: Summary

Students' intrinsic motivation is a natural resource that teachers capitalise on for optimal classroom experiences and maximum student learning (Deci et al., 1991). Intrinsically motivated students exercise greater self-regulation (Burman et al., 2015), deeper learning processes (Garcia & Pintrich, 1992) and higher levels of persistence (Vallerand & Bisonette, 1992). In particular, the present thesis addresses the role that teachers play in students' intrinsic motivation: namely, the stronger the teacher–student connection, the greater students' motivation is likely to be (Deci et al., 1991; Pianta et al., 2008; Reeve, 2009). The Model of Interpersonal Teacher Behaviour (MITB, Wubbels et al., 2012) extends the communication systems theory of human interaction by highlighting the messages that people unavoidably send through their behaviour and non-behaviour (Watzlawick et al., 1967). The MITB also forms the basis of the Questionnaire on Teacher Interaction (QTI, Wubbels et al., 1993). Since another's gaze impacts on the observee's motivation (e.g., Sato et al., 2010) and perceptions (Einav & Hood, 2008) outside the classroom, the interpersonal (or socio-emotional) impact of teacher gaze on students inside the classroom was explored by relating QTI measures to teacher gaze patterns. Indeed, teachers' expertise (e.g., Livingston & Borko, 1989) and culture (Cheng & Borzi, 1997) are likely to define what the optimal teacher interpersonal style involves.

6. CHAPTER SIX: ANALYTIC STRATEGY

The present thesis explores the analytic possibilities of the novel eye-tracking technology and associated data. Accordingly, the present chapter presents the rationale for the specific analytic choices made that are subsequently described in the Method, Results and Discussion sections of this thesis.

6.1. Gaze Events in Focus: Attentional and Communicative Gaze

Attentional gaze refers to information-seeking eye movements. Communicative gaze refers to information-giving eye movements. Until recently, eye-tracking research has been confined to the laboratory, a context largely limited to attentional gaze investigation. Yet, the eyes have arguably been designed with the primary function of facilitating interactions (Emery, 2000; George & Conty, 2008; Langton, Watt & Bruce, 2000)—a dual-process requiring both attention and communication. Meanwhile, the equally significant role that gaze plays in communication is recently emphasised in human vision research, with multiple calls for researchers to give due consideration to communicative gaze, rather than devoting research solely to attentional gaze. The argument for going beyond attentional gaze is that important questions regarding human behaviour, such as psychiatric conditions, involve social interaction rather than passive observation: vision research that addresses real-world questions should therefore take communicative gaze into account alongside the processes constituting attentional gaze (Schilbach, 2015).

To demonstrate, Jarick and Kingstone (2015) primed dyads with competition by asking them to race each other to completing a puzzle on opposite sides of the table to each other. Authors primed other participants with cooperation by asking them to complete the puzzles together, sitting next to each other. Following the priming (puzzle), participants were asked to sustain eye contact with each other for as long as they could. Other than the contrast in quantity of verbalisations (i.e., talking, laughing, smiling) exchanged within the dyads (cooperative: more; competitive: less), Jarick and Kingstone found that the competitive dyads sustained eye contact significantly better than cooperative dyads, such that breaking eye contact was the exception among competitive dyads. Authors concluded that, by priming the social context in which the dyads made eye contact, the gaze exchanged served both to send (i.e., communicate) and receive (i.e., attend to) signals corresponding with the primed social dynamic.

Myllyneva and Hietanen (2015) carry out the same discussion about the duality of gaze. Authors demonstrated that humans use their gaze to seek information, to see others, as shown when participants could see another person, with significant neurological responses to demonstrate their awareness of this person. Human gaze also makes an impact on us, thereby having a communicative effect. Neurological responses in participants demonstrated their awareness of another’s gaze—the impact of the other’s gaze (i.e., communication)—even when the participant could not themselves see that person. Moreover, Hietanen demonstrates that different gaze directions have different effects—communicate different signals—to the recipient (Hietanen, Leppänen, Peltola, Linna-aho & Ruuhiala, 2008).

Senju and Johnson (2009) described the impact of others’ gaze towards us to be the ‘eye contact effect’. The gaze of another upon oneself is related to our detecting of another’s *communicative* intent. Equally, authors emphasise that the eye contact effect is part of an *attentional* mechanism by which we track others’ faces for social or task-relevant information, as part of the fast-track modulator model (cf. Banich et al., 2000). The duality of gaze—for both attention *and* communication—is clear. Hence the present investigation of both mechanisms in teachers’ classroom gaze.

Communicative gaze can be simulated in the laboratory. For example, Farroni, Menon and Johnson (2006; cf. Valenza, Simion, Macchi Cassia & Umiltà, 1996) simulated communicative gaze with infants using a project images of faces. Participating infants sat on their carer's lap. A blinking light (i.e., fixation point) in the centre of the projection screen was switched on until the infant began fixating their gaze on it, at which point the infant was shown two faces on the screen: one face displayed direct gaze, the other averted gaze. When the infant's gaze shifted from the screen, the fixation point was switched back on before two faces were shown again, with direct and averted gaze reversed (e.g., if the left face showed direct gaze before, it now showed averted gaze).

Another example of communication being simulated in the laboratory was given by who used dynamic stimuli with adult participants (Senju, Vernetti, Kikuchi, Akechi & Hasegawa, 2013). Senju presented animated heads, which either shared or differed from the participant's on ethnic background. Seven-second animations were generated, in which the heads either smiled or had their mouth open. Simultaneously, the heads either displayed direct or averted gaze. Moreover, the eyes moved 25 degrees towards (for direct gaze) *or* away (for averted gaze) from the viewer. In this way, Senju simulated experiences of an observee orienting their gaze towards or away from participants which, in turn, were received as differential messages (i.e., communication), depending on each participant's culture.

Holler, Kokal, et al. (2014) provided another demonstration of simulated communication through dynamic stimuli. Holler was interested in the role of gaze combining speech and gesture. The dynamic stimulus was a video showing female actor speaking short sentences while using direct or averted gaze. This utterance was either accompanied or not accompanied by corresponding gestures (e.g., a sentence about typing would involve typing actions, in the with-gesture condition). The gestures, when present, either contained information about the object's shape, size or function. The information successfully communicated about the target object (through verbalisations and/or gestures) was assessed by the participant's reaction time (treated as processing speed) when participants were presented an array of objects that could fit the description.

A final example of laboratory gaze research used a live person in the laboratory. To explore the impact of adult gaze on infant gaze, Brooks and Meltzoff (2002) sat participating infants on their parent's lap, with the parent sitting in a chair. This chair faced the experimenter, sitting in a chair directly opposite. The experimenter displayed gaze in the 'open eyes' condition and suppressed gaze in the 'closed eyes' condition. Two toys were placed between the experimenter and infant. Each toy took turns operating as the 'target' toy, to measure 'correct' looks, or the 'distractor' toy to measure 'incorrect' looks. At the beginning of each trial, the experimenter would make eye contact with the infant. In the open-eyes condition, the experiment would then turn her head with her eyes open; in the closed-eyes condition, she would close her eyes before turning her head. The direction of the experimenter's head-turn determined the target toy; the other, non-viewed, toy was accordingly the distractor.

However, research into professional and expert gaze has been predominantly limited to attentional or singular cognitive processes. Gegenfurtner et al.'s (2011) review of 296 studies into professional gaze consisted entirely of attentional gaze research questions. Researchers' appreciation of the capability of professional gaze has thus limited the function and investigation of gaze to its support to professional attention, with no questions asked of professional—expert—communication through gaze. While many professionals use gaze primarily for attentional, information-seeking, purposes (e.g., aviators, Schriver, Morrow, Wickens & Talleur, 2008; chess players, Reingold et al., 2001; radiologists, Kundel et al., 2007), an equal proportion of professionals use gaze to communicate, or information-giving, as well (e.g., business negotiations, Swaab & Swaab, 2009; counselling, Gorawara-Bhat & Cook, 2011; paramedics; Dean, 2012). Even where communication is explored in the professional gaze literature, only communication is considered: in each study, there is little recognition that gaze performs more than one function, namely both attention and communication. While the businessman is using his or her gaze to signal persuasiveness (Swaab & Swaab, 2009), while the therapist is conveying encouragement and receptiveness (Gorawara-Bhat & Cook, 2011), and while the paramedic is updating the nurse in the emergency ward, the communicator is also assessing the recipient's reactions—an attentional process—to adjust to new demands.

Educational science has also demonstrated a singular focus on the attentional role of teacher gaze. Van den Bogert focused on teachers' attentional focus and processing speed (van den Bogert et al., 2014). Wolff studied the top–down perception among expert teachers in contrast to the bottom–up processes among novices (Wolff et al, in press). Though conducting a real-world classroom study in which communicative gaze was particularly accessible (Hietanen et al., 2008), Cortina only documented the distribution of attention (Cortina et al., 2015). While Dogusoy-Taylan went attentional teacher gaze by exploring teachers' problem-solving gaze (Dogusoy-Taylan & Cagiltay, 2014). Dogusoy-Taylan compared expert with novice teachers' gaze during problem-solving through concept-mapping: a non-social information-organisation and knowledge-generation process, which is non-interactive others) 'communication' (i.e., without the presence of or not being directed to at most. Thus, no mention has so far been made in teacher gaze literature to teachers using their gaze for communication with students.

It should be noted that I do not dispute the centrality of attention in the classroom teaching. Indeed, seminal classifications of teacher expertise emphasise readiness for classroom management—as shown by prompt awareness of potential issues—as a vital skill. Specifically, classroom management—and attention towards this respect—is given distinct importance in Berliner's (2004) theory of teacher expertise, Pianta's CLASS system (Pianta, La Paro & Hamre, 2008), Shulman's (1987) tripartite theory, and Klieme's instructional quality model (Klieme, Lipowsky, Rakoczy, & Ratzka, 2006; Praetorius, Lenske & Helmke, 2012). As already noted above (Section 5.5.1. Expert Interpersonal Style), awareness and considerations regarding discipline (among novices) and whether students are learning deeply (among experts; Wolff et al., in press) is a significant distinguishing factor between expert and novice teachers.

Yet teaching can arguably be defined as an information-giving profession, one that is centred on imparting knowledge to learners. In fact, Leinhardt (1987) has gone so far as to define teaching as "the art of transmitting knowledge [i.e., communication] in a way that ensures the learner receives it" (p. 225). Students agree, as they rate teacher communicative effectiveness as second only to their own natural ability for academic achievement (Waxman & Eash, 1983). Others quantify teacher effectiveness by the teacher's success in bringing across subject material to students, especially the abstract and complex areas (Treagust, Chittleborough & Mamiala, 2003). To Leinhardt, the quality of teachers' explanations (in communication) is a direct indication of the teachers' subject ("understand… the key concepts, p. 225) and pedagogical content knowledge ("[know] which concepts and procedures are…difficult to grasp", p. 225, cf. Livingston & Borko, 1989, 1990). Effective explanations (i.e., communication) are also a key skill distinguishing experts from novices (Livingston & Borko, 1990), with experts going deeper and more conceptual than novices do. Duffy (2002) has argued that direct, information-giving, expositional teaching is necessary when students cannot respond to less explicit, more independent modes of learning. The teacher effectiveness literature has repeatedly investigated clarity in communicating learning goals as part of their framework for assessing instructional quality (Seidel & Shavelson, 2007). Hodge (2014) has even argued that teaching is embedded in a multi-party network of communication, necessarily taking national policy, local guidance, school ethos, departmental and parental preferences on board, not to mention student needs too. Thus, teachers' communication skills are integral to their profession. Investigation into teacher gaze for communication, in addition to attention (information-seeking), is therefore imperative for a true analysis of the profession in practice.

6.2. Using Simultaneous Verbalisation to Interpret Gaze

The present study follows the McNeillian tradition of interpreting non-verbal behaviour through co-occurring speech. Gestures are "the spontaneous, unwitting, and regular accompaniments of speech that we see in our moving fingers, hands and arms" (McNeill, 2005, p. 3). McNeill (1985) has long contended that gestures are closely tied with our speech. That is, gestures are united with speech during the message transmission process. McNeill distinguishes gesture from language on three levels (McNeill, 2005). In meaning, gestures are global whereas speech is analytic. In creation, gestures are spontaneously generated in the moment whereas words are formulated in conformity with established rules. In direction, gestures are driven by imagery whereas words are driven by society's arbitrary rules of word morphology. Together, gestures contrast with words by being instantaneous, global and unconventional. Gestures are therefore the perfect counterpart to spoken language, making gesture and speech well-suited to the interpretation of each other.

As fully formed language systems, sign language has been used to highlight the close relationship between linguistic and non-linguistic hand movements and, in turn, speech and gesture. Duncan (2005) asked fifteen signers to tell an action-packed story—Canary Row (Freleng, 1950) using their native language, Taiwanese Sign Language. As participants told this story, hand movements were used to *tell* the story (i.e., signing) as well as to *demonstrate* the story's actions (i.e., enactments). For example, one signer switches from narrating the story to providing an image of it, by putting "the left hand in the half circle form… the right hand in the thumb-and-pinky 'vertical figure' handshape. The right hand then moves through and up past the left hand" to show the cat moving through the drainpipe (Duncan, 2005, p. 301). Sandler (2009) too contends for the close relationship between the linguistic and the non-linguistic (or gestural) using Israeli Sign Language, whose culture involves mouth-pointing in spoken discourse. Whereas speakers use hands to supplement the linguistic content of their mouths (i.e., speech), signers in Sandler's study used the mouth to supplement the linguistic content of their hands. For example, in retelling the story of Canary Row, while narrating with their hands, signers used their mouths to convey the tightness of a drainpipe, the zig-zag shape of the drainpipe and the roundness of a bowling ball. There is a sense that gestures—non-linguistic behaviour that accompanies linguistic content—are indispensable, such that, even when hands are unavailable for gesturing, gesturing is nonetheless utilised as part of the message-giving process.

The close relationship between speech and gesture has additionally been demonstrated by the synchrony between speech and gestural *planning* (or the 'growth point', McNeill, 1992). That speech and gesture (at least the planning) occur at the same time suggests that they operate in the same mechanism, as one integrated image-language system. To explore this, Church and colleagues distinguished between gesture and action by allowing participants to use objects as part of their activity (e.g., dart-throwing) description only in the speech-and-action condition (as opposed to the speech-and-gesture condition, Church, Kelly & Holcombe, 2014). By making this gesture-action distinction, Church found significantly greater speech–movement synchrony in the speech-and-gesture condition, with movement onset. That is, the start of gestured movements coincided with the timings of speech content more than action movements did with speech.

In another study on the integrated system of speech and gesture, Kelly and colleagues used an ‘incongruence paradigm’ to demonstrate that, rather than leaving the spoken message uninterrupted, mismatched speech and gesture disrupts the recipient’s understanding of the message as a whole (Kelly, Özyürek & Maris, 2009). That is, by disrupting the gestured content, the spoken content becomes less accessible, even distorted. The incongruence paradigm distinguished gesture that were weakly incongruent with speech from those that were strongly incongruent with speech. The incongruent conditions together were compared with the baseline, congruent, condition that had no speech-gesture incongruence. After being shown a video of an action prime (the target behaviour, e.g., ‘chop’), participants watched a video of one of these speech-gesture conditions. Participants were tasked to identify whether the target behaviour was present, yes or now, while their reaction times and error rates were measured. Significantly faster reactions and fewer errors occurred in congruent (baselines) conditions; in the incongruent conditions, reaction times and errors rates increased whether disruption occurred in the speech or the gesture. It was thus shown that speech and gesture are comparably important in message-giving and that the two modalities belong in one integrated system.

Gaze has long been treated as a sub-category of gesture, as researchers have attempted to decode non-verbal interactions. In a seminal study, Kendon (1967) documents the way gaze direction and speech work together to show that differing speech content co-occurs with differing gaze directions that are sustained for differing durations. In the dyadic conversations, interlocutors looked away during longer speeches to indicate hesitation, as if to obtain planning time, and looked toward the listener during fluent speech, as if to invite prolonged attention from the listener. As such, gaze direction partners with speech to achieve the overarching goal of the speaker—to generate planning space, or to command attention. Kendon thus suggested that gaze direction functions like gesture: synchronised with speech timing and content, supporting conveyance of specific messages, emerging from the same unified mechanism—much like the integrated system of hand gesture and speech (Kelly et al., 2009).

In further support for the comparability of gaze with gesture, Jokinen (2009) suggested that gaze and gesture have comparable functions in conversation. During conversation, listeners' gaze direction, especially eye contact, played a synchronised role with gesture and body posture in non-verbally conveying responses to speakers. For instance, maintaining eye contact was part of the overall non-verbal demonstration of empathy and willingly sustained attention towards the speaker. Jokinen contended that gaze is one part of non-verbal, gestural, support system for speech. Gaze seems to be used together with hand gestures to feed unified non-verbal messages to interlocutors.

That gaze, gesture and speech work closely together suggests that gaze can be analysed in the same way as gesture. Quek and colleagues asked individual participants to explain a given plan of action to a group of listeners, who needed to understand the plan in order for the participant to perform their task successfully (Quek et al., 2000). The most consistent function of gaze direction, especially eye contact, in this task emerged to be checking and maintaining listener understanding. Meanwhile, hand movements were used to point to geographical parts of a display board, thereby having the function of indicating the main point of interest. Similarly, Sidnell (2006) suggested that gaze supports gesture and speech by organising the other two modalities during message-giving. In his analysis of a group conversation, involving a re-enactment of multiple characters with differing perspectives, speakers assumed body movements that appropriated the character they were assuming. Simultaneously, gaze directions also appropriated those of the re-enacted character, averted away from the conversational partners—even though the whole message (or re-enactment) was for the audience of these conversational partners. In this way, research has shown that gaze and gesture work with—indeed, complement—each other, alongside speech in a co-active manner (Jones & LeBaron, 2002, p. 503).

Neuropsychology research has also given support to the perspective that gaze and gesture are equivalent in the integrated gesture-speech system. In this research, the Grèzes laboratory uses amygdalic reactions as a measure of social judgement, that is the detection of social intention in viewed stimuli. Conty and colleagues showed image sequences of gaze and gesture to explore the differing extent of social intention detected (i.e., amygdalic response) through differing timings of gaze and gesture (Conty, Dezecache, Hugueville & Grèzes, 2012). Authors found that the strongest detection of social intention (e.g., threat or anger) occurred when viewers received *combined* cues of gaze (i.e., direct gaze) and gesture (i.e., pointing) rather than individual cues involving either gaze or gesture alone. In particular, gaze direction seems to enable the addressee to determine whether the viewed behaviour is relevant to oneself (Conty et al., 2012, Grèzes, Adenis, Pouga & Armony, 2013), such that angry messages only trigger associated neurological responses in viewers when they are accompanied by direct gaze (or eye contact). Moreover, the Grèzes team (laboratory study, Grèzes, Valabregue, Gholipour & Chevallier, 2014) and others (meta-analysis, Hinojosa, Mercado & Carretié, 2015) have also emphasised the overall role of the motor and visual regions of the brain in amygalic activations, whereby the physical movements of others are integrated to make judgements of their social intentions possible, lending further support to the relationship between message-giving (or message-reading) and gestures (or gesture-reading).

In view of the above evidence for the shared responsibility of gaze and gesture in supporting message transmission, and given that gesture and speech seem to be tightly linked, the way gesture and speech interpret each other (McNeill, 1985, 2002, 2005) can be extended to expect gaze and speech to interpret each other. Accordingly, the present thesis distinguishes between broad interpretations of gaze using speech that occurs simultaneously with gaze.

6.3. Frequency Analysis

Frequency analysis was performed in the present thesis. Frequency measures of gaze are valuable for distinguishing attentional gaze among experts from novices. Frequency measures reveal the need for expertise, as high gaze counts have been documented to reflect task complexity (Chisholm, Caird & Lockhart, 2008) and interpretive difficulty of a viewed scenario (Rötting, 2001). High gaze counts are also associated with knowledge-building (Tatler, Gilchrist & Land, 2005), indicating the need for these viewers (i.e., novices) to acquaint with the stimulus compared with viewers yielding low gaze counts (i.e., experts). This pattern has been replicated among teachers in the laboratory, where experts and novices looked at the same regions, but novices yielded higher gaze counts than experts did (Dogusoy-Taylan & Cagiltay, 2014).

Frequency measures also reveal expert awareness of the importance in specific regions. Frequency measures have, in the past, reflected viewer interest during free-viewing of laboratory images (Mackworth & Morandi, 1967; Yarbus, 1967) and in the real-world (Schumann et al., 2008). Additionally, the relevance and importance of a gaze target to the viewer's task also increases its gaze frequencies in the laboratory (Charness, Reingold, Pomplun & Stampe, 2001) and in the real-world (Foulsham & Kingstone, 2012). This pattern has been shown in classroom teaching too, where experts used higher gaze frequencies towards every student compared with novices (Cortina et al., 2015).

Gaze proportions were used as frequency measures of teacher gaze in the present thesis. Because they reflect what is most important to the viewer, gaze proportions are best placed to demonstrate both novices' need for expertise and experts' awareness of regional importance. Outside the education and gaze literature, proportion measures are established to be useful as indicators of explicit processes and ongoing strategies, due to their consistency over time (Bröder & Schiffer, 2003; Glöckner & Betsch, 2008). Proportion measures have already demonstrated the integrative way in which humans make their decisions (Ayal & Hochmann, 2009), that we consistently take all information into account and formulate priorities before we act upon our environment (Brandstätter, Gigerenzer & Hertwig, 2006).

In line with their superior knowledge and experience in their domains (Bédard & Chi, 1992; Ericsson & Kintsch, 1995), expert decision-making is significantly better informed by knowledge and past experience than novices' (Chassy & Gobet, 2011; Norman, Brooks & Allen, 1989). 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). Gaze proportions have also been distinguished by culture, whether the viewer lives in a rule- or relationship-oriented setting (Kärtner, Keller & Kovsi, 2010). Accordingly, expert teachers in each culture should the most adaptive gaze strategies (or proportions) for the classroom.

6.4. Temporal Analysis

Temporal analyses involve the investigation of time and, in the present study, were run using state space grids. A state space comprises of two or more behavioural *streams*, with each behavioural stream consisting of a number of behavioural *acts*. In the present research, one behavioural stream is an individual teacher's gaze, while a second behavioural stream is the same teacher's didactic (i.e., instructional) acts. When one act from each stream co-occurs within the state space, an *event* takes place. A state space grid is a visual representation of all the possible combinations between behavioural streams. One *axis* represents one behavioural stream; each *interval* along a behavioural stream represents one behavioural act; one *cell* in the state space represents an event. To relate state spaces to the immediate research on teacher gaze, Figure 6.1 shows examples of how gaze behaviours are related to didactic behaviours, to form a didactic gaze state space.

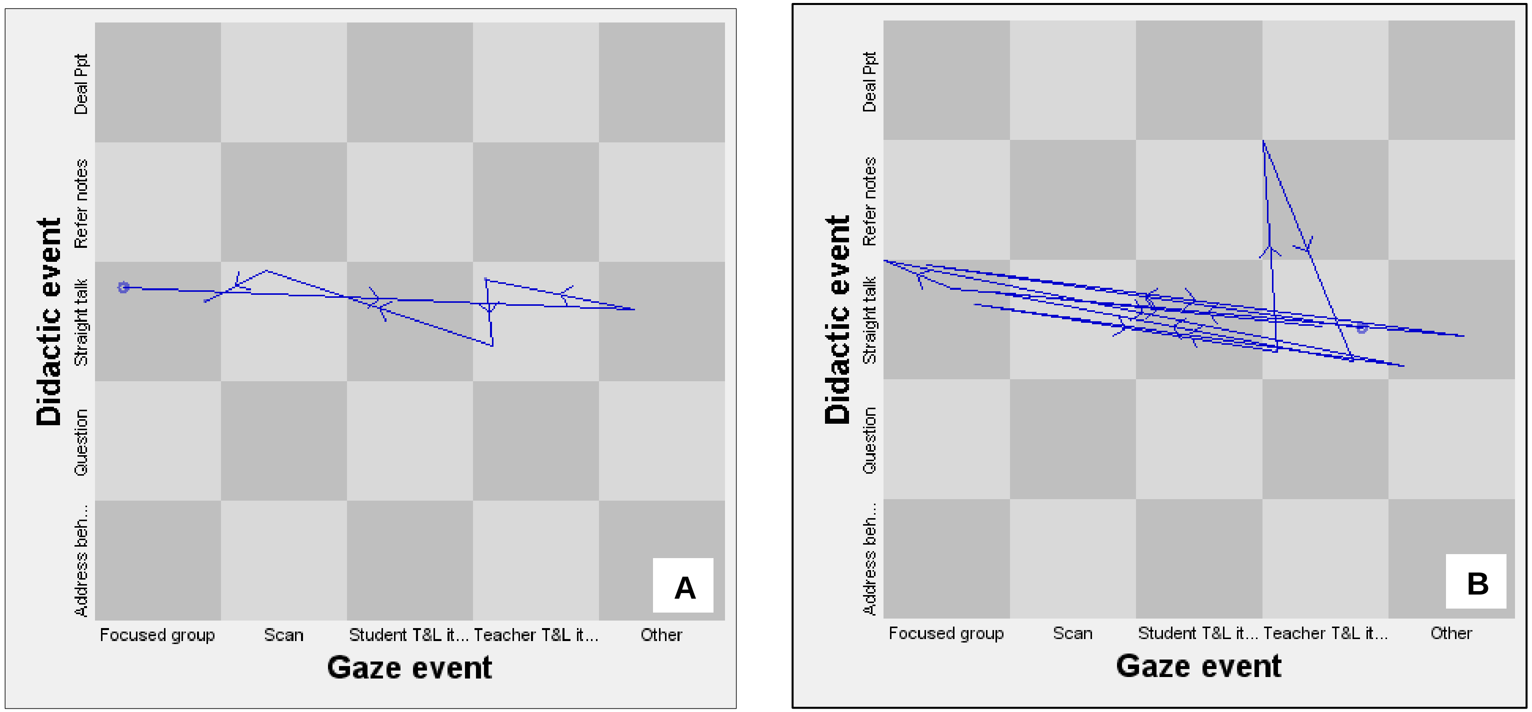


Figure 6.1. Example state spaces from two participants in the present research, with the two behavioural streams (i.e., gaze acts and didactic acts) constituting a 'didactic gaze' state space. The node is where the behavioural changes began. The lines connect each event change, with arrows representing the origin event and destination event of each change. Panel A is Participant 24, a UK expert teacher; Panel B is Participant 1, a Hong Kong expert teacher. Both panels show the first 10 seconds of state space changes.

The concept of state spaces stems from the dynamic systems tradition. Dynamic systems theory holds that self-organisation, and therefore change, is taking place continually in all phenomena (Haken, 1977; Lewis, 2000; Thelen & Smith, 1998). Change should therefore of central interest, how much and in what way it occurs. Analyses of state spaces thus concern *processes* of how one event moves onto another. As such, process analysis is distinguished from analysis of specific stationary events, with process analysis asking 'how' behavioural streams combine differently over time and analysis of stationary events investigates 'how much' two behavioural acts come together (Lewis, Zimmerman, Hollenstein & Lamey, 2004). The latter is conventional practice in education psychology (e.g., Clarridge & Berliner, 2001; Henrich & Broesch, 2011; Wentzel, Battle, Russell & Looney, 2010) and vision research (e.g., Kundel et al., 2007; Masuda & Nisbett, 2006; Rehder & Hoffman, 2004). However, through state space grids, temporal analysis in the present research addresses both the 'how' and the 'how much', by performing both *dynamic* and *static* analyses on teacher gaze.

Compared with its dynamic analysis counterparts, state space grids have a number of additional advantages that are relevant to the present study. Unlike other dynamic analytic techniques, state space grids do not limit dynamic investigation to levels of a single behaviour, but make simultaneous analysis of multiple and diverse behaviours possible. For example, using time series analysis, Perels and colleagues could demonstrate that learners report increasing rates of goal-setting over the course of 50 days, thereby highlighting changes in one self-regulatory dimension (Perels, Gürtler & Schmitz, 2005). Using cross-recurrence analysis, Richardson and colleagues could demonstrate when and the extent to which two people used the same behaviour (i.e., cross-occurred) during social interaction (Richardson, Dale & Shockley, 2008). Using the GINI index, Cortina and colleagues documented the way teachers' student-oriented gaze is distributed with increasing equality with teachers' increasing years of classroom experience (Cortina et al., 2015). Using state space grids, the present analysis goes beyond these dynamic analytic approaches in two ways. First, whereas the cited examples of dynamic analysis address only one behaviour category, the present analysis addresses five (Section 7.6.4.1 Temporal Analysis: Measures). Second, whereas the cited dynamic analyses explore only one aspect of change, the present analysis addresses three (Section 6.3.2, 6.3.3 and 6.3.4). With the complex nature of classroom teaching in mind (e.g., Berliner, 2001, 2004), state space grids meet the need for deep, process—dynamic—analysis of teacher gaze, enabling us to more fully investigate the processes of human interaction that are taking place in the classroom (cf. Fogel & Garvey, 2007).

6.4.1. Temporal Analysis: Static Duration Measures

The static analysis available through state space grids are conventional: gaze duration measures. Gaze durations are the most typical eye-tracking measure in vision research. When relativized, duration measures of gaze have an advantage over frequency measures of gaze is that durations they take into account the temporal dimension of each visit (i.e., count)—that is, rather than how often a teacher is looking at a target, durations reveal how long a teacher is looking at a target. Analysis of teacher gaze durations therefore examines a dimension that frequency analysis cannot address: namely, gaze time.

Gaze durations primarily reveal depth of cognitive processing. The longer a region is gazed at, the more it is being explored by the viewer. For example, deeper processing is shown by longer fixations when reading longer (Kuperman, Bertram & Baayen, 2008) and more sophisticated words (Rayner, 1998; Rayner & Pollatsek, 1989). Task-relevant regions also receive longer fixations than irrelevant areas (Mackworth & Bruner, 1970).

Moreover, compared with novices, experts typically display longer gaze durations to regions of relevance and importance in general picture viewing (with ‘experts’ being adults; Mackworth & Bruner, 1970), chess (Reingold et al., 2001) and in sport (Mann, Williams, Ward & Janelle, 2007). Conversely, higher stress relates to shorter gaze durations (van Orden, Limbert, Makeig & Jung, 2001), which can be related to novices’ cognitive load (Feldon, 2007). Novice teacher gaze might also resemble that of the viewer who is finding a web page inaccessible (i.e., difficult to engage and process) and who therefore displays shorter gaze durations than those more familiar with the web page or those using a more accessible web page (Ehmke & Wilson, 2007). Likewise, gaze durations decrease as task complexity increases in driving (Chapman & Underwood, 1998). In the classroom, students are the region requiring the greatest depth of attentional processing in the teacher (Livingston & Borko, 1989), given that students are the intended beneficiaries of classroom instruction (Kinchin, 2003; Rimmer, 2015). Indeed, expert teachers consider classroom situations from the perspective of the student more readily than novice teachers do (Wolff et al., 2014), which is reflected in their gaze (Cortina et al., 2015; Wolff et al., in press.). Likewise, since teacher–student eye contact is central to learning processes (Csibra & Gergely, 2009), students are the gaze target of the communicative attempts too (Frith & Frith, 2012).

An interplay between cognitive depth and expertise is likely to be highlighted as I explore cultural differences (Sternberg, 2004, 2014) in teachers’ gaze durations. Cultures give importance to different aspects of social relationships. For instance Western populations, ordinarily individualistic, pursue inter-individual connection and personal success, whereas East Asian populations, who are characteristically collectivist, regard connection with non-family (or out-groups) as threatening while giving worth to hierarchical authority structures (Triandis, 1989, 1995). In turn, Western classroom learning features greater openness to confrontation between individuals as a process of reaching a consensus regarding an idea, whereas East Asian classrooms prefer between-learner harmony and actively sustain the teacher–student power distance (Hofstede, 1986; Leung, 1995 vs. McCroskey et al., 1995). Correspondingly, collectivist attentional gaze is typically more holistic (i.e., fewer gaze changes required; Norenzayan et al., 2002), compared with individualistic attention, as collectivistic viewers pursue relationships between features rather than feature-by-feature analysis. Additionally, collectivistic communicative gaze involves less eye contact compared with individualistic (i.e., Western) gaze, due to the increased likelihood of threat when making interpersonal connections (Akechi et al., 2013).

6.4.2. Temporal Analysis: Dynamic Measure 1, Efficient Teacher Gaze

The first dynamic measure available through state space grids relate to efficiency. Experts employ more task-relevant behaviour than novices. With experience and deliberate reflection, experts are those who have identified the optimal way to perform a task (Haider & Frensch, 1996). Unlike novices, experts are able to function, using the minimal resources for the task at hand (Anderson, 1982). It is by identifying and sustaining the best solution to a recurring problem—that is, automatisation—that experts operate with greatest adaptivity (Feldon, 2007; van Merriënboer et al., 2002). Experts are thus established to be more efficient when compared with novices. Expert gaze has demonstrated the same efficiency compared with novices (Haider et al., 2005), regardless of task difficulty (Rehder & Hoffman, 2004). That is, experts are those who display experience- and knowledge-informed shortcuts even in their gaze during task performance (Jarodzka et al., 2010). Indeed, expert teachers notice classroom problems more quickly than novices do (van de Bogert et al., 2014).

Optimally efficient solutions, however, might differ across cultures. Cultural differences certainly exist for the prevalent (Stevenson & Lee, 1995 vs. Perry, 2000) and preferred (Bryan et al., 2007; Kennedy, 2002) instructional styles. Differences also exist in the aspect of prototypical teacher expertise (Shulman, 1986) that teachers in differing cultural settings excel at (König et al., 2011; Zhou et al., 2006). Accordingly, expert teachers are likely to regard different gaze types as the most 'efficient' depending on their cultural setting.

6.4.3. Temporal Analysis: Dynamic Measure 2, Teacher Gaze Flexibility

The second dynamic measure available from state space grids are flexibility. The dynamic systems perspective delineates between dynamic and reactive flexibility (Hollenstein, Lichtwarck-Aschoff & Potworowski, 2013). Whereas reactive flexibility relates to longer term adaptations of behaviour in compliance with context, dynamic flexibility relates to short term adjustments of one's behaviour in response to immediate events and occurrences. Dynamic flexibility was presently conceptualised as gaze flexibility: teachers with greater gaze flexibility are those who change their gaze direction according to the classroom's needs at each moment.

As a result of their advanced knowledge and skill, experts are well-positioned to handle the demands of their profession with greater flow and flexibility than novices can (Taatgen, 2005). Not only are experts more flexible in responding to standard situations, experts outside the classroom have displayed a greater ability to adapt to the challenges of unusual or disrupted situations too (Bilalić et al., 2008; Lehmann & Ericsson, 1996; Star & Newton, 2009). Inside the classroom, experts are known to be responsive to unforeseen classroom events (Livingston & Borko, 1989), with greater priority given to student needs that arise over and above the lesson plan devised (Castejón & Martínez, 2001).

Educational researchers regard expert teachers to be more flexible because of their superior professional knowledge and experience (Leinhardt & Greeno, 1986).

In the same way, expert *gaze* can be expected to display greater flexibility than novice gaze. Expert teachers have displayed attentional flexibility by directing their gaze across multiple—relevant—regions of the classroom (i.e., at multiple students), rather than becoming preoccupied with salient regions and events (Van den Bogert et al., 2014). Indeed, the more expert the teacher, the more widely distributed their gaze (Cortina et al., 2015). Culture may further accentuate expert–novice differences in gaze flexibility. Whereas student-centredness more of a Western than East Asian priority among teachers (Bryan, Wang, Perry, Wong & Cai, 2007), the importance of student expression (Kim & Sherman, 2007) is outweighed by the Confucian priority given to respect for authority (Leung, 2014) and social harmony (i.e., non-confrontation; Matsumoto & Kupperbusch, 2001). Moreover, the upper threshold for student-oriented gaze (i.e., teacher–student eye contact) among East Asians is lower than that among Western populations (Akechi et al., 2013), which means teacher gaze may transition from student to student (or other targets) at a significantly higher rate in East Asia (e.g., Hong Kong) than in the West (e.g., the UK).

6.4.4. Temporal Analysis: Dynamic Measure 3, Teacher Gaze Strategy

The third dynamic measure available through state space grids is strategic consistency. Reactive flexibility (Hollenstein et al., 2013) is likely among experts, as they have grasped and optimised their gaze strategies for their cultural context. Resulting from this form of flexibility, however, experts are more likely to use more consistent strategies from moment to moment, compared with novices. Experts across domains demonstrate consistent use of selective strategies (Ericsson, 2006). Experts in teaching can be expected to demonstrate the same advantage. By exploring teacher gaze consistency, we can establish how teachers tackle demands on both attentional and communicative processes. In organising their subject knowledge, novice teachers use the same problem-solving procedures as experts, but they are slower to employ these processes—and less knowledgeable—as they do so (Dogusoy-Taylan & Cagiltay, 2014). Experts demonstrate consistent focus on student-centred needs whilst observing another teacher (Wolff et al., 2014). Novices, on the other hand, are diverted and directed by salient, classroom management events, which is likely to yield more frenetic and inconsistent gaze. Together, I expected experts to display greater consistency in teacher gaze, whereas novices should exhibit greater unpredictability in a "stream-of-consciousness manner" (p. 91, Dogusoy-Taylan & Cagiltay, 2014), revealing an absence of strategy derived from past experience.

Teacher gaze in the East, however, may display exceptional levels of consistency. Whereas flexibility is a Western trait in problem-solving, persistence is an Eastern characteristic (Imbo & Le Fevre, 2009). Imbo and Le Fevre (2011) demonstrated that Eastern participants reach the upper threshold of their cognitive load quicker during problem-solving, reducing their likelihood of opting for novel problem-solving solutions—even when these are more efficient. Imbo surmised that this Eastern stickiness may be due to their educational history which strives for establishing routines—and increases tolerance of alternative solutions that call on approximation strategies. Together, while experts were expected to display greater gaze consistency on the whole, Eastern experts may display even more predictability when compared with their Western counterparts.

6.5. Scanpath Analyses

6.5.1. Scanpath Analysis: Background

A scanpath is a "repetitive sequence of saccades and fixations, idiosyncratic to a particular subject [person] and to a particular target pattern of loci" (Choi, Mosley & Stark, 1995). Scanpath analysis is therefore the investigation of gaze sequences. The scanpath theory is a theory for human vision that contains a number of assumptions derived from early vision research. Each individual assumption has continued to receive support since. Each assumption will be outlined now along with supporting evidence.

The first assumption of scanpath theory is that people repeat scanpaths. Even without considering visual content, human gaze demonstrates a consistent bias towards particular regions of their visual field. Specifically, Brandt (1940) highlighted that first fixations are often directed at the above left of the centre-point, with immediately subsequent fixations then continue in an upward-left direction. The upper left of the stimulus is prioritised over the bottom left, while the left visual field is preferred to the right. Subsequent work has supported the central bias in human vision, regardless of differences in the viewed stimulus (Mannan, Ruddock & Wooding, 1996, 1997), or viewer task (Tatler, 2007). More recent support is found for these innate visual biases, that horizontal saccades are more likely and sizeable than vertical saccades, while upward saccades occur more than downward saccades (Tatler & Vincent, 2009).

The repetitive nature of scanpaths is also seen across *repeated scenarios* such that repeated gaze sequences correspond to repeated visual content. Seminally, one observer's free-viewing (unguided, unstructured observation) of *The Unexpected Visitor* landed on the most interesting regions during the first observation—which was then repeated in subsequent views of the same image (Yarbus, 1967). Likewise, gaze at dimly-lit images repeated identical scanpaths (Noton & Stark, 1971) and scanpaths are significantly self-consistent over multiple presentations of the same image, presented under standard conditions (Choi, et al., 1995). Further support for the content-driven nature of scanpath repetition is in the way subsequent gaze directions can be predicted based on where gaze is currently being directed (i.e. the 'Markov' nature of scanpaths, Pieters, Rosbergen & Wedel, 1999). Even internal regenerations (i.e., imagining) of the viewed stimulus yield repeated scanpaths over the same regions during free-viewing (Stark & Choi, 1996; Laeng & Teodorescu, 2002) and image recall (Laeng, Bloem, D'Ascenzo & Tomassi, 2014).

The second assumption of Scanpath Theory is that scanpaths are top–down. One bottom-up account for repetitive scanpaths is that the visuo-sensory memory is limited in capacity (Yarbus, 1967, cf. De Angelus & Pelz, 200; Tatler, Gilchrist & Land, 2005). Another is that the same regions receive attention consistently because of their salience (Stark & Privitera, 1997, cf. Parkhurst, Law & Niebur, 2002). However, these explanations are exceeded by the ability of competing top-down processes for predicting repeated scanpaths, as later scanpaths were more similar to initial scanpaths than purely saliency-models, suggesting that scanpaths cannot be guided solely by salient—or bottom–up—properties of an image (Foulsham & Underwood, 2008; cf. Ellis & Stark, 1986; Henderson et al., 2007). Even the conventional bias among healthy populations reported by Brandt (1940) can be skewed to another bias through changes to top–down, neurological traits of the observer, such as right-hemisphere stroke patients (Mannan et al., 2005).

Accordingly, the second assumption of scanpath theory is that top-down processes drive gaze sequences. While the internal cognitive model of the observed scenario is constructed during the first viewing, Scanpath Theory proposes that subsequent viewings of the same or similar scenarios are a matching, recognition process, so that the cognitive model is eventually confirmed or rejected (Noton, 1970). Authors of the theory showed the cognitive model in action by experimentally manipulating visual stimuli: that is, lined drawings were displayed under low-level illumination, within a normally illuminated room (Noton & Stark, 1971). In so doing, viewers' cognitive control was especially important to compensate for the disrupted vision. During the learning phase, viewers revisited the same scanpaths (gaze sequences); during recognition, the scanpath developed during learning (i.e., initial viewing) re-emerged and did so repeatedly. Authors propose that this re-emergence of the scanpath from the learning phase was a feature-checking process (the "feature ring", p. 936, Noton & Stark, 1971), with each gaze target revisited in the same sequence as during the cognitive model construction, to confirm whether the stimulus is a match—that is, the same object.

Scanpath theory thus posits that an "intelligent vision approach" (Stark & Privitera, 1997, p. 2294) operates as an "internal attention mechanism" (Spitz, Stark & Noton, 1971, p. 753) that drives gaze sequences. Each scanpath that emerges is therefore "the read-out of the internal representation of pictures, the so-called 'cognitive model'" (Choi et al., 1995). As such, scanpath theory proposes that humans have a cognitive model, functioning as "the basis of our percept" (Itti & Koch, 2001, p. 201), guiding our gaze to match specified aspects of the scene to our expectations.

In support for the cognitive model, Llewellyn-Thomas (1968) reported that the eye appeared to follow a mental map for sequences of where to look next on a visual stimulus. The cognitive model also corresponds with Friedman's (1979) 'frame theory' of perception, whose 'frames' operate much like the scanpath theory's cognitive model. The frames are thus "semantic pattern detectors" (p. 316), which steer the observer's gaze direction towards critical regions of the visual field as part of a process in which the scenario is compared and contrasted with the internal frame for the anticipated object. Indeed, scanpath repetitions are faster and longer when image-transformations were incongruous with the original object—or the cognitive model (Friedman, 1979). This finding was paralleled by comparisons of scanpaths untransformed pictures. Scanpaths began significantly sooner and lasted longer regarding incongruent pictures—containing objects that do not belong in the overall scene—compared with congruent ones (Loftus & Mackworth, 1978). In art, also, the cognitive model is demonstrated by the way captions increase gaze towards otherwise un-seen areas of art (Hristova, Georgieva & Grinberg, 2010). Captions thus generated cognitive models for viewers to match using features within the associated visual stimulus.

The scanpath theory's proposed compare and contrast between the cognitive model and the viewed scenario relates to a number of top–down processes. Visual search is a major top–down process that corresponds with the cognitive model. Once viewers are accustomed to the locations of target objects comparable scenarios, self-consistency in scanpaths are employed by viewers (Choi et al., 1995). Indeed, initial gaze at new stimuli do not consistently relate to the scanpath that becomes characteristic of the viewer (Noton & Stark, 1971). Additionally, target/distractor studies have revealed visual search for targets among real-world (image) distractors to be dominated by top-down rather than bottom–up processes, since university students' visual search reaction times—and initial saccades (as instinctive measures of gaze)—were not significantly detrimented when there were coloured (i.e., salient, bottom-up) distractors present (Chen & Zelinksy, 2006). Target selection is substantially more likely when the target is identified to have direct value for one's overarching goal.

Object recognition and categorisation is another top–down process that echoes the cognitive model. Viewers commence recognition processes, regardless of the bottom–up vagueness in stimuli (Schyns & Oliva, 1994). That is, recognition reactions remained unchanged from those relating to standard, unmanipulated images, when experimental stimuli were manipulated through filters or adjusted to extreme frequencies. Additionally, humans respond within the first 150 milliseconds, when categorising whether an image contained an animal or not (i.e., ‘go/no-go task, Thorpe, Fize & Marlot, 1996). The capacity for recognition of complex stimuli is further shown by adults who could answer questions regarding many factors of images, namely gist (i.e., overall meaning or context), object presence, shape, colour, position and relative distances between objects (Tatler, Gilchrist & Rusted, 2003). Additionally, different parts of the first few seconds of viewing a stimulus seems dedicated to different factors of visual information (Tatler et al., 2003). It seems the human visual system computes a large amount of information within a short time, which can only be managed through top-down guidance. The same capability and tendency is seen in real-world studies (Land & Hayhoe, 2001). During tea-making, gaze is used for object identification and location, followed by the monitoring of required actions for implementing said objects. Depending on the task and the central object involved, the main object can be fixated upon for full durations of task performance. The kettle lid, for example, will be fixated upon for the full duration of its removal before the actor fills the kettle itself. Everyday gaze undergoes top-down guidance by each specific task at hand (Land & Hayhoe, 2001).

Task-relevance is a third top–down process relates to the cognitive model. Scanpaths, on art pieces for example, are significantly influenced by instructions given (Buswell, 1935). Yarbus (1967) and a replication of his procedure (DeAngelus & Pelz, 2009) demonstrated the significant difference in scanpaths when instructions were introduced to observers’ viewings—in the place of free-viewing. That is, scanpaths toward a painted scene significantly altered according to the instructions given to the viewer. For example, free-viewing found faces and the scene background to receive the most attention initially, but then the background receives more focused attention before the faces—and these regions alternate. In comparison, the figures (i.e., body shapes) received a sharp increase of attention during a memory task for clothing; by contrast, the task involving estimations of the financial situation of the people in the painting saw a decrease in facial attention and a significant increase in attention towards the physical setting (i.e., background, De Angelus & Pelz, 2009). An further extension to Yarbus' study further demonstrates the same influence of instructions on gaze towards a face and a portrait of the man, Yarbus, himself (Tatler, Wade, Kwan, Findlay & Velichkovsky, 2010). Using the same tasks as Yarbus (1967), Tatler revealed the same influence of task instructions on scanpaths towards facial stimuli. This importance of task-instructions in scanpath is further seen with task-only stimuli. Variation of task demands significantly alters the frequency and duration of attention given to each relevant gaze target during decision-making (Glaholt, Wu & Reingold, 2010). That is, when undergraduates were given six rather than two choices, each option was viewed significantly less often and for shorter durations. Glaholt further suggests that the 'manner' of visual processing differs when larger quantities of stimuli require processing, in that participants looked at significantly fewer items during second viewing for the six-item selection task, whereas there was no difference in the number of items viewed foe the two-item selection task (i.e., each of both option was viewed the same amount during the first and second trial; Glaholt et al., 2010). Changing the task changes the corresponding scanpath (see also van Diepen et al., 1998; Foerster & Schneider, 2013).

6.5.2. Scanpath Analysis: Expertise Shapes Scanpaths

Expertise is likely to play a significant role in scanpaths. Reasons for such expectations are as follows.

Since scanpaths are more guided by top–down processes, experts should produce significantly different scanpaths to novices. With expertise, observers gain in experience- and knowledge-informed cognitive models. In accordance with the general and teacher expertise literature, expert teachers' cognitive models are more developed and expansive than novices'. Therefore, not only will expert teacher scanpaths receive more top–down guidance, but this guidance will be significantly more refined and effective than any top–down guidance that novices have. Indeed, knowledge supplements visual information with memories (Henderson, 2003). With experience, observers look at empty regions in familiar settings when these regions have a history of being relevant (Henderson & Ferreira, 2004). For example, observers with greater experience in an office area are more aware that staplers are generally found inside desk drawers (Biederman, Mezzanotte & Rabinowitz, 1982; Friedman, 1979). In fact, object detection was significantly more reduced when an unusual object accompanied the target object than when the image was contorted on a superficial, bottom–up level (i.e., a background image showing through a foreground object, thereby disrupting interposition; Biederman et al., 1982).

Scanpaths change within individuals over time, as automisation occurs (Foerster et al., 2011). For example, university students looked decreasingly at their own hands and increasingly at the goals of hand movements as they automatized to a stacking task (Foerster et al., 2011). This development corresponds with the way expert gaze concentrates on task-relevant regions, whereas non-expert gaze is also directed towards task-irrelevant regions (e.g., Haider, Frensch & Joram, 2005; Kundel, Nodine, Conant & Weinstein, 2007). Viewers with expertise in a professional domain yield significantly different scanpaths to those yielded from naïve viewers. Having training (i.e., expertise) in art yields significantly different scanpaths on visual art stimuli, compared with those without training (Buswell, 1935). Correspondingly, scanpaths on stimuli within viewers' own expertise (e.g., realistic art) contrast markedly with the same individuals' scanpaths on stimuli outside of their expertise (e.g., abstract art, Zangemeister, Sherman & Stark, 1995). Among naïve (i.e., novice) viewers, scanpaths from the first-viewing of a stimulus resembles random baseline models more than scanpaths do from second-viewings

(Henderson et al., 2007): however, first-viewing scanpaths do not resemble this random baseline among experts (Humphrey & Underwood, 2009). Novice viewers' scanpaths additionally differ more across first- and second-viewings differ more among naïve viewers: in contrast, expert gaze sequences during first- (encoding) and second-viewing (recognition) significantly resemble each other (Humphrey & Underwood, 2009). Additionally, expert scanpaths diverged from saliency-based predictions of scanpaths more than novice scanpaths do (Humphreys & Underwood, 2009), demonstrating that expertise increased top–down guidance of gaze, displacing the influence of bottom–up features on gaze.

With experience, human gaze is significantly more likely to be directed towards regions that are rewarding (i.e., valuable, or greater economic value) compared with more visually salient regions, as shown by shorter latencies in gaze direction towards rewarded compared with non-rewarded gaze targets (Milstein & Dorris, 2011). More directly relevant to the present discussion of scanpath, Sohn and Lee (2006) found monkey gaze *sequences* to consist of significantly shorter gaze transition latencies, as gaze drew closer to rewarding targets, in contrast to non-rewarding targets. Moreover, it is the scanpath rather than the final gaze direction (or destination) that is consistently shaped by target rewards (Stritzke, Trommerhäuser & Gegenfurtner, 2009). Other than reward, 'intrinsic' value of gaze targets also receive visual attention more readily. Human faces, for example, trigger faster gaze changes (i.e., saccades) than neutral stimuli (Xu-Wilson, Zee & Shadmehr, 2009).

The role of expertise has already received some support. Firstly, cognitive load detriments the visual task-performance of undergraduates (Longstaffe, Hood & Gilchrist, 2014). That is, when participants had to memorise previously viewed locations, they were less able to resist looking at flashing (i.e., salient) regions compared with when they were not assigned this memory task. Given that novices are known to carry greater cognitive load than experts (e.g., Feldon, 2007), this finding suggests that experts have greater top–down control over their gaze and are less susceptible to bottom–up (i.e., salient) competitors for their attention. In more direct support, expert–novice differences have also been found among drivers in the frequency of a scanning strategy: this strategy involved looking at the road far ahead, mid-left, then mid-right. Expert drivers use this strategy more often than novices, but they also terminate this scanning process more promptly than novices to resume focus on the road mid-ahead (Underwood et al., 2003). Moreover, within-individual self-consistency are usually greater than across-individual similarities in scanpaths (Choi et al., 1995), suggesting that scanpaths are idiosyncratic. Thus, experiences specific to each individual guide gaze sequences above and beyond the influence of any visual properties in a stimulus.

6.5.3. Scanpath Analysis: Culture Shapes Scanpaths

Given that scanpaths habituate through experiences, culture can reasonably be expected to shape scanpaths in a comparable with to expertise. Rather than being a skill developmental process as in expertise, culture might function as a factor generating consistent contextual cues. Scenarios (e.g., an office or classroom) should possess consistencies that characterise their shared, over-arching culture. However, consistencies—or characteristics—of counterpart scenarios in another culture (i.e., an office or classroom in another culture) should be notably different, such as where equivalent task-relevant areas are ‘normally’ found. Teacher scanpaths—especially expert teachers’—should develop significantly different cognitive models (e.g., DeAngelus & Pelz, 2009), in accordance with the different classroom scenarios typifying each culture.

6.5.4. Scanpath Analysis: String Edit Distance

In scanpath tradition, scanpaths are compared between individuals to uncover top–down guidance from the internal cognitive model. The more comparable the experiences—and therefore the internal representation—of the scenario, the more similar the between-observer scanpaths will be. By comparing scanpaths within and across *a priori* groupings, factors contributing to the top–down guidance.

Scanpath comparisons involve calculation of *string edit distances* (SED) between the relevant scanpaths (Brandt & Stark, 1997). The SED is an extension of the Levenshtein distance to gaze data (Levenshtein, 1966), which involves the quantification of insertions, deletions and substitions to derive an overall editing cost before two sequences become identical. The SED is a similarity score that ranges from 0 to 1, with 1 being 'most identical' (i.e., identical). To derive this similarity score, each individual's scanpaths are translated into single letters for each gaze behaviour (or target) to form gaze *strings*. These strings are then truncated to one consistent length across all participants. A minimum (or maximum) string length of ten letters, for example, can be decided: all strings failing this minimum (or maximum) requirement are dispensed of. The remaining strings for each individual are compared with those of other individuals through an algorithm, eventually yielding a mean similarity score (i.e., SED). This similarity score is derived by the number of *edits*—both deletions and additions—on one of the two strings that are required before the two strings are identical. This number of edits is the *distance* between the two strings, which is normalised by dividing the distance by the string length. The similarity score (i.e., SED) is finally obtained by subtracting this normalised distance score from 1 (Figure 6.2). The expectation is that, the more experiences shared by individuals, the more similar their cognitive model (i.e., top–down guidance of eye movements), and the greater the similarity score will be when their scanpaths when compared.

Accordingly, the value of scanpath comparison lies in its capability to go beyond aggregated quantities of gaze behaviours to compare the *structure* of gaze patterns across participants by examining the whole sequences of gaze. Additionally, scanpath comparisons address sequences of *semantic* gaze behaviours, which is appropriate when geometric gaze coordinates are not available Indeed, an array of scanpath metrics have emerged since Brandt and Stark's (1997) time (for direct comparisons, see Anderson, Anderson, Kingstone & Bischof, 2014).

Most notably, alternatives to the SED take into account temporal and spatial properties of gaze behaviour, which SED does not. For example, in addition to factoring in sequential aspects of gaze, ScanMatch (Cristino, Mâthot, Theeuwes & Gilchrist, 2010) takes gaze durations and spatial (i.e., geometric) locations into account by taking the fixation location and duration data at the same time as the order of each fixation. Like the SED, ScanMatch compares strings of letters; unlike SED, it factors in gaze duration by an additional decision to represent a 'bin' of time (e.g., 0.50 second per letter). In the 'substitution matrix', ScanMatch addresses either spatial or semantic (non-spatial) similarities. Rather than the Levenshtein (edit-driven) distance, the Euclidean distance is computed instead, which is a geometric measure of distance between two points (or spatial gaze positions). Segments that are the same as each other receive the highest, positive score; dissimilarities between segments receive lower, negative scores. The researcher determines degree of similarity based on geometric distance, or based on a theory-driven view of distance (or similarity) between concepts (or gaze targets). ScanMatch's equivalent to the SED similarity score is the 'gap penalty', which represents increasing difference with increasing values. An extension of ScanMatch is MultiMatch (e.g., Foulsham, Dewhurst, Nyström, Jarodzka, Johansson, Underwood & Holmqvist, 2012). In all, MultiMatch takes into account five dimensions: namely, gaze direction, shape, length, position and duration.

However, the added computations of ScanMatch and MultiMatch are both improvements *and* limitations when compared with the SED. First, by taking temporal information (i.e., gaze duration) into account alongside spatial details, the decision on which channel to prioritise—temporal or spatial—is in fact problematic. Second, spatial details are not necessarily the central information of interest for every research question or possible with all eye-tracking data. That is, SED alternatives rely on consistency of the visual stimuli, such that they must be two-dimensional and by-and-large static. Yet, real-world eye-tracking data is three-dimensional, dynamic and unpredictable, making geometric coding is redundant. I therefore concluded that the SED is has both the flexibility (i.e., no requirement of spatial data) and detail (i.e., sequential analysis) that I needed as the logical next step in analysis.

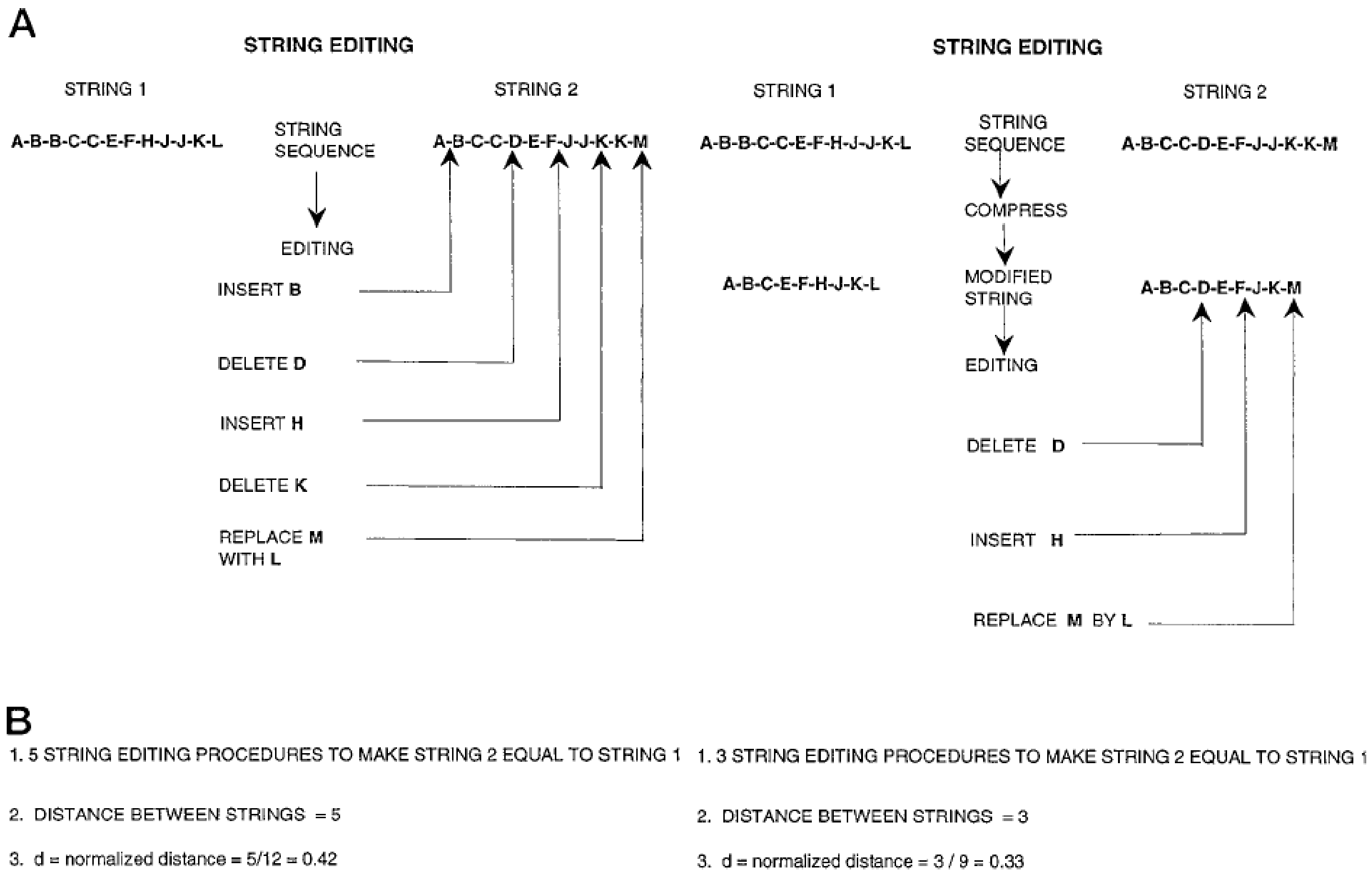


Figure 6.2. String editing procedure. The string edit distance is the number of changes that are needed by one scanpath out of two before both are identical. (Image from Choi et al., 1995, p. 445.)

Whereas bottom–up guidance for gaze is highlighted through between-observer consistency of scanpaths, top–down gaze is shown through between-observer difference—and within-observer similarity. Mannan leads this approach to identifying when top–down perception is taking place (Mannan, Kennard & Husain, 2009). Mannan showed the same image under several visual manipulations, through frequency filtering (Mannan, Ruddock & Wooding, 1995). Whereas the initial period of viewing a stimulus triggers significant between-observer similarity, image-viewing from the third second onwards yield significant between-observer differences and within-observer consistency (Mannan et al., 1995, 1997). It seems between-observer similarity occurs in scanpaths towards unfamiliar images, during which bottom–up guidance occurs, but top–down vision takes over once the viewer is accustomed to the stimulus. Top–down vision is further supported by the way hemianopic patients—whose unilateral lesions result in blindness to half of their visual field—use significantly different scanpaths (i.e., between-observer difference) to controls who have no deficits in their visual field (Pambakian, Wooding, Patel, Morland, Kennard & Mannan, 2000). Meanwhile, neither the hemianopic patients of their non-clinical counterparts required more gaze correction, as indicated by comparable refixations and gaze amplitudes (Pambakian et al., 2000). Thus, between-observer differences—and within-observer similarity—is a consistent indication of top–down visual guidance. Corresponding comparisons have been found through posterior cortical atrophy patients, who suffer from visual degeneration. In initial gaze, such patients yielded between-observer similarity when compared with controls, but subsequently differed notably as viewing continued (Benson, Davis & Snyder, 1988). Together, greater within-observer similarity was expected from the present sample, in anticipation of the top–down guidance of expertise and culture in teacher scanpaths.

So far, this thesis has demonstrated both the importance of expertise in shaping teacher gaze. Different measures demonstrate expertise variations in teacher gaze in different cultures. Some aspects are universal; others culture-specific. The present and final ‘part’ of this thesis aims to analyse teacher gaze in one further level of detail: that is, sequentially. As the literature above has demonstrated, scanpaths are repetitive within individuals because they are guided top–down (e.g., Stark & Privitera, 1997). This top–down guidance is referred to as a cognitive model (Noton, 1970), which is constructed during learning phases—or early-stage viewing—and accessed in face of the same scenarios as part of a recognition, or compare-and-contrast, process. The present thesis aims to apply the scanpath theory and comparison derived to teacher attentional gaze. I expected the role of teacher expertise to accord expertise findings so far in the scanpath literature (e.g., Humphrey & Underwood, 2009). I also extended the principle of cognitive model construction (e.g., DeAngelus & Pelz, 2009) by anticipating classroom culture to result in culturally-divergent expert teacher scanpaths. I additionally extended scanpath theory to the present dual-cognition approach to teacher gaze. That is, whereas traditional scanpath research has only applied to attentional gaze, I apply scanpath comparisons to communicative as well as attentional gaze.

7. CHAPTER SEVEN: METHOD

7.1. Research Questions

7.1.1. Research Question 1: What is Expert Teacher Gaze?

Do expert and novice teachers show different gaze patterns in the classroom, regardless of culture? That is, are there teacher gaze patterns that could be marks of universal expertise? Universal expert teacher gaze would be found when experts use significantly more (or less) of a particular gaze pattern than novices in the sample overall. Additionally, a teacher gaze pattern would be universal if experts in each cultural group both significantly differ from their novices—in the same way (e.g., both UK and Hong Kong experts use more eye contact than their respective novices).

Frequency Hypothesis 1: Expertise was expected to yield differential gaze 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 pedagogically important areas gaze targets, whereas novices' gaze proportions should reveal their lack of knowledge and misplaced pedagogical priorities.

Temporal Hypothesis 1: Experts will focus more on important classroom regions, namely students (e.g., Wolff et al., in press.), as shown by longer gaze durations towards students, greater gaze efficiency (i.e., focusing on classroom-relevant gaze types), greater gaze flexibility to respond to the classroom situation, and more consistent gaze strategies among experts than novices.

Scanpath Hypothesis 1a: To demonstrate the relevance of scanpath theory—and comparisons—to teacher scanpaths, I made intra- and inter-individual scanpath comparisons to demonstrate the cognitive model at work in the classroom context. I expected teacher scanpaths to be significantly more similar when they are compared within each individual than when comparisons are made across teachers (or individuals).

Scanpath Hypothesis 1b: Scanpaths of expert teachers should reflect significantly different (i.e., more developed) experiences to that of novice teachers. Expert teachers should therefore be more similar among themselves than when compared with novice teachers.

7.1.2. Research Question 2: What is Cultural Teacher Gaze?

Do teachers from Hong Kong and the UK display different gaze patterns? These gaze patterns would be prevalent in one cultural group (e.g., Hong Kong), but non-significant in the other (e.g., the UK). A cultural teacher gaze pattern would be found is one cultural group uses significantly more (or less) of a gaze pattern than the other cultural group. A cultural pattern would also be found if both experts and novices in one cultural group differ from their counterparts in the other cultural group—in the same way (e.g., both the experts and novices in the UK use more eye contact than their counterparts in Hong Kong).

Frequency Hypothesis 2: Culture was expected to yield differential gaze priorities, in accordance with differing priorities across cultures in teaching (e.g., Hofstede, 1986) and in vision—with differences in attentional holism (e.g., Nisbett & Miyamoto, 2005) and communicated friendliness of eye contact (e.g., Akechi et al., 2013). Together, Hong Kong teachers were expected to use lower proportions of student gaze than UK teachers.

Temporal Hypothesis 2: Compared with UK teachers, Hong Kong teachers were expected to show shorter gaze durations towards students, different efficient gaze types, greater gaze flexibility, and greater strategic consistency.

Scanpath Hypothesis 2: Teacher scanpaths should reflect significantly different cognitive models of classroom scenarios. Scanpaths should therefore be more similar when compared within cultures than when they are compared across cultural settings.

7.1.3. Research Question 3: What is Culture-Specific Expert Teacher Gaze?

Do *expert* teachers in Hong Kong and the UK display different gaze patterns? That is, which gaze patterns are predicted by a significant interaction between expertise and culture? Alternatively, which gaze patterns are significantly more prevalent among expert teachers in one cultural group than those in the other cultural group? Otherwise, which gaze patterns are significantly different between experts and novices in one cultural group, but non-significant in the other cultural group?

Frequency Hypothesis 3: Expertise in teacher gaze was expected to be culture-specific. Since student-oriented gaze and eye contact are less prevalent in East Asian attention (e.g., Miellet et al., 2013) and more related to negative messages in East Asian communication(e.g., Akechi et al., 2013), using less student gaze and more non-student gaze (e.g., teacher material gaze) might be East Asian signs of teacher expertise. In contrast, Western European expertise should be characterised simply by greater quantities of student gaze.

Temporal Hypothesis 3: Experts in differing cultures will diverge in what they regard to be important classroom regions to look at during attentional gaze (Hofstede, 1986; Norenzayan et al., 2002). Cultures will also differ in how they communicate with their gaze (Akechi et al., 2013). Moreover, cultural differences in task performance and vision will extend into the classroom (e.g., Imbo & Le Fevre, 2009). As such, teachers—especially experts—will differ across cultures in where they look at more, in the gaze types that are treated as more efficient (or relevant), in the gaze flexibility (i.e., rate of gaze transitions), and in how consistent their gaze strategy is.

Scanpath Hypothesis 3: The culture-specific nature of teacher expertise should be reflected in the way scanpaths of teachers within the same expertise *and* cultural group should be significantly more similar than those of teachers in different expertise *and* cultural group.

7.1.4. Research Question 4: How does Teacher Gaze Relate to Teacher Interpersonal Style?

How much does teacher gaze predict interpersonal style in addition to teacher expertise, culture and the expertise × culture interaction? Expert teachers are documented to show stronger interpersonal style (i.e., student-centredness) compared with novices (Wolff et al., 2014; van den Bogert et al., 2014). Yet, cultures differ in their optimal interpersonal styles, with East Asians giving lower importance to teacher–student relationships (Neuliep, 1997) and attributing learning benefits to ‘healthy’ classroom hostility (Li, 2002, 2003). On top of expertise and culture, teacher gaze is likely to play a role due to the connection between eye contact and emotional experiences (e.g., Adams & Kleck, 2005) and person perception (Einav & Hood, 2008).

Hypothesis 1: Given that teacher expertise has corresponded to effective interpersonal classroom behaviour in the past (e.g., McCroskey et al., 1995), the present hypothesis was that experts would use significantly different gaze to novices—in correspondence with the experts’ more developed interpersonal style.

Hypothesis 2: Given that culture has been associated with different conceptualisations of expert teacher interpersonal behaviour (e.g., Hofstede, 1986; Park &

Kim, 2008), the present analysis was expected to yield culture-specific interpersonal gaze in correspondence with culturally diverse interpersonal styles.

Hypothesis 3: Given that research has related teacher gaze with interpersonal dimensions (e.g., Wirth et al., 2010), the present expectation was that measures of teacher gaze will be significantly associated with interpersonal measures (i.e., interpersonal style, agency, communion).

7.2. Participants

Forty teachers participated: 20 from the UK and 20 from Hong Kong. Schools were approached on the basis of their conformity with their national curriculum and if they consisted of the first to the fifth years of secondary education. Schools meeting these criteria were approached through an information letter addressed to the headteacher and a headteacher's consent form. One UK and two Hong Kong schools agreed to participate. The author ensured that the designated contact person in each school understood the present requirements for each category of teachers, expert and novice. The contact person in the UK was a Psychology teacher: this contact person sent an email to all teaching staff in his school, requesting that volunteers participate in this study. In addition, he specified that newly qualified teachers were of particular interest (for the novice group). He also encouraged highly rated teachers in the staff community to put themselves forward (for the expert teacher group). In Hong Kong, a member of the school leadership got involved: they selected and approached teachers who they deemed to best suit the study requirements. Selected teachers agreed most of the time; when they did not, the contact person approached alternatives who also suited the given criteria.

7.2.1. Participants: Expertise Classification

Experts were identified from among the participating school populations using the criteria described by Palmer, Stough, Burdenski and Gonzales (2005). Palmer's classification system comprised of four criteria: (1) years of teaching experience, (2) teacher performance ratings (1 being 'Outstanding'; 4 being 'Inadequate'), (3) social nomination (i.e., senior leadership identifying the teacher as an expert), and (4) additional qualifications (e.g., extra school responsibilities, Masters-level qualifications). Novices, in turn, were those who least conformed to these criteria; teachers were selected who contrasted with the experts as much as possible within the school sample.

With social nomination (criterion 3) as the predictor variable, I ran MANOVA comparisons of teachers who were nominated experts with those nominated as novices on the other three criteria for teacher expertise (Palmer et al., 2005). When experts were compared with novices on each of Palmer's criteria, the experts were very different from the novices overall, according to MANOVA, $F(3,37) = 14.22$, $p < .001$, $\eta_p^2 = .54$. In terms of Palmer's individual criteria, teaching experience (criterion 1) was significantly different, with experts ($M = 15.15$ years) having significantly more years' experience in the profession than novices ($M = 3.88$ years), $F(1,39) = 33.28$, $p < .001$, $\eta_p^2 = .46$. Performance ratings (criterion 2) were also significantly different among experts (M = 1.40) compared with novices (M = 2.40) in their performance ratings, $F(1,39) = 13.90$, $p < .001$, $\eta_p^2 = .29$. Experts ($M = 2.40$) had significantly more additional qualifications and memberships (criterion 4) than novices ($M = 1.19$), $F(1,39) = 14.99$, $p = .001$, $\eta_p^2 = .26$. The designations of expert and novice teachers in the present study were thus well corroborated across all of Palmer's criteria. Full demographic details are shown in Table 7.1 and 7.2.

Table 7.1

Teacher Demographics

			Age		Gender		Years' experience				Perf Ratings		Add Quals	
Culture	Expertise	*N*	*M*	*SD*	M	F	*M*	*SD*	Min	Max	*M*	*SD*	*M*	*SD*
HK	Expert	10	44.00	9.94	3	7	19.30	7.47	10	32	1.60	.84	2.70	1.49
	Novice	10	26.00	3.16	3	7	4.60	3.24	1	10	2.70	.95	1.10	1.10
UK	Expert	10	35.00	8.16	4	6	11.00	7.36	3	28	1.20	.42	2.10	.74
	Novice	10	33.00	10.33	4	6	3.23	2.48	2	10	2.09	.70	1.27	.65

Note. 'Perf Ratings' abbreviated performance ratings which are reverse-scored (1 bring 'Outstanding'; 4 being 'Inadequate'); 'Add Quals' abbreviated additional qualifications.

Table 7.2

Student Demographics

			Student age				Subject			
Culture	Expertise	*N*	*M*	*SD*	Min	Max	Sci/ Maths	Native Lang	Hum	Other
	Expert	332	14.19	1.37	12	16	0	4	4	2
HK	Novice	456	13.39	1.71	12	16	2	1	4	3
	Expert	290	11.10	.97	11	14	2	0	7	1
UK	Novice	254	12.14	1.06	11	14	3	2	4	2

Note. Student demographics are included as indications of the way class groups varied across teachers. ‘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.

7.2.2. Participants: Cultural Classification

The cultural grouping for each teacher was based mainly on whether they taught in the UK (‘West’) or Hong Kong (‘East’)—that is, a *geographical* criterion. To corroborate the cultural difference between the two groups of teachers, I put cultural *heritage* eligibility requirements in place (Soto, Perez, Kim, Lee & Minnick, 2011). Hong Kong teachers were only eligible for this study if they, their parents and their grandparents were all born in Hong Kong *or* Mainland China. Likewise, UK teachers were only eligible if they, their parents and their grandparents were all born in the UK.

Additionally, I compared teachers in their cultural *inclination*, as proposed by Hofstede (1986). For the present cultural inclination data, items were adapted from Triandis and Gelfand (1998, p. 120). Because this data was collected after the research visits were made, I have to maximise my chances of participants responding to this data request. To this end, I abbreviated the original questionnaire by selecting two out of four items for each dimension—horizontal-individualism, vertical-individualism, horizontal-collectivism and vertical-collectivism. Horizontal dimensions emphasise equality; vertical dimensions emphasise hierarchy. Horizontal individualism therefore describes people who want to be unique and different from others whereas vertical individualism emphasises the self being higher status than others. Horizontal collectivism describes the self as being similar to others (e.g., with common goals) whereas vertical collectivism emphasises the importance of the in-group such as the family. For each dimension, I chose items with the highest loadings as published by Triandis and Gelfand (1998)—that is, with the exception of one item in VI, where I chose the item with the third highest loading, alongside the first highest loading. I deviated from selecting the highest loadings in this case in order to appeal more sensitively to the target population in mind: I believed that few teachers would consciously identify with a statement declaring that “winning is everything", since they would be expected to teach the opposite each day (with the growth mind-set being a more politically accepted value system than its alternative; Dweck, 2006, 2012). Consequently, both horizontal-individualism items related to self-reliance, one vertical-individualism items related to work performance and the other to staying ahead of colleagues, both horizontal-collectivism items related to colleagues' success, and both vertical-collectivism items related to family duties (see Table 7.3). Seven-point ratings were derived (0 being 'not important at all'; 7 being 'most important).

Table 7.3

HVIC items selected for the present study

HVIC Dimension	Theme	Item	Factor loading	Thesis inclusion
Horizontal Individualism	Self-reliance	I'd rather depend on myself than others.	.68	Y
		I rely on myself most of the time; I rarely rely on others.	.66	Y
	Independence	I often do "my own thing."	.55	
		My personal identity, independent of others, is very important to me.	.40	
Vertical Individualism	Work performance	It is important that I do my job better than others.	.59	Y
		Winning is everything.	.56	
	Staying ahead	Competition is the law of nature.	.53	Y
		When another person does better than I do, I get tense and aroused.	.45	
Horizontal collectivism	Colleague success	If a co-worker gets a prize, I would feel proud.	.67	Y
		The well-being of my co-workers is important to me.	.64	Y
	Social time	To me, pleasure is spending time with others.	.61	
		I feel good when I cooperate with others.	.49	
Vertical collectivism	Family duties	Parents and children must stay together as much as possible.	.61	Y
		It is my duty to take care of my family, even when I have to sacrifice what I want.	.60	Y
		Family members should stick together, no matter what sacrifices are required.	.52	
	Respect for others	It is important to me that I respect the decisions made by my groups.	.45	

Note. Factor loadings were derived from Triandis and Gelfand (1998). The notated items (marked 'Y') were used in the present thesis to measure participants' cultural inclinations.

I compared Hong Kong and UK teachers on their cultural inclinations. To do this, I first generated an aggregate score for each HVIC dimension (e.g., horizontal collectivism) by adding participants' ratings then dividing this value by two. Since the theoretical framework of this thesis has only referred to collectivism as compared with individualism, the distinction between horizontal and vertical aspects of each, collectivism and individualism, were collapsed to maintain the focus on these two dimensions. To do this, an interaction term was then produced between the aggregate horizontal and vertical scores for each, collectivism and individualism. Teachers' geographical setting (i.e., Hong Kong vs. UK) were set as predictors in a repeated-measures ANOVA model, with the collectivism and individualism scores as levels of the outcome variable, 'cultural inclination'.

Geography did not significantly predict cultural inclination (p = .76), according to repeated measures ANOVA. In fact, Hong Kong teachers (M = 17.21) were non-significantly *more individualistic* than UK teachers (M = 14.76); UK teachers (M = 22.47) non-significantly *more collectivist* than Hong Kong teachers (M = 21.13), when aggregate scores ranged from 0 to 36 (since 6 was the maximum rating for each HCIV item). These findings were surprising. However, given that cultural research has long given geography precedence over self-reported cultural inclination (e.g., Senju et al., 2013; Zhang, 2006; Zhou, Peverly & Xin, 2006) such that the present research has on balance been exceptionally thorough on this issue—and participants' cultural heritage was strongly supported a geography-based grouping—the present thesis also bypassed the unexpected cultural inclination results to prioritise geography for participants' cultural classification.

7.3. Design

7.3.1. Design: Real-World Research

The value of adopting a real-world design for exploring teacher expertise is two-fold. First, real-world research is better suited to investigating applied—including teacher—expertise. Second, real-world settings are more relevant for exploring gaze.

7.3.1.1.Design: Real-World Gaze

Vision researchers have recently been calling for real-world studies (Risko, Laidlaw, Freeth, Foulsham & Kingstone, 2012), underscoring the difference between real-world and simulated gaze (Schilbach, 2015). The difference between schematic drawings of and images of real human faces is significant, as shown by Hietanen and Leppänen (2003) who used both types of stimuli as cues for gaze direction. Human adult gaze follows the direction of schematic faces more readily than images of real faces, which authors suggested is due to the additional social 'noise' present in real images. The viewer is distracted by subtle features in the image of the real face—the potential age or ethnicity of the viewed person, for example. Whilst laboratory processes are useful for factoring out such 'distractions' of the real-world, applied research into professional behaviours like classroom teaching need to take into account the many dynamics that will always be present. Greater ecological validity is therefore more relevant to the present thesis. In support, viewers are more likely to detect emotions in videoed faces than in static images of the same emotion (Schultz & Pilz, 2009, 2010;), echoing the efficacy of greater approximations of real-world experiences of social gaze to obtain true responses in each given directional or emotional scenario. Furthermore, mimicry—or learning—responses in the brain take place more readily in response to dynamic faces than static stimuli (Sato & Yoshikawa, 2007).

Laboratory and naturalistic settings also yield different gaze patterns. In one study, university students were individually asked to walk along a designated path while wearing a mobile eye-tracker. During this time, a pedestrian passed them by ('walking' condition;

Foulsham, Walker & Kingstone, 2011). The following week, participants returned to be shown a video of a pedestrian ‘passing by’, while their eye movements were recorded by the desktop (i.e., static) eye-tracker (‘watching’ condition). Authors found that students distributed their gaze across a larger area and gazed at each target—especially the pedestrian—for shorter durations in the walking condition. The difference between the social gaze—viewing other people—in the laboratory and in the real-world was thus obvious: the potential for one’s gaze to make an impact on the social situation in the real-world is absent and irrelevant in the laboratory. Teacher attention necessarily involves gaze towards other people, namely students, and must be expected to differ in the real-world compared with the laboratory. Therefore the value of an investigation into teachers’ real-world use of eye gaze is clear.

The real-world is also the most representative setting for exploring communicative gaze. The ease of designing and simulating procedures resembling attentional gaze is demonstrated by the availability of such studies. However, simulating full interactions—in which communication, or information-giving—takes place is more difficult to represent. In the real-world, people adjust their messages, verbal and non-verbal, according to the morphing cues and reactions given by their audiences. That is, while we are talking (giving information), we are all the while observing (seeking information), monitoring whether and how we should be conveying new information or amending the manner in which we deliver our message (cf. Hietanen & Leppänen, 2003). Indeed, Hietanen et al. (2008) found the presence of a real person to activate whole neurological systems of motivation, whereas the image of a person did nothing at all. It is clear that it would be extraordinarily difficult to simulate the whole classroom experience that is central to teaching in laboratory conditions.

7.3.1.2. Design: Real-World Expertise

For expertise, a number of researchers have highlighted the importance of going into the real-world context in order to examine professional expertise. Dreyfus and Dreyfus (2005) define expertise development as the appropriation of one's behaviour to the real-world situation. In this view, isolated laboratory experiences do not accumulate to bring—and do not constitute valid experiences for exploring—genuine expertise. Correspondingly, Sternberg outlines the prototype view of expert teaching by citing strictly real-world examples to illustrate each point (Sternberg & Horvath, 1995). Ericsson (2014) defines expertise as being domain-specific, emphasising the need for full reproductions of tasks in a profession for a genuine investigations of expertise (Bédard & Chi, 1992; Ericsson & Lehmann, 1996; cf. Dipboye & Flanagan, 1979; Ilgen, 1985; Levitt & List, 2006). Hence the extensive expertise investigations into chess, medical imagery and musical sight-reading—all of which can be fully simulated in the laboratory—where much expertise research has taken place, but little on complex professions such as classroom teaching. Related, all teacher expertise research has been conducted in the real-world, much of which has been qualitative and case study based (e.g., Livingston & Borko, 1989). What laboratory research has been conducted have utilised real-world stimuli, such as videos of classroom events that themselves took place in real-world classrooms (e.g., Wolff et al., in press).

The real-world is too complex for laboratory processes to be likened to performance of the same task in naturalistic settings—and teaching is a notoriously complex profession (e.g., Berliner, 2001) which is best explored within the context of the profession (i.e., real-world classrooms; Rich, 1993). As such, teacher expertise has a particular need of real-world investigation for a valid map of teachers' classroom behaviour. Moreover, since intuition has proven to be one major facet of teacher expertise (e.g., Berliner, 2004; Rubin, 1989), and if intuition is synonymous with tacit (i.e., practical) intelligence (Wagner & Sternberg, 1985), then one must explore this practical-level of teacher behaviour in the practical arena, namely the real-world classroom. Related to the greater intuition that expert teachers have is their stronger decision-making compared with novices (e.g., Fadde, 2007). Accordingly, part of the decision-making literature has long taken their research into the real-world, in order to obtain a valid and representative problem domain. In particular, Gary Klein has led the Naturalistic Decision-Making movement (NDM, since Klein, 1993), which is characterised by pursuit of what expert decision-makers do on a process-level (i.e., the stages of decision-making and looking beyond the aggregated, ultimate decision made), in-situation and in-context basis (Lipshitz, Klein, Orasanu & Salas, 2001). Moreover, the NDM framework acknowledges and emphasises the fundamentally different decision-making processes of the complex, time-pressured task in contrast to the simple, slower and more ponderous tasks (Klein & Klinger, 1991), with the former requiring an entirely different research approach: this applies to teaching.

7.3.2. Design: The Expert–Novice Comparison

Two approaches exist for exploring expertise (Chi, 2006), the absolute and the relative approach. One is to identify and document the behaviour of *experts only* in the domain of interest: the ‘absolute’ approach to viewing and investigating expertise (Chi, 2006). For example, Radišić and Jošić (2015) identified one teacher on the basis of authors’ own judgement, following a two-year observation of 35 teachers. This teacher was also highly rated by colleagues in her school and had over ten years’ experience in classroom teaching. Based on this one expert teacher, Radišić conducted qualitative analysis of diary accounts, videotaped lessons and lesson plans—treating all these as distinct markers of how expert teachers operate. Altogether, Radišić used multiple concurrent (Chi, 2006) measures as indications of absolute expertise. As another example of an absolute approach to teacher expertise, Ainley and Luntley (2007) only documented expert teacher patterns, with ‘experts’ being those with at least ten years’ teaching experience. In all, the absolute approach can be taken through retrospective or concurrent indicators, or through an independent index, of exceptional professional performance (Chi, 2006).

The second approach to investigating expertise is to identify *the way experts differ from* non-experts: the ‘relative’ approach (Chi, 2006). Chi (2006) highlights that this, relative, approach takes an incremental view of expertise, with experts and novices sharing a *spectrum* of ability and performance, but at varying points on this developmental spectrum. One relative approach involves the use of a scale to categorise participants as either expert or non-expert—again with the view to making comparisons. This approach should not be confused with the absolute approach because experts are not identified according to an a priori score they are in the absolute approach. Rather, experts in the relative approach are identified according to their score in comparison with and as distinct from lower performers (or non-experts). Byra and Sherman’s (1993) teacher expertise study did just this where ‘experience’, the sole measure of expertise, was explored as a predictor of adaptability in decision-making. Brekelmans, Wubbels and van Tartwijk (2005) documented the way teachers’ interpersonal style developed over the course of two decades. Thus, Brekelmans used years’ experience in teaching as the measure of teacher expertise and the predictor of dimensions of teacher interpersonal style (i.e., agency and communion). Clermont, Borko and Krajcik (1994) explored the relationship between teacher expertise and Chemistry-related pedagogical knowledge. In doing so, Clermont treated years’ experience in chemical demonstrations as an interval measure for expertise, but added participants’ self-rated confidence (on Likert scales—another continuous measure) in performing these demonstrations as a corroborating measure of expertise.

While the relative approach can treat expertise as an interval level predictor of task performance, it can also treat expertise as a categorical predictor variable. For example, Luft (2001) simply extricated experts from novices on the basis of whether participants were undertaking a teacher training programme: those still in-training were novices; those who were teaching in schools were experts, whose years' experience ranged from three to seventeen years. In terms of eye movement research, Cortina distinguished experts from novices in terms of their position in relation to each other: experts were 'mentor' teachers and novices were these teachers' mentees (Cortina et al., 2015). The relative approach to expertise can thus involve two distinct groupings, in which experts and novices are in direct contrast to each other on one critical factor or more.

Within the relative approach to expertise, combined factors can be used to distinguish experts from novices in a categorical way. Expert teachers have beendistinguished from novices by virtue of their years' experience, their seniority of position among colleagues, the peer consensus of their expertise: these factors are combined or used separately to investigate how expertise predicts task performance. Indeed, combined factors are usually employed for identifying teacher expertise. Teacher expertise studies have usually selected the 'very best', in the sample population, on multiple levels, as their experts, while novices are usually those still undergoing professional training, or still undertaking their probationary period. Livingston and Borko (1989, 1990) classified teachers as experts only if they obtained high performance ratings as teachers, yielded high student achievement outcomes, and were recommended by their leadership team as especially high-performing teachers. Leinhardt's (1989) expert teachers were those who yielded exceptional student performance growth (i.e., greatest increase over the year) as well as bringing about student end-of-year achievement in the top 20 per cent within that year group. Tan (1996) identified expert teachers mainly on the basis of their years' experience in the profession, but also on account of the school leadership's recommendation of them as experts as well as their ongoingly strong performance (i.e., student grades and in-school reputation). Correspondingly, Berliner's (2001, 2004) theory of teacher expertise is an incremental one, in which teachers go through stages of skilfulness until they reach expertise.

The present thesis uses the teacher expertise classification constructed by Palmer et al. (2005). Palmer's classification system was formulated based on a review of teacher expertise studies that were conducted in school settings. The review was limited to studies which employed careful definitions of teacher expertise before exploring them. That is, studies included were those that took into consideration a systematic view of expertise such as exceptional performance (e.g., Sternberg, 1977), knowledge (e.g., Ericsson & Lehmann, 1996) and domain-specificity of the individual's high performance (e.g., Glaser, 1985). As such, studies which only compared teachers across expertise in terms of 'experience' (e.g., Housner & Griffey, 1985) were excluded. This selection process yielded 27 studies. Palmer then coded the factors used across these studies to represent teacher expertise. In all, criteria for teacher expertise consisted of years' experience, social nomination (e.g., chosen by the school administrator as an expert), social or professional membership (e.g., mentor for the local university's teacher-training programme) and performance criteria—which were either normative based (e.g., best in the school), criterion based (e.g., in-class evaluations), or both. In terms of the coded criteria for teacher expertise, two-thirds of the reviewed studies used *experience*, *social nomination* and *performance criteria*. Half the studies used *professional membership* for teachers to qualify as experts.

Palmer's classification of teacher expertise (see Section 7.2.1. Participants: Expertise Classification) was chosen for a number of reasons. First, the relative view on teacher expertise is the most compelling reason for using Palmer's criteria. That is, the goal of maximising the usefulness and applicability of the present thesis for beginning teachers. The absolute view has often been criticised for not viewing professional expertise to be attainable by individuals without 'innate' talent (Chi, 2006; Simonton, 1977).

Secondly, Palmer et al.'s (2005) criteria for teacher expertise takes into account multiple approaches to identifying expert teachers. By meeting the requirements of Palmer's criteria, the present sample incorporates the conventional measure of expertise, namely years' experience. Palmer's criteria recommend five years or more in the teaching domain as one marker of teacher expertise, since that would be the time allowed for sufficient hours of deliberate practice (6500 hours, cf. Ericsson et al., 1993): this cut-off was used in the present research where possible. It is emphasised that the conceptualisation of teacher expertise in the present research takes into account additional marks of teacher expertise: namely, the objective measure of each teacher instructional quality as evidenced by their observed classroom performance (i.e., classroom ratings). This means that, even where experts' experience is comparable with novices' (Table 7.1 above), experts' classroom performance will consistently exceed that of novices. A further, objective measure of the teacher's genuine performance and instructional capacity are the additional qualifications and responsibilities they have been awarded. More subjective, qualitative insight from authoritative sources on the teacher's classroom practice is also consulted in Palmer's criteria: that is, the school leadership recommendation and the in-school reputation of the teacher concerned. Thus, a thoroughly triangulated approach to identifying expert teachers was taken in accordance with the relative and documented approaches to this decision.

A third and final reason for choosing the Palmer et al.'s (2005) relative and expert–novice approach was so that I would continue established practice in visual expertise research. Jarodzka investigated fish expertise by contrasting experts to novices, with experts being professors or advanced PhD students and novices being Biology undergraduates (Jarodzka, Scheiter, Gerjets & van Gog, 2010). Van Meeuwen compared expert–novice gaze during air traffic control problem-solving (Van Meeuwen, Jarodzka, Brand-Gruwel, Kirschner, de Bock & van Merriënboer, 2014). In this study, experts were air traffic controllers with at least two years' experience on the job and novices were those who were in their first months of the air traffic control training programme. In exploring clinical expertise as a predictor of diagnostic accuracy and gaze patterns, Jaarsma, Jarodzka, Nap, van Merriënboer and Boshuizen (2014) identified experts are those with at least ten years' experience and novices as those who were still in medical school. Additionally, in using an expert–novice comparison to identify expert teacher gaze, I continue the research design of existing teacher expertise research. Both Van den Bogert and Wolff used the Palmer criteria in their laboratory comparisons of teacher expertise. Palmer's classification of teacher expertise was thus used to make inferences about teacher classroom management perceptions (Van den Bogert et al., 2014), for comparing experts' cognitions when viewing classroom management scenes with novices' (Wolff et al., 2014) and for distinguishing between expert and novice gaze distribution across a two-dimensional, video classroom scene (Wolff et al., in press). Yamamoto and Imai-Matsumura (2013) conducted a study comparable with Van den Bogert and Wolff's by showing expert and novice teachers videos of classroom scenes. Yamamoto's definition of teacher expertise was their years' experience in the profession. The only known real-world expert teacher gaze study is Cortina's, which compared expert with novice teachers by comparing mentor teachers with their mentees (i.e., their associated teacher-trainee). The latter two approaches to defining teacher expertise was not satisfactory to my mind, so I adopted the former approaches which was dramatically more comprehensive for the complex profession and skillset that teaching is, namely Palmer's classification of teacher expertise.

7.3.3. Design: The Cross-Cultural Comparison

Alexander (2001) outlines a number of conditions that justify culturally comparative research in education. The first is to have a solid basis from the research literature for expecting cross-cultural differences in teacher behaviour, including their gaze. The first of Alexander's (2001) condition for making cross-cultural comparisons is grounded in the literature review above, which documents the rich and diverse differences that can be found in the way differing cultural groups use their gaze patterns. Cultural groups also differ in what they regard as 'good teaching practice' as well, including the differential student preferences for the way they learn in the classroom. Likewise, teachers' interpersonal styles can reasonably be expected to differ—which should be reflected in their gaze patterns.

The second of Alexander's (2001) conditions for carrying out cross-cultural comparisons of teacher behaviour (i.e., gaze) is to ensure that teaching practice is not investigated on its own. Rather, teacher behaviour should be explored in conjunction with teachers' cultural values. This condition is fulfilled in my thesis by two measures additional to the the geographical settings in which teachers worked. The two corroborating measures I obtained were teachers' cultural identity (cf. Soto et al., 2011) and their cultural values (i.e., collectivist vs. individualist; cf. Triandis & Gelfand, 1998; see Section 7.2.2. Participants: Cultural Classification) to corroborate the differences I expected between the two 'cultural' groups, which were expected from the two geographical settings. My use of Palmer's criteria for teacher expertise also addresses this condition (Alexander, 2001). The two (out of four) criteria in particular that meet this requirement is the social opinion of the teacher's expertise and the additional qualifications and responsibilities, which are awarded within the cultural context, decided upon by authorities in the specific school within its respective cultural paradigm).

The third of Alexander's (2001) conditions for cross-cultural teacher investigation is to take into account the multi-layered system of the teaching profession. Teaching is a multi-layered profession by virtue of being relevant to multiple stake-holders: parents, in-school authorities, local and national policies, and not least the students themselves. Berliner (1994) echoes this criterion for embarking on cross-cultural research seems less relevant to the present behaviour of interest, namely teacher gaze. Specifically, it is unlikely that parents or national authorities have explicit requirements on how teachers ought to use their gaze. However, the way parents and authorities wish for teachers to operate in and manage their classrooms, including their clarity of communication to and immediacy with students, will be shaped by culture-specific priorities. Since the relative importance parents place on student achievement—or enjoyment—varies from one culture to another, the related teacher behaviour and classroom climate preferred by networks in each culture should fluctuate accordingly. The investigation of culture-specific teacher behaviours therefore indirectly addresses this requirement that Alexander (2001) prescribes.

7.3.4. Design: Teacher-Centred Gaze

The present gaze data was sampled from teacher-centred parts of lessons. Teacher-centred parts of lessons were chosen as opposed to alternative activities for a number of reasons. Firstly, all lessons in every subject are more likely to involve and require this process at some point every lesson than any other learning activity. Even if the teacher only uses teacher-centred sessions to introduce the lesson and remind students where they are in the overall syllabus, that is still a teacher-centred part of the lesson that is comparable across classes and more likely to occur in lessons across class-groups (of varying subjects) than any other learning activity. Teacher-centred learning is therefore the most naturalistic requirement of teachers and the best forum on which to compare teacher gaze.

Since teacher-centred sessions involve the teacher at the forefront of all classroom events, teacher-related data—such as teacher gaze—is also most concentrated during these than any other type of learning activity. In particular, information being transmitted during these sessions is likely to relate directly to the teacher, which makes teacher attention (information-seeking or information-receiving) particularly important. Information that the teacher gives during this time is likewise relevant to all students in a way it is not during most other learning activities, accentuating the need for and chances of communicative processes making the relevant impact.

Teacher-centred learning additionally maximises control over extraneous classroom variables. Since the teacher assumes the single, unified, focal event of interest, the rate of unforeseen classroom events is diminished significantly compared with alternative learning activities. For example, off-task discussions or student 'walkabouts' are remarkably unusual during teacher-centred sessions compared with those during student group-work. Van den Bogert et al.'s (2014) video description illustrates this contrast, with no misbehaviours during the teacher-centred session and an instant onset of disruptive behaviour as group-work (i.e., cooperative learning) began.

7.4. Apparatus

7.4.1. Apparatus: Eye-Tracking

Tobii 1.0 glasses eye-trackers were used to record teacher gaze (see Figure 7.1).

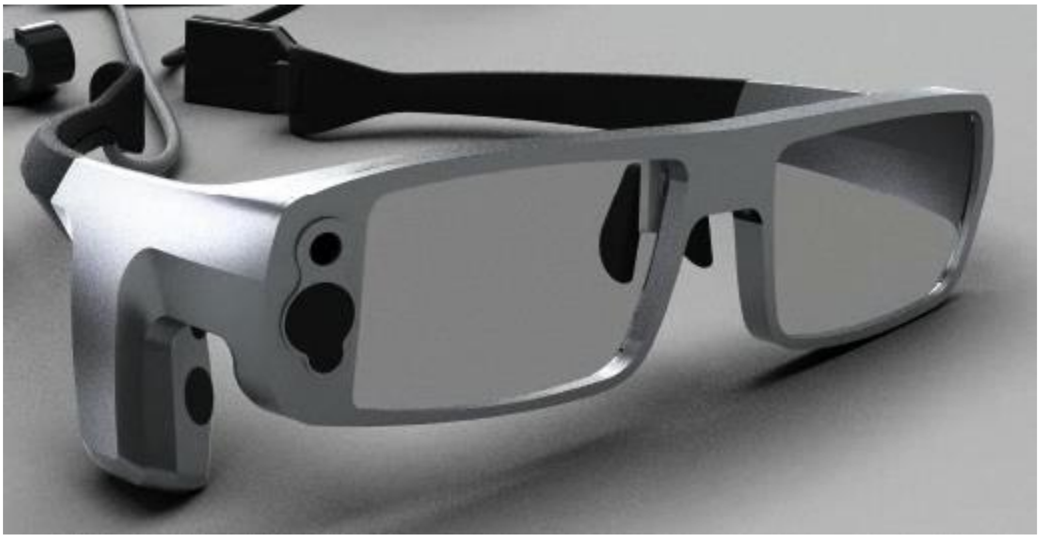


Figure 7.1. The Tobii 1.0 eye-tracking glasses that were used for data collection in this thesis.

Data rate with these glasses was 30Hz and calibration involved nine gaze points. To calibrate, an infra-red marker (Figure 7.2) is used to cover nine gaze points (Figure 7.3A) as shown on the Recording Assistant (Figure 7.4). Calibration of this eye-tracker thus involves instruction of nine regions of the participant's visual field through a nine-point calibration, which is conducted on a flat, preferably white, surface that is one metre away from the participant (Figure 7.3B).

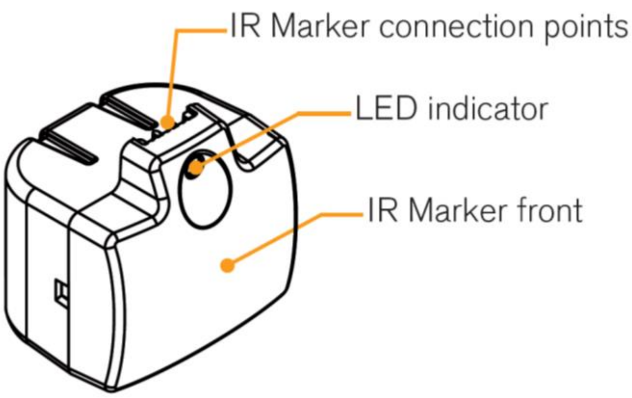
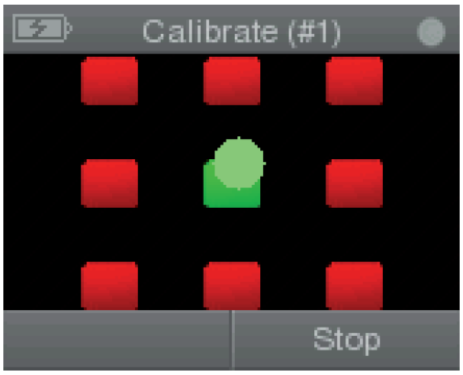
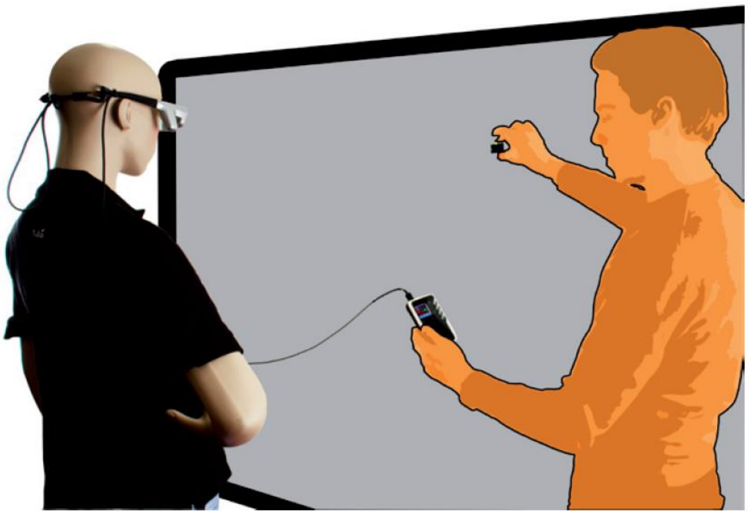


Figure 7.2. Infra-red marker for calibration. (Image by *Tobii AB.*)



(A)



(B)

Figure 7.3. The calibration pattern (A). This is an example display from the Tobii 1.0 Recording Assistant. Each block goes green when that area of the participant's visual field has been successfully calibrated. Before then, every block is red. The researcher (B) needs to move the infra-red marker across the participant's visual field to meet these nine points. (Images by *Tobii AB*.)

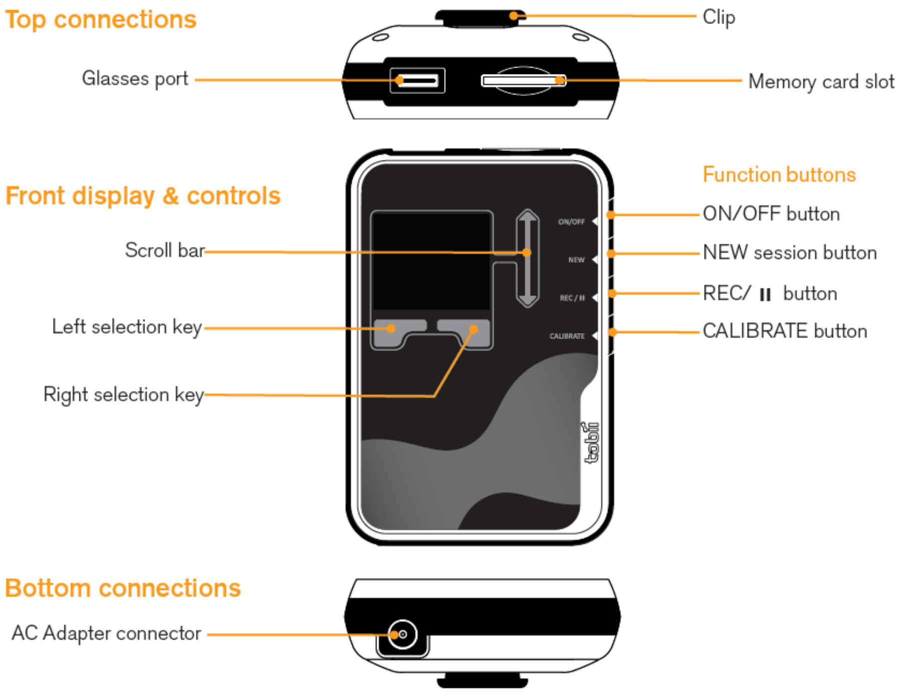


Figure 7.4. Recording Assistant for Tobii 1.0 eye-tracking glasses. (Image by *Tobii AB*.)

The researcher activates the eye-tracking process itself through the Recording Assistant. This eye-tracker records three levels of data (Figure 7.5). First, the scene camera records the viewed environment itself. Second, the eye-tracking sensor records the pupil movement, whose position is corroborated by two additional lights emitted onto the eyeball (an established feature in eye-tracking technology). Third, the microphone records sound heard around the participant, including the participant's and interactants' speech.

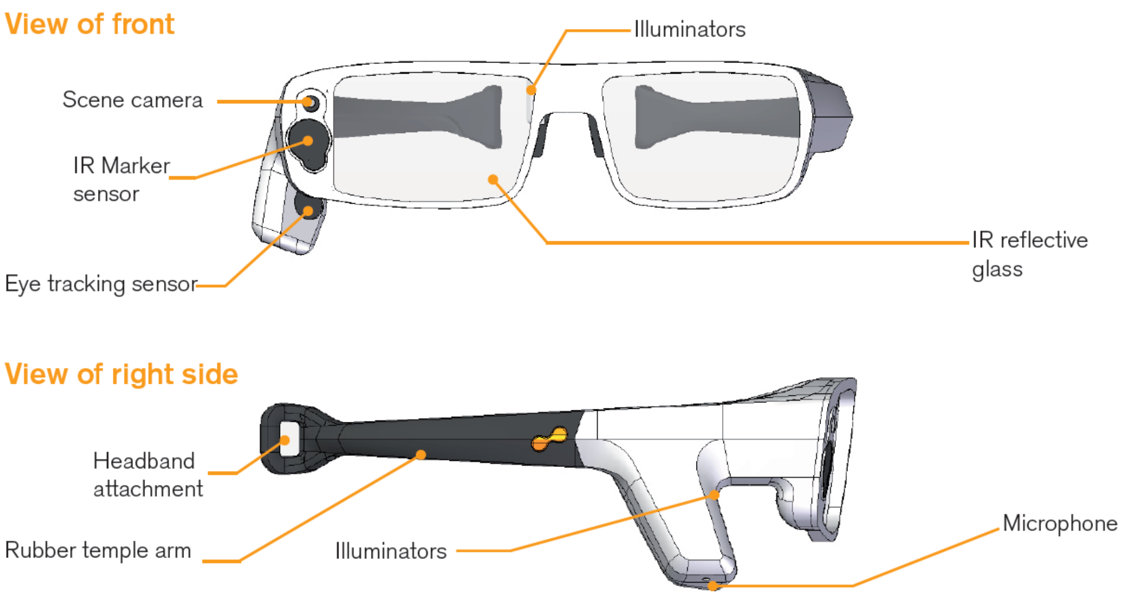


Figure 7.5. Tobii 1.0 eye-tracking glasses that were used for data in this thesis. (Image by *Tobii AB*.)

Once uploaded, the glasses yielded a 640 by 480 px video, capturing 56 degrees horizontally and 40 degrees vertically. The participant's gaze is overlaid onto the scene recording (Figure 7.6), while the sound is played back as in any audio-video recording.

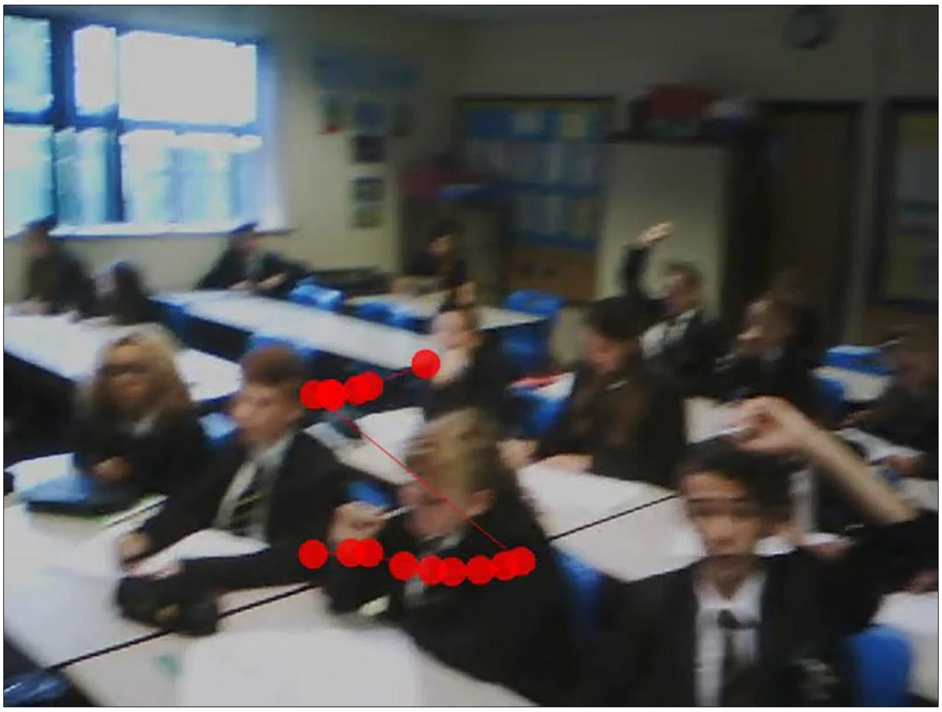


Figure 7.6. Screenshot example of gaze replay from the present teacher gaze data. The red dots and (scan)paths indicate where the teacher was looking.

7.4.2. Apparatus: Questionnaire on Teacher Interaction (QTI)

The Questionnaire on Teacher Interaction (QTI) is based in the Model of Interpersonal Teacher Behavior (MITB; Wubbels et al., 2012) and was used to measure an aspect of classroom climate, namely teacher–student interaction. The student perspective was obtained on each teacher's interpersonal style. Theo Wubbels developed the Questionnaire on Teacher Interaction using Leary's Interpersonal Adjectives Checklist (La Forge & Suczek, 1955). The Interpersonal Adjectives Checklist itself did not to relate to educational settings sufficiently (Wubbels & Levy, 1993). For example, the statement, "obeys too willingly" does not apply to teachers at all (p. 163). Additionally, Wubbels found the Interpersonal Adjectives Checklist not to contain sufficiently extreme items for student perceptions of teachers and which classrooms needed to teachers exercise with unique intensity. For instance, the 'can be uncertain' items were meant to apply to most teachers (i.e., 90 per cent), yet students only indicated these for about half of their teachers (i.e., 60 per cent; Wubbels & Levy, 1993). Finally, Wubbels and Levy (1993) highlighted that the Interpersonal Adjectives Checklist required students to make stark yes-or-no decisions, when students often prefer and require more precise—and therefore detailed—options (e.g., a little). The Questionnaire on Teacher Interaction (QTI) was therefore developed, first in the Netherlands (Wubbels, Créton & Hooymayers, 1985). The American (English language) version was subsequently developed, containing 64 items (Wubbels & Levy, 1991). Eventually, a 48-item Australian (English language) one was produced (Wubbels, 1993) which I used for the present thesis.

The Chinese QTI was used with the Chinese sample in the present thesis. Because the QTI was used to make cultural comparisons of teacher interpersonal behaviour, cross-cultural reports on the QTI is relevant. An early QTI comparison across major cultural groupings was made between Singapore, Brunei and Australia by Den Brok, Fisher, Wubbels, Brekelmans and Rickards (2006). The Malay version had been translated from the Australian to Malay then back-translated to English again (Scott & Fisher, 2001). This Malay version was then used in Singapore and Brunei by Den Brok et al. (2006). While specific meanings of each octant (and their corresponding items) were somewhat different across cultures, Den Brok et al. (2006) demonstrated that the octants could be understood in terms of the two major dimensions across cultures, in accordance with the MITB. Specifically, although the East Asian QTI responses were higher in communion than anticipated, responses in all three regions correlated strongly with the theoretical positions proposed by the MITB.

The QTI that I administered for the present thesis was developed by Wei, den Brok and Zhou (2009). Four classes in mainland China were administered the Chinese translation of the QTI (Wei et al., 2009). This Chinese translation was produced by Wei himself from the American QTI (Wubbels & Levy, 1991), corroborated and adapted by three additional ‘experts’ in the Chinese language. In this first attempt at validating the Chinese QTI, Wei ran regression analyses to confirm the predictive power of each, leadership and communion, as predictors of the outcome variable, student achievement, and class membership was inputted as a covariate. Construct validity for the Chinese QTI was thus obtained, based on the confirmatory factor analysis supporting the MITB model.

Since 2009, however, Wei was able to obtain a sufficiently large sample for multilevel analysis (Wei, Zhou, Barber & den Brok, 2015). This time, 19 classes were involved and the QTI was shown to be able to distinguish between classes (i.e., groups with different teachers; accounting for 30% between-class variance), showing the Chinese-QTI to have promising capability for distinguishing between individual teachers’ interpersonal style. One issue of present relevance, however, was that the ‘student freedom’ octant demonstrated low across-class reliability in both the 2009 and 2015 analyses. Other than that, teachers’ within-class ratings for the remaining seven QTI scales (or octants) were shown to be highly reliable (λ=.81 to .94).

7.4.3. Apparatus: Screen-Recording Software

The screen-recording software, Camtasia, was used during cued retrospective reporting (Section 7.5.1. Procedure: Data Collection). Camtasia is installed separately and in addition to the eye-tracking analysis software, Tobii Studio 3.2.0. While the gaze replay is presented to participants, I recorded the screen (i.e., gaze replay) through Camtasia. Camtasia’s audio-recording capability was used simultaneously to record verbal prompts and questions put to the participant, to sustain the flow of their commentary regarding their in-class cognitions. Since the eye-tracking software interface was recorded through Camtasia, the cued retrospective reporting verbalisations could subsequently be aligned with the teacher’s in-class gaze timestamps, so that the participant's cued retrospective speech could be used to interpret in-class gaze and verbalisations.

7.5. Procedure

7.5.1. Procedure: Data Collection

The teachers wore eye-tracking glasses during one ten-minute 'teacher-centred' segment. The eye-tracking glasses were calibrated by the researcher just before recordings took place. To protect calibration accuracy, teachers were explicitly requested not to move their eye-tracker after calibration. 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, I administered a questionnaire (Appendix 1 and Appendix 2) to both students and the teacher. Ethical guidelines were stated explicitly to both staff (including teaching assistants, if present) and students. In particular, confidentiality and anonymity were emphasised, especially to protect teacher credibility. The completion of the QTI took 10-15 minutes. Some items proved consistently challenging; these were rephrased for students when necessary (i.e., when students asked for clarification). When the questionnaire was completed and collected from all students and the teacher, I left the classroom and the lesson resumed.

An interview appointment was made with each participating teacher during the eye-tracking or questionnaire session. The appointment was scheduled to last 30 minutes. During the interview, the purpose and functionalities of Camtasia were explained. Next, I explained the gaze replay interface (especially what and where the gaze cursor was) and the task of cued retrospective reporting (CRR) to the participant. The explanation consisted of the following points: "You are to provide a live commentary of your thoughts during the part of the lesson that is playing at each point. The videoed classroom events and your gaze replay are meant as a memory prompt for you. Try to keep a continual commentary going throughout this interview. Any pauses you have should ideally last no longer than three seconds. Shall we practise this task a bit first?" A short section of that participant's gaze replay was presented before I demonstrated how he or she might perform CRR in relation to that section. The participant then had a chance to practise the task before the 'real' CRR commentary began. Once ten minutes of CRR was completed, the participant was asked to fill in demographic details relating to culture (Section 7.2.2. Participants: Cultural Classification) and expertise (Section 7.2.1. Participants: Expertise Classification). The participant then gave signed consent for the use of their data on this project and was finally debriefed.

The CRR process was also used as an opportunity to check the quality of recorded eye-tracking data (Section 7.2.3. Procedure: Eye-Tracking Data Inspection). In fact, due to time limitations and the intensive nature of gaze analyses alone, the present thesis made no further use of the CRR than for data quality assurance. No CRR analysis is presently reported.

7.5.2. Procedure: Coding

I systematically coded teacher gaze and simultaneous verbalisations. Both the teacher gaze and simultaneous verbalisations were categorised gaze and cognitive codes respectively from the start to the end of analysed periods of eye-tracking. Codes were applied comprehensively: that is, the full duration of the data was classified to constitute a specific gaze and didactic behaviour simultaneously. For a full list of codes applied and analysed, see Table 7.4.

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 focused gaze at student, student scan, student material, teacher material, other (i.e., miscellaneous) and unsampled gaze. Focused student gaze were comparable with fixations, towards students: this code was applied when the gaze cursor overlaid students for more than four key frames. This approach has been used by others in mobile eye-tracking educational research (e.g., Franchak, Kretch, Soska & Adolph, 2011; Hanley et al., 2015). Student scans were student-oriented gaze, during which the gaze cursor overlaid students for less than four key frames. Unsampled gaze was coded when the gaze cursor disappeared from gaze replay. Through both the pilot and actual coding process, these gaze codes proved adequate and comprehensive in addressing all possible gaze behaviours.

Simultaneous verbal data was coded manually while playing the video in real-time (i.e., full playback speed). The simultaneous verbal data from eye-tracking recordings was divided into five cognitive (or didactic) behaviours: address behaviour (of students), straight talk (to measure communicative gaze), questioning (to measure attentional gaze), references to notes, logistics. Some codes that were originally coded separately from this list were merged with these wider categories due to insufficient occurrences and to increase parsimony: collapsed within straight talk are *rhetorical questions* and *teacher demonstrations*; within refer notes are *references to the PowerPoint* and any *screen-based presentations* (e.g., PowerPoint animation and videos). All simultaneous verbalisations have also been fully transcribed to corroborate when each cognitive (or didactic) behaviour is taking place.

Table 7.4

List of gaze and didactic codes applied to eye-tracking data

Code type	Code name	Code criteria
Gaze		
	Focused	Fixation on student; more than four key frames on the same student (individual or cluster)
	Scan	Saccade on student; four or fewer key frames on each student (individual or cluster)
	Student material	Gaze cursor overlaying students' textbook, handout, or stationary
	Teacher material	Gaze cursor overlaying teacher's PowerPoint slide, textbook, handout
	Other	Gaze cursor overlaying non-instructional and non-student targets
Didactic		
	Address behaviour	Teacher asking for specific behaviour from students (e.g., stop talking, look up, turn page)
	Question	Teacher asking the whole class questions and looking for responses; information-seeking
	Straight talk	Teacher giving information and lecturing or instructing; information-giving
	Refer notes	Teacher referring to learning materials, including student and teacher materials
	Logistics	Teacher organising him or herself (e.g., setting up PowerPoint, looking for board pen)

Note. By student 'cluster', I mean 2-3 students. Didactic codes relate to teachers' classroom (instructional, pedagogical) behaviour.

7.5.3. Procedure: Eye-Tracking Data Inspection

Three approaches were available to ensure quality of eye-tracking data coding. Firstly, the parallax correction tool is available with the data analysis software, Tobii Studio 3.2.0., which is provided with the eye-tracking glasses. Since these eye-tracking glasses were monocular (i.e., only recorded the movement of one eye), the usual risk of convergence (common in binocular eye-tracking), as depth of vision increases, is avoided. However, monocular eye-tracking holds the alternate risk of inaccurate parallax with increasing depth of vision. The eye-tracker is calibrated at one metre away from the participant, yet classroom teaching involves more a great variety of visual depths. Parallax occurs when, at closer distances, the gaze overlay (or gaze cursor) risks being offset to the left; at further distances, it risks being offset to the right. However, Tobii Studio has the capability of specifying the range of visual depth, to adjust for where the gaze overlay is placed. The present research took advantage of the default parallax correction settings which modify the gaze cursor location according to parallax problems that are typical of differing depths of vision. As an additional measure, the code, Unsampled, was applied when the gaze cursor disappeared. Thirdly, each participant was asked to point out concerns, if they arise, regarding the location of the gaze cursor during the cued retrospective reporting process (Section 7.5.1. Procedure: Data Collection; Van Gog, Paas & van Merriënboer, 2005).

Because only one coder was involved, intra-rater reliability was inspected. Intra-class correlation (ICC) was selected as a measure of agreement between the first coding attempt (Time 1) and the second (Time 2). In addition to its flexibility to various data types (e.g., and to reveal agreement where an objectively correct code is not possible (Müller & Büttner, 1994). ICC also has the capacity to reveal the *magnitude* as well as presence of agreement (Hallgren, 2012), ICC was chosen because it is appropriate as a measure of observational reliability when continuous data was involved, which applies in the present thesis. ICC suits continuous data because it is an ANOVA with random effects, which are the basis for variations between ICC models: the ‘random effects’ are those whose variation is of concern and how an ICC model is chosen. Other than suiting continuous variables, existing research has consistently used ICC to assess intra-rater reliability (e.g., Beck, Schaefer, Pang & Carlson, 2011; Hinton-Bayre & Geffen, 2005; Hohn et al., 2015; Puig et al., 1999; Roberts & Norman, 1990), giving precedence to the present use of it.

One out of a number of ICC models must be chosen for reliability analysis. Whereas ICC[1] (i.e., one-way random ICC model) is a comparison of each data point between Time 1 and Time 2 (thereby treating rater and ratee [i.e., codes applied] as one single effect [hence one-way]), ICC[2] (i.e., two-way random ICC model) is an averaged similarity between Time 1 and Time 2. ICC[2] is therefore concerned with rater variation and analyses this separately from ratee varation, yielding estimates for two effects (hence two-way). Meanwhile, ICC[3] treats rater variation as a fixed effect, which is appropriate when the coders involved are the only coders the research is concerned with. ICC[2] is therefore appropriate for Time 1–Time 2 comparisons of the same rater’s coding (Landers, 2015; Müller & Büttner, 1994; Shrout & Fleiss, 1979). Given the interchangeability of the ICC with Kappa (Fleiss & Cohen, 1973; Landis & Koch, 1977), the interpretation of ICC values is the same as for Kappa. Namely, rater agreement at ICC=.60 is acceptable, ICC=.70 is good and ICC≥.80 is high. Meanwhile, it should be noted that the value given to an ICC value varies, some more lenient in general (Cichetti et al., 2006), others stricter on intra-rater assessment as in this thesis (Eilasziw, Young, Woodbury & Fryday-Field, 1994). It is also conventional to report the limits of the ICC value for coder agreement by reporting the associated 95 per cent confidence interval (e.g., Bartko, 1966, 1976; Ioanan, Polley, McShane & Dobbin, 2011), which ranges from 0 to 1.

In this study, intra-observer reliability assessment was undertaken by first asking the coder to re-code part of the gaze recordings. Two members of each sub-group (e.g., Western novices) were selected for re-coding; the first two out of ten minutes re-coded. Given that intra-class correlation is in essence an ANOVA model, the usual parametric assumptions should be met by the measures being compared. Moreover, coding from Time 1 and Time 2 cannot be exactly matched in terms of precise duration of each segment compared: duration measures should therefore be standardised in order to truly be compared. As such, frequency measures for totals of each gaze type were transformed into *proportions* for linearization and relativisation; duration measures were transformed into *duration per visit* for relativisation. Both the frequency (ICC[2] = .91, 95% CI[.83, .95]) and the duration (ICC[2] = .88, 95% CI [.77, .94]) measures yielded high reliability scores. The coder and the coding scheme were therefore ratified.

7.5.3.1.Procedure: Questionnaire Data Inspection

Data from the QTI was also assessed. The reliability of students' questionnaire responses was first assessed using Cronbach's alpha. For agency, reliability reached α = .72; for communion reliability was α=.85. These alpha levels are satisfactory.

Nonetheless, it would be more theoretically valid to take into account the nested nature of this data. Student responses were, therefore, additionally assessed by deriving the intra-class correlation (ICC) among students with the same eye-tracked teacher. Because only ratings (or observations) were of interest with no additional variable (e.g., observers, as in gaze coding, Section 7.5.2. Procedure: Coding), a one-way random model of ICC (ICC[1]) was used. Given that this was a thesis focused on teachers, students' ratings related to and were nested within teachers. Since multiple teachers (or student groups) were involved, the ICC calculation was a multilevel one, with student ratings at level 1 as the level 1 random effect and teacher (i.e., student group) as the level 2 random effect (Lüdtke, Robitzsch, Trautwein & Kunter, 2009; Mainhard, Brekelmans & Wubbels, 2011; Miller & Murdock, 2007). By ICC[1] standards (a 'high' ICC[1] = .30, Kline, & Kozlowski, 2000; Mainhard et al., 2011), the students in the present study were highly consistent with each other regarding teachers' agency (ICC[1] = .55) and communion (ICC[1] = .22).

The structure of students' responses to the QTI was assessed in terms of the theory itself. The QTI consists of an orthogonal relationship between two dimensions: agency and communion. This orthogonal relationship was supported by the low correlation between agency and communion factors, $r = .15$, $p < .001$ (two-tailed). Next, exploratory factor analysis was employed to confirm that items relating to each dimension were satisfactory. The Varimax rotation was used in accordance with the orthogonal nature of the QTI construct, to extract two factors—agency and communion. When both Hong Kong and UK responses were analysed together, communalities of individual octants ranged from .46 (octant 7 'admonishing') to .72 (octant 4 'student responsibility') and the total variance explained following rotation was 56.32 per cent, demonstrating some explanation of octant scores by the QTI framework. The octants were also sequenced in the order that complied with the theoretical framework, from 1 to 8 (see Figure 7.7). From Figure 7.7, it appears that student ratings of teachers were skewed towards agency, as octants with more theoretical relevance to communion—understanding (octant 3) and dissatisfied (octant 6)—are closer to agency (component 2) than they should be. Still, the theory's circular structure is more or less present.

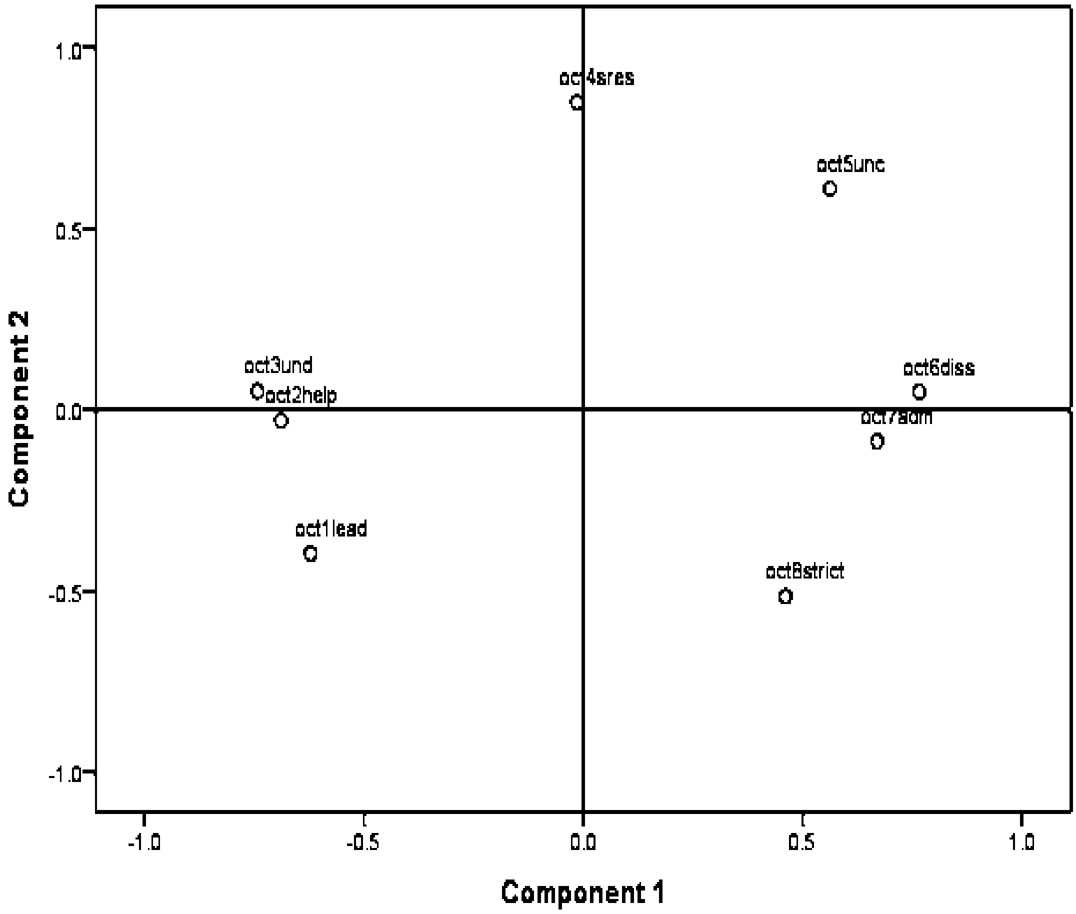


Figure 7.7. The principal component plot for students' QTI responses, when agency and communion were extracted as the sole—orthogonal—factors of interest. Component 1 = Agency; Component 2 = Communion; oct1lead = Leadership, oct2help = helpfulness, oct3und = understanding, oct4sres = student responsibility, oct5unc = uncertainty, oct6diss = dissatisfied, oct7adm = admonishing, oct9strict = strictness.

Finally, I went beyond the orthogonal relationship between agency and communion and take into account the circular structure of the QTI. The CircE package in R (Grassi, Luccio & di Blas, 2010) was employed for circumplex fit analyses of the students' questionnaire responses. Fit indices were satisfactory (Root Mean Square Error of Approximation (RMSEA; Browne & Cudeck, 1993; Hu & Bentler, 1998) = 0.05; Standardized Root Mean Square Residual (SRMR; Bentler, 1995) = .05, 90%CI[.051,

.054]; Bentler (1990) CFI = .86; Bentler-Bonett NFI (Bentler & Bonett, 1980; Hu & Bentler, 1999) = .82; Adjusted Goodness of Fit (AGFI; Jöreskog & Sörbom, 1981; McDonald & Marsh, 1990) = .88). Indeed, this satisfactory fit is shown in Figure 7.8 below, with scales clustering together in their respective octants. Octants are also distributed in the correct order, in accordance with QTI theory.

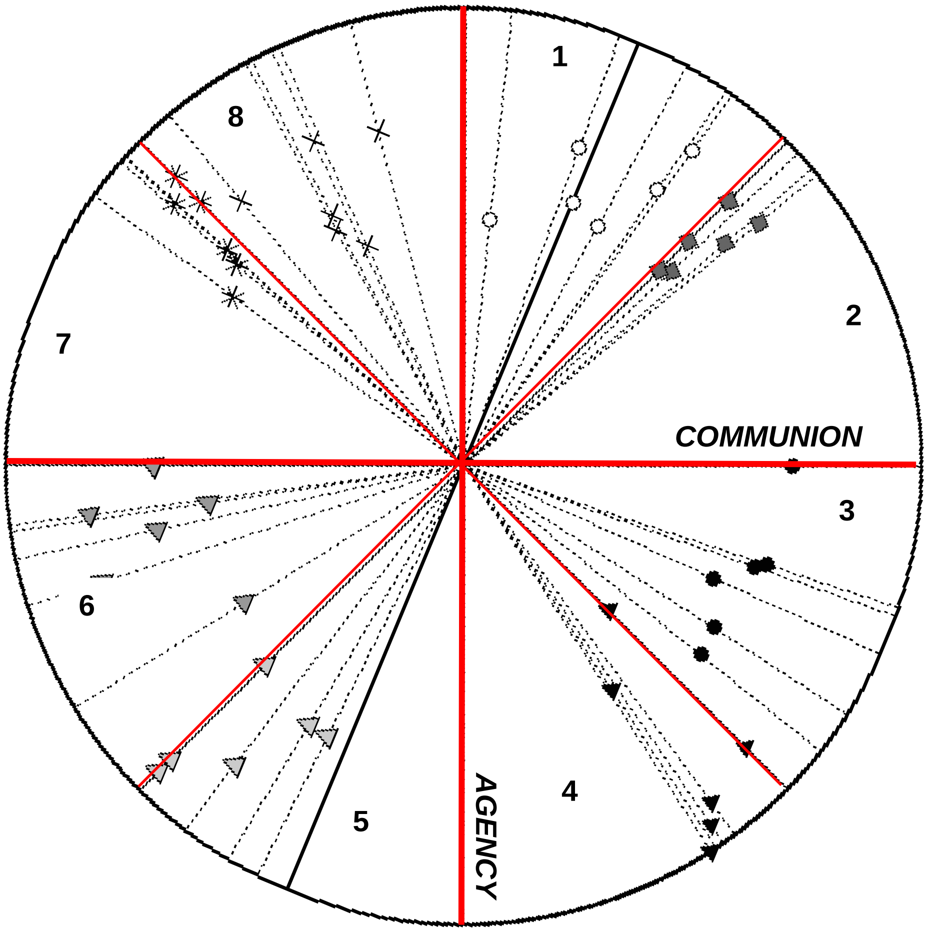


Figure 7.8. The circumplex plot for students' QTI responses, when they were analysed together as one circumplex structure. Each item in the questionnaire is shown by a marker; each octant (or scale) possesses one consistent marker shape. This graph shows that the items belonging to the same scale are indeed clustered together. The octants are also emerging in the correct order, according to the QTI theory.

7.6. Analysis

7.6.1. Analysis: Deriving Gaze Events

Each gaze event was aligned with either attentional or communication as its co-occurring cognition. The gaze was identified according to the cognitive code it 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. In other words, the didactic gaze event, ‘attentional gaze’ for example, was isolated by analysing the gaze behaviour *while* the teacher was using the cognition of ‘attention’. To illustrate, one attentional gaze event might be attentional student fixations, which would be identified from when the teacher is using the cognition of attention (i.e., questioning) whilst looking at students with focused (rather than scanning) gaze. Admittedly, one cannot be fully confident that attentional gaze in the present data involves attentional processes exclusively, or communicative processes in communicative gaze. However, the benefits of the present real-world design and that the present research initiates delineation between attentional and communicative gaze surpass the occasional similarity between attentional and communicative gaze.

7.6.2. Analysis: Deriving attentional and communicative gaze

Three streams of time-driven data were derived from each participant through the present procedure. The first data stream was the participant’s (i.e., teacher’s) gaze; the second data stream was the participant’s simultaneous verbalisations (i.e., cognitive codes); the third data stream was the CRR verbalisations (not analysed beyond gaze data inspection). These three streams of data were collated onto one spreadsheet for each participant, in a time-driven manner. Both sources of verbal data were related to the gaze data; that is, both verbalisation datasets were organised according to the gaze codes' timestamps (Figure 7.9).

Timestamp	Gaze event	Didactic event	Teaching transcript	Interview transcript (CRR)
			Transcript	Transcript
00:00:00.0	GlassesRecordin			
00:06:14.31	Start	Straight talk	...but uh...	OK, so, um, I was um attempting to
00:06:14.31	Focused Group	Straight talk		
00:06:19.472	Other	Straight talk	it's not famous for that reason, Sam? [student answering] YES! Well done...	
00:06:19.563	Teacher T&L Iter	Straight talk		
00:06:21.153	Teacher T&L Iter	Straight talk	Very good, ok so! [name of place] is a place, and it's a famour place beca	Um, gauge what students understand about the, information that they'\
00:06:22.133	Scan	Straight talk		
00:06:22.511	Focused Group	Straight talk		
00:06:25.17	Scan	Straight talk	famous, accident. And what is used to have there and still does, but doe	Um looking through, so I'm, scanning to, just,
00:06:25.189	Other	Straight talk		
00:06:25.326	Focused Group	Straight talk		
00:06:26.253	Other	Straight talk		
00:06:26.510	Focused Group	Straight talk		
00:06:27.300	Other	Straight talk		
00:06:27.369	Focused Group	Straight talk		
00:06:30.939	Other	Straight talk	is a nuclear powerplant that had had a... disaster. OK.	Who, is engaged and who is listening, and, maybe identify some people
00:06:31.8	Scan	Straight talk		
00:06:31.76	Other	Straight talk		
00:06:31.272	Focused Group	Straight talk		
00:06:32.210	Teacher T&L Iter	Straight talk		
00:06:33.999	Teacher T&L Iter	Question		
00:06:34.957	Other	Question		
00:06:35.95	Focused Group	Question	Green Peace! Come on, who got green peace, how many people got gree	That um, want to offer responses, and also try and encourage
00:06:57.121	Other	Question		
00:06:58.325	Scan	Question		
00:06:58.464	Other	Question		
00:06:59.923	Focused Group	Question		

Figure 7.9. Data layout for synchronising gaze, simultaneous and retrospective (i.e., CRR) verbal data.

The two main gaze events of central interest in this thesis were attentional and communicative gaze. Attentional gaze was derived from the ‘questioning’; communicative gaze was derived from ‘straight talk’. In other words, attentional gaze consisted of all gaze codes (or behaviour) occurring alongside the cognitive (or didactic) code of ‘questioning’. Likewise, communicative gaze consisted of all gaze codes occurring alongside straight talk.

To illustrate each cognition, *attentional gaze* occurred during teacher talk such as the following: “Green Peace! Come on, who got green peace, how many people got green peace [clicking fingers] Danny, well done, what do you know about green peace, anything? [student answering]…. you can what, sorry Danny that last bit… [student answering] [laughing] it is the environment, excellent, well done [points at another student] yeah? [student answering] mm. [student answering] mmhm, [student answering] mm, mmhm? [student answering] yeah. [student answering] Very good, they're about protecting the environment, excellent, well done, plutonium? Anybody heard of plutonium? Yes, connor. [student answering] very good, anybody else heard of it? Yeah? Tony? Back to the Future, very good…” (UK Expert, Participant 24).

Communicative gaze occurred during teacher talk such as this: “Why do we get certain effects - certain responses in countries like England, we looked at Sheffield, and also, …in Bangladesh. A poorer part of the world. … So far, we've got a revision case done on Sheffield, everybody's done, we've got, one, on Bangladesh that most people have done. Ok? And some people have even started to compare, the differences, we need to continue that today. So our learning challenges today, are, ok, so they're our challenges today. We're gonna get Bangladesh finished, we're gonna make sure we've compared both, case studies. If, like [student name] there, we've compared both case studies, effects and responses, we're then gonna do a little summary table, which will, help you for what's happening in a week today" (UK Expert, Participant 37).

7.6.3. Frequency Analysis

The present thesis recognises the value of frequency measures in exploring differing dimensions of teacher gaze (cf. Kliegl, Olson & Davidson, 1982). Specifically, I used gaze proportions with the expectation that they would unveil expert patterns in each, attentional and communicative, teacher gaze. Proportion measures are related to deliberate decisions being made by the teacher enabling us to tap the way teachers actively use their gaze in the classroom.

7.6.3.1.Frequency Analysis: Measures

In the frequency analysis, the gaze code, *student scan,* was collinear with *other gaze*. I needed to dispense of one gaze code from analysis. Because it held more conceptual potential, *student scan* carried greater risk of misinterpretation and therefore the more conservative choice to be removed. *Student scan* was accordingly removed from the frequency analyses, leaving only focused gaze at students to represent teacher gaze towards students. As such, focused gaze at students is referred to as *student gaze* in frequency analyses.

To confirm that the present analysis needed relativized frequency measures, I compared cultures on untransformed gaze counts of each, attentional and communicative, gaze. East Asian teachers emerged to display more communicative gaze overall than their Western European counterparts; Western Europeans used more attentional gaze. I 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., focused + student material + teacher material + other) by the same participant. It was gaze proportions that I analysed for expertise, culture and interaction effects.

7.6.3.2.Frequency Analysis: Statistical Analysis

For statistical analyses of proportion measures, I employed beta regression analyses. Whereas linear regression involves the prediction of interval scaled variables which are characterised by a normal (or Gaussian) distribution, beta regression involves the prediction of probability variables (i.e., $0 < y < 1$) whose distribution typically violate the Gaussian assumption of linear regression. Beta regression thus allows for proportion measures to be interpreted in terms of what they originally represented. Beta regression analysis therefore take advantage of beta distributions for their flexibility in catering for the typically asymmetric—non-normal—distribution of proportions. In other words, 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 other 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 any absent heteroscedasticity was not a problem.

Alongside standard regression values (*B*, s.e., *t*, *p*), R^2 values were also computed. The present R^2 value is a generalised r-squared and relates to beta regression, typically smaller than R^2 values from comparable models in linear regression. The R^2 value ranges from 0 to 1 and represents the improvement from the null to the fitted model. The default R^2 value in the gamlss package is reported, namely the Cox-Snell R^2 (Cox &Snell, 1989). During whole-sample analysis, the Cox-Snell R^2 value for each DV was obtained from the full model, which included the two main effects and the expertise × culture interaction term. During within-group analysis, the Cox-Snell R^2 value for each DV was obtained from a model containing only one main effect. For example, if within-culture expertise was being explored, then the Cox-Snell R^2 only related to the main effect of expertise.

For each DV, I ran one main effects beta regression model, without the interaction term: I reported these outcomes regarding the predictors of interest (i.e., expertise and culture). I then ran a second beta regression model, containing the interaction term as well as the main effect terms (now conditional effects): I reported the outcome from this model for the interaction term. Thus the outcomes for the main effects are derived from a regression model separate from the model containing the interaction term. Additionally, within-group analyses were run the same way to identify within-expertise cultural differences and within-cultural expertise differences. No interaction analyses were run, for within-group analyses, given that only one main effect was present on each occasion. Together, both *whole-sample* and *within-group* analyses will be reported from frequency analyses.

I considered running class size as a covariate in frequency analyses, to control for its potential confounding agency 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. I therefore ran analyses with no covariates, focusing entirely on expertise and culture as predictors of teacher gaze.

7.6.4. Temporal Analysis

The goal of the second analytic approach was to proceed onto the next logical step in exploring teacher gaze. The temporal nature of teacher gaze was now in focus. Two broad perspectives were taken to the temporal dimension of teacher gaze. The first was the conventional, static (i.e., aggregated) measure of time: namely, gaze durations. The second was a dynamic (i.e., structural) approach to time: namely, the use of classroom-relevant gaze (i.e., efficient gaze, or 'attractors'), flexibility (i.e., 'transitions') and strategic consistency (i.e., 'dispersion'). The rationale and nature of each approach will now be explained.

7.6.4.1. Temporal Analysis: Measures

To generate my own State Space Grid, I needed to prepare two behavioural streams from my data: gaze and didactic behaviours. Gaze behaviours related to *student gaze*—which included focused gaze students (i.e., more than four key frames) and scans of students (i.e., four key frames or less) and *non-student gaze*—which consisted of student materials, teacher materials and other miscellaneous behaviours (e.g., window). Gaze behaviour codes are represented on the x-axis of the State Space Grid (SSG) as represented in Figure 7.10.

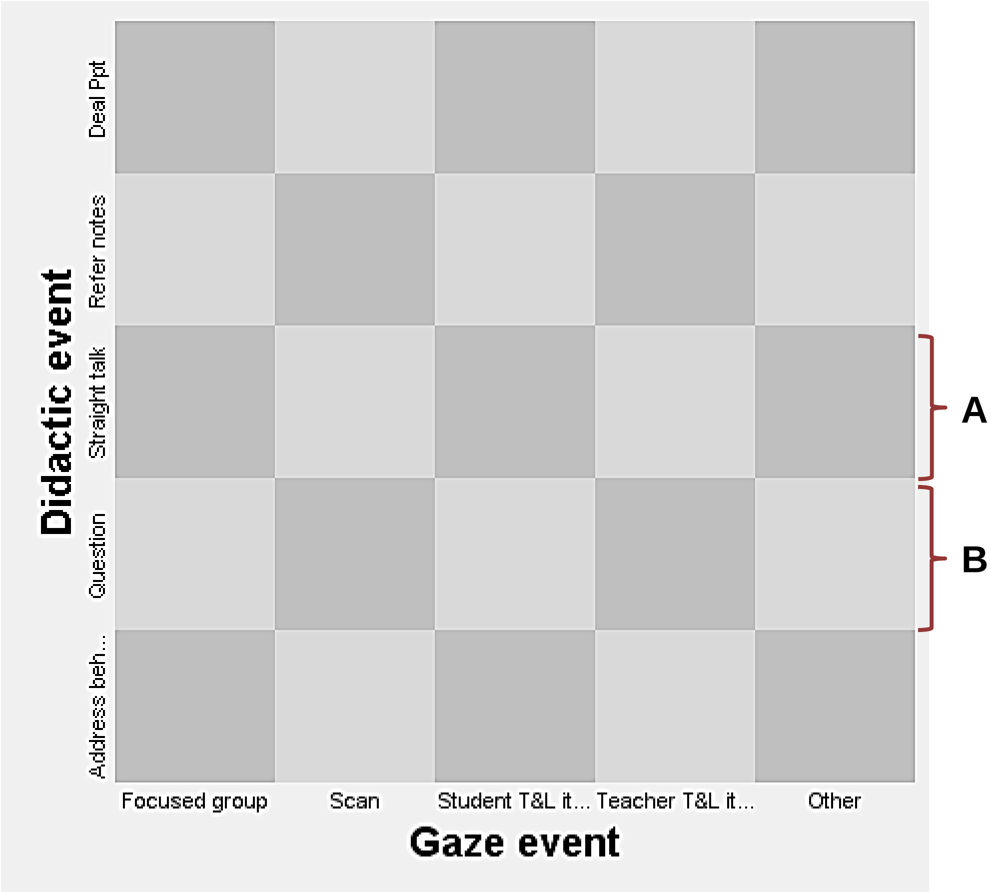


Figure 7.10. The 'state space' of teachers' didactic gaze. The x-axis consists of five gaze *behaviours*; the y-axis of five didactic *behaviours.* Each cell is a one didactic *event*. The present thesis focuses on rows A and B, row A being communicative gaze and row B being attentional gaze.

Didactic behaviours included address behaviour (i.e., directly instructing students to change their behaviour), interacting (i.e., student or teacher asking and answering questions; 'question' in Figure 7.10), lecturing (i.e., teachers talking; 'straight talk' in Figure 7.10), refer notes (i.e., teacher referring to presentation slides or students' resources), logistics (e.g., teacher moving the presentation onto another slide). Didactic behaviour codes are represented on the y-axis of the SSG as represented in Figure 7.10. Together, gaze and didactic behaviours combined to form didactic gaze.

State space grids were constructed using GridWare 1.15a (Lamey, Hollenstein, Lewis & Granic, 2004). To do this, observational data files were created for each participant for generating these grids. A 5×5 grid was generated, yielding 25 possible states as my state space grid shows 25 cells in total. Gaze behaviours were plotted along the x-axis; didactic behaviours along the y-axis. Each axis thus represented one behavioural stream of the same individual; each cell represented the co-occurrence of their gaze and didactic behaviours. On each axis, behaviours were plotted from the most to the least people-oriented, so that the intersection of the two axes was the most people-oriented state (i.e., focused gaze at students vs. address behaviour). It was in this way that I strived to plot categorical variables together so that two behavioural streams coincide to become ‘states’. Together, the multiple states form the ‘state space’ of teachers’ didactic gaze.

Each cell of the SSG (Figure 7.10) represents a didactic gaze state. Such a state consisted of a co-occurrence of gaze behaviour and didactic behaviour. Two didactic gaze types are of central interest in this paper: attentional gaze was inferred from gaze behaviours that occurred during interacting (i.e., within-questioning gaze); communicative gaze was inferred from lecturing (i.e., within-talk gaze).

For each, attentional and communicative gaze, I exported mean duration per visit for analysis. Accordingly, the static measures that I analysed were as follows: mean attentional student gaze duration per visit, mean attentional non-student gaze duration per visit, mean communicative student gaze duration per visit, and mean communicative non-student gaze duration per visit.

Didactic gaze attractors among all the teachers in my sample were identified—that is, the most prevalent and stable didactic gaze used across both, the UK and Hong Kong. Attractors can be interpreted as the *most relevant teacher gaze:* the more teachers use these, the more they are sticking to the task-relevant gaze, and the more efficient they are.

Attractors were estimated visually at first, using state space grid images (e.g., Figure 8.1). Attractors were then derived systematically, using a ‘winnowing’ procedure (Lewis, Lamey & Douglas, 1999, see Table 7.5.

Table 7.5

An illustrative winnowing table

Step	Duration (from short to long)											Expected	
	$x1y1$	$x1y2$	$x1y3$	$x2y1$	$x2y2$	$x2y3$	$x3y1$	$x3y1$	$x3y3$	Total (D)	No. cells left (C)	value (D/C)	
1											9		
2											8		
3											7		
4											6		
5											5		
6											4		
7											3		
8											2		
9											1		
	((Observed-Expected)^2)/Expected									Sum	No. cells left	H-Score	H-Prop
1											9		
2											8		
3											7		
4											6		
5											5		
6											4		
7											3		
8											2		
9											1		

Note. This is an example table for the winnowing process which a 3 × 3 state space grid would need (N.B. The thesis itself involves a 5 × 5 grid). The 'H-Score' is the heterogeneity accounted for by each cell: the H-score formula is in Appendix 5.

The aim of winnowing is to find the cell(s) that account for the most heterogeneity in the state space. The procedure involves listing the mean duration of each cell, from the smallest to the largest value. The heterogeneity accounted for (H-score) by each cell is calculated using observed and expected values for that cell, from the shortest to longest mean cell duration. From the H-score, the heterogeneity proportion accounted for is calculated (H-prop). When the H-prop decreases by .50 (i.e., 50%) or more, the cell responsible for this decrease is named as the scree (Figure 7.11). The cell(s) following this, which will have longer mean cell durations, are then named as the attractor(s; Lewis et al., 1999).

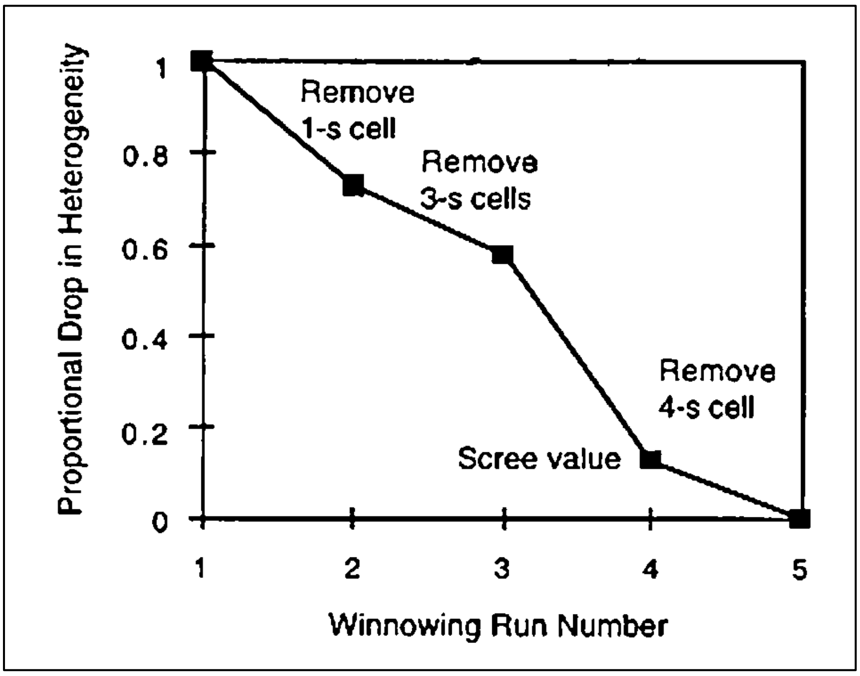


Figure 7.11. Winnowing process, with the cells following the scree identified as the attractor(s). Image from Lewis et al. (1999).

Once attractors (or efficient gaze types) were estimated, they were analysed in two ways. First, attractor presence was explored by examining mean cell durations. Attractor presence reflects how much a teacher uses gaze the winnowing method has identified to be most relevant to teaching (i.e., how much teachers use an attractor): attractor presence will henceforth be referred to as *rates of efficient gaze*. Second, attractor strength was explored by examining mean cell return times—that is how long a teacher is away from the relevant gaze (i.e., attractor region) before returning to it. Attractor strength reflects how prominent the teacher's use of this specific gaze event is (rather than their general, strategic stability; see Section 7.6.4.1. Temporal Analysis: Measures). Attractor strength will henceforth be referred to as *strength of efficient gaze.*

To investigate teacher gaze flexibility, transitional entropy measures were used. Transitions are shifts between events. Entropy is a probability-based measure that represents the complexity of an event sequence (Shannon & Weaver, 1949; see Appendix 5 for transitional entropy formula). That is, the more entropic a behaviour, the more complex it is. The more transitions made in teacher gaze, the more complex the gaze sequence is and therefore the higher the entropy. For example, entropy has been used to investigate the complexity of adolescent male friendships (Dishion, Nelson, Winter & Bullock, 2004), intelligent tutoring system use (Snow, Jacovinam, Varner, Dai & McNamara, 2014), and discourse during psychotherapeutic treatment (Lichtenberg & Heck, 1986). In the present research, entropy values related to teachers' gaze transitions, as transitional entropy measures. The present transitional entropy values were obtained from GridWare (Lewis, Hollenstein et al., 2004) by identifying *student gaze* regions as the 'origin' and *non-student gaze* regions as the 'destination'. This approach was taken for attentional gaze (i.e., questioning, Figure 7.10, Row B) and then for communicative gaze (i.e., straight talk, Figure 7.10, Row A). Didactic gaze flexibility therefore reflected the tendency for teachers to alternate *between* the *specified regions* of student and non-student gaze (rather than within one attractor region, as in Section 7.6.4.3 Temporal Analysis: Measures).

To explore teacher's strategic consistency in their gaze deployment, I examined the structural properties of teachers' didactic gaze as a whole. To do this, I obtained whole-grid dispersion values (Hollenstein, 2013), a proportion metric indicating the range of cells occupied in a specified duration. Its whole-grid property meant that, in addition to attentional and communicative gaze, the dispersion value also accounted for gaze when teachers addressed students' behaviour (i.e., address behaviour), when they referred to learning materials (i.e., refer notes) and when they were carrying out logistics (i.e., logistics). Thus, dispersion was a measure of overall strategic consistency in their didactic gaze: the higher the dispersion, the lower the strategic consistency. The dispersion measure ranges from 0 to 1, with 0 representing no variation (i.e., high consistency) from one cell and 1 being maximum variation (i.e., low consistency), with every cell visited equally.

7.6.4.2.Temporal Analysis: Statistical Analysis

For statistical analyses, I ran multivariate, followed by univariate, analyses of co-variance, depending on the number of variables being predicted. Following these overall comparisons, I report within-cultural expertise then within-expertise cultural differences in teacher gaze in order to capture any contribution of culture-specific expertise to gaze measures that were missed in the whole-sample analyses. Thus, both *whole-sample* and *within-group* analyses will be reported from temporal analyses. Where necessary, measures were square-root transformed and outliers removed in order to meet linear model assumptions prior to analysis. To avoid over-stating the relationship between teachers' culture with their gaze (Grace-Martin, 2012; Keppel & Wickens, 2004), we also class size as a covariate when covariate assumptions were satisfied.

7.6.5. Sequential (Scanpath) Analysis

To conduct string edit analysis, I obtained ‘scanpaths’ by generating didactic gaze event sequences from the first ten gaze behaviours occurring alongside each didactic behaviour. Thus, for each participant, attentional scanpaths were identified and listed from gaze sequences during *questioning* and communicative scanpaths were derived from gaze sequences during *straight talk* (Table 7.6).

Table 7.6

Example attentional scanpaths from the present sample

	Participant number				
String no.	1	2	3	4	5
1	CFCOFCF	**FTCFCFOSCF**	**TOFOOCFTOS**	**TFTFCFOCFO**	FT
2	FCFSSC	CFTFTOFOT	**TFCFCFCFTC**	**FOTCFOFCOF**	OTF
3	**FCSCSCFOCF**	**TCSCOCFSFS**	TFCOCFTF	**OFFOFOFCOC**	TFFOFF
4	**FOFCFCTCFT**	**FTCFSOFTCO**	**TTTSSFFCST**	**FOFOFOCOFO**	**TCTFOCOFOF**
5	OTCFT	OCFT	TCOFCT	FOFOCFFT	CFFT
6	TCFOFOF	**COSOSCSOCS**	CF	**FTFCFCFCOF**	FFFFFT
7	TCFOFOF	**FSFFOFCOCF**	**OFCOCFOFOF**	**TOOCFOFOFS**	**COFCFFTFOF**
8		**TFCFTOFOFT**	TOFSCFT		**OCOOOFCOFO**
9		**OCFFOFTCOC**	OFCT		**TOFOFOFFOF**
10		**TOFSFTCFOC**	FOCOFOCTO		
11		**TCOTCFTOFO**	F		
12		**OOCOCOCOFT**			
13		**FCOFCOFOCF**			
14		**TFOCOFOFSF**			
15		FST			
16		**TCTCOFFTFC**			
17		FCFCT			

Note. Abbreviations for gaze targets were as follows: F=*focused group*, C=*scan*, S=*student materials*, T=*teacher materials*, O=*other*. Strings in bold are those that were sufficiently long (i.e., ten gaze codes in one episode) to be included in my string edit analysis.

I generated and analysed string edit distance (SED; i.e., similarity) measures in Matlab. The SED measure is a similarity score that ranges from 0 to 1, 1 being 'most similar' (i.e., identical). To derive similarity scores, I first generated didactic gaze event sequences from the first ten gaze behaviours occurring within each didactic behaviour. Thus, for each participant, I generated *attentional gaze scanpaths* from gaze behaviours during questioning; I also generated *communicative gaze scanpaths* from gaze behaviours during talking.

Next, I generated similarity scores. To confirm that inter-individual (e.g., expert vs. novice) comparisons would be worthwhile, the first set of similarity scores related to comparisons within and between each individual (Table 7.7). I anticipated similarity scores for within-individual comparisons to be greater than between-individual scores (Hypothesis 1a), making between-individual (e.g., expertise) comparisons worthwhile. Each participant was thus given a mean similarity score for scanpath comparisons within him or herself as well as a mean similarity score for the scanpath comparisons between him (or her) and others.

Table 7.7

Intra- and Inter-Individual comparisons

	Comparison	
IV	**Within**	**Across**
Individual	Participant x vs. Participant x	Participant x vs. Participant $y1$ Participant x vs. Participant $y2$ Participant x vs. Participant $y3$ … Participant x vs. Participant $y39$

Note. An illustration of how intra- (within) and inter- (across) individual comparison of scanpaths were run. Note that this table only shows a sample of all inter-individual comparisons run: the total number of inter-individual comparisons were 39, since the sample overall contained 40 participants. For each participant, it was also likely that multiple intra- (within) individual comparisons were made, given that one teacher can display relevant gaze sequences several times (e.g., using attentional gaze more than once in the ten minutes of gaze recording).

The second set of similarity scores related to teacher expertise and culture. I ran string edit comparisons within and across single-IV groupings (Table 7.8). That is, I compared teacher scanpaths within expertise (e.g., experts vs. experts) and then across expertise (i.e., experts vs. novices); I also, separately, compared teacher scanpaths within cultures (e.g., UK vs. UK) and then across cultures (i.e., Hong Kong vs. UK).

Table 7.8

Single-IV scanpath comparisons

	Comparison	
IV	**Within**	**Across**
Expertise	Expert vs. Expert Novice vs. Novice	Expert vs. Novice
Culture	Hong Kong vs. Hong Kong UK vs. UK	Hong Kong vs. UK

Note. All the comparisons for deriving single-IV scanpath similarity scores are listed in this table.

I finally generated further similarity scores by running string edit comparisons within and across *sub*-groups, combining both IV's, expertise and culture (Table 7.9). That is, I compared teacher scanpaths within the same expertise *and* the same cultural grouping (i.e., same sub-groups). I also compared teacher scanpaths across different expertise but within the same culture, within the same expertise but across different cultures, and across different expertise and different cultures (i.e., different sub-groups).

Table 7.9

Dual-IV scanpath comparisons

Comparison			**Scanpath 1**		**Scanpath 2**
A	Within sub-group	1	Hong Kong Expert	↔	Hong Kong Expert
		2	UK Expert	↔	UK Expert
		3	Hong Kong Novice	↔	Hong Kong Novice
		4	UK Novice	↔	UK Novice
B	Within culture,	1	Hong Kong Expert	↔	Hong Kong Novice
	Across expertise	2	UK Expert	↔	UK Novice
C	Across cultures,	1	Hong Kong Expert	↔	UK Expert
	Within expertise	2	Hong Kong Novice	↔	UK Novice
D	Across sub-groups	1	Hong Kong Expert	↔	UK Novice
		2	UK Expert	↔	Hong Kong Novice

Note. All the comparisons for deriving dual-IV scanpath similarity scores are listed in this table. If *both* expertise and culture matter, scanpaths will be most similar in comparison A; if only *expertise* matters in teacher scanpaths, scanpaths will be most similar in comparison B; if only *culture* matters, comparison C will be most similar.

7.1.1.1.Scanpath Analysis: Statistical Analysis

For statistical analyses of similarity scores I ran repeated measures univariate analyses of variance for each cognition separately (i.e., attentional gaze, then communicative gaze). Transformations were conducted prior to running ANOVAs where necessary in order for all dependent variables to meet parametric assumptions, while raw scores are reported for descriptive statistics. For a broad analysis of whether scanpaths significantly differ across expertise, I explored if scanpaths were more similar within expertise compared to across expertise. Likewise, to address whether teacher scanpaths significantly differ across cultures, I investigated whether scanpaths were more within than across cultures. Thus ANOVAs of single-IV scanpath comparisons were computed to identify if expertise and culture correspond with decreased similarities.

Following that, dual-IV comparisons were addressed. First, each IV was treated as a covariate by exploring scanpath similarities within and across the other IV. This means that, to explore the role of expertise in differentiating scanpaths, scanpaths were only compared within and across expertise while constraining culture to remained the same (i.e., Comparison A vs. B in Table 7.9). Likewise, to explore the role of culture in differentiating scanpaths, scanpaths were only compared within and across culture while controlling for expertise (i.e., Comparison A vs. C in Table 7.9).

Finally, the combined contribution of expertise and culture was investigated through dual-IV comparisons. To do this, the similarity scores from within sub-groups were compared with those derived across sub-groups (i.e., Comparison A vs. D in Table 7.9). This final analysis was thus my attempt at analysing the role of culture-specific expertise in differentiating teacher scanpaths.

7.1.2. Hierarchical Regression Analysis

Rather than investigating each *octant* in the Questionnaire on Teacher Interaction (QTI), the present analyses will address the two *dimensions* of the model—namely, *agency* and *communion*—and the overall style represented by the interaction between the two—which will here be called *interpersonal style*. This approach to handling QTI data is well-established in its community. For example, student ratings of teachers' interpersonal style in terms of agency and communion to have been used to explore (1) ethnic differences within a multicultural classroom (Den Brok, van Tartwijk, Wubbels & Veldman, 2010), (2) cultural differences across two cultural settings (Den Brok, Fisher, Wubbels, Brekelmans & Rickards, 2006), (3) the relation between teacher interpersonal style and student outcomes (Den Brok, Brekelmans & Wubbels, 2004; Wubbels, Brekelmans, Mainhard, den Brok & van Tartwijk, 2016), (4) to validate the Chinese QTI (Wei, denBrok & Zhou, 2009; Wei, Zhou, Barber & den Brok, 2015), and (5) the relationship between teacher interpersonal style and student motivation (den Brok, Levy, Brekelmans & Wubbels, 2005).

7.1.2.1.Hierarchical Regression Analysis: Measures

Teachers' *interpersonal style, agency* and *communion* served as the outcome variables for the present analysis. To derive these three DVs, octant variables were first computed from their respective items. Each octant variable functioned as the average of all items and was created by subtracting 1 from the mean of the octant's items, then dividing the outcome by 4.

Den Brok's syntax for transforming octant ratings into agency and communion dimensions was then employed (Den Brok, van Tartwijk, Wubbels & Veldman, 2010). This syntax regards communion and agency as two dimensions that are completely uncorrelated with each other, which is one approach to handling circumplex structures (Tracey, 1994) such as the QTI. Specifically, to derive the agency dimension, the following syntax was used:

```
compute a=0.923880.
compute AGENCY=  ((a*oct1lead) + (b*oct2help) - (b*oct3und) - (a*oct4sres)
        -(a*oct5unc) - (b*oct6diss) + (b*oct7adm) + (a*oct8strict)).
```

To derive the communion dimension, the following syntax was used:

```
compute b=0.382683.
compute COMMUNION=  ((b*oct1lead) + (a*oct2help) + (a*oct3und) +
(b*oct4sres)
        -(b*oct5unc) - (a*oct6diss) - (a*oct7adm) - (b*oct8strict)).
```

In this way, the agency and communion scores were computed for each participant. Finally, I generated interpersonal style scores for all participants by computing an interaction term between agency and communion scores (interpersonal style = agency × communion).

The predictors were teachers' expertise, culture and gaze measures used in preceding analyses, whose computations are reported in each respective section.

7.1.2.2.Hierarchical Regression Analysis: Statistical Analysis

Hierarchical multiple regression was used to analyse the relationship with expertise, culture and gaze as predictors and interpersonal style, agency or communion as outcome variables. Expertise and culture were included in the regression analysis because they are central to this thesis. As such, they were generally expected to play a role in how teachers gaze and, in turn, how gaze relates to interpersonal style. Hierarchical multiple regression was selected rather than multiple regression because notable changes were seen when expertise and culture were not controlled for via hierarchical multiple regression—that is, when gaze variables predicted teacher interpersonal style on their own. The hierarchical multiple regression model was therefore run three times: once with interpersonal style as the outcome variable, then agency, finally with communion as the outcome variable.

Student age was run as a covariate because the two cultural groups differed notably in age. Any 'cultural' effect may therefore be conflated with the age differences between the two cultural samples. Specifically, the Hong Kong sample consisted of students aged M=13.65 (12-16) years whereas the UK students were M=12.00 (11-14) years old, which was a significant age difference between the two cultural groups, $F(1,39) = 14.59$, $p < .001$, η_p^2=.27. UK teachers may thus have been rated more highly than Hong Kong teachers because UK students were younger than the Hong Kong students. Indeed, although the variance accounted for by student characteristics is typically smaller (Levy & Wubbels, 1992), students' ratings of teacher interpersonal style—that is each, agency and communion—do change with student age. In view of this, student age was explored as a covariate (cf. Den Brok, Levy, Wubbels & Rodriguez, 2003; Den Brok, van Tartwijk, Wubbels & Veldman, 2010), to ensure that any cultural effect would be genuine effect on each, attentional and communicative TIS, agency and communion, rather than being conflated with the sample differences in age. To do this, the same hierarchical regression models run with student age as a covariate, which is accomplished by adding student age as a factor before all predictors of interest.

In all, my hierarchical regression model always consisted of four stages. Stage 1 involved only student age, the present covariate. Stage 2 analysis involved only expertise as the predictor; in Stage 3, culture was added; Stage 4, the expertise $\times$ culture interaction term was added; in Stage 5, all the gaze variables were added that could be used from the present thesis. Specifically, measures from the scanpath analysis could not be included in the interpersonal gaze analysis, since the similarity scores can only relate gaze strings to each other and are inapplicable in relation to anything else. Stage 5 was then refined until the best-fitting model was identified, in which only the relevant gaze predictors are included in the regression analysis. For this model refinement process, the $\bar{R}^2$ value was examined until it ceased to improved (i.e., stayed the same) or started declining. For model refinement, the (standardised) β coefficients of the gaze variables were also examined: the strongest were identified, the moderately strong listed, and the weakest were identified and dispensed from the subsequent model. When the $\bar{R}^2$ stopped improving, the most recent decision to dispense gaze predictors was retracted so that the preceding model is chosen. In this way, Stage 5 was the key part of the hierarchical multiple regression model by which the relevant gaze predictors from this whole thesis were identified. Outcomes reported below are derived from the best-fitting (i.e., optimal) model.

The advantages to reporting standardised regression outcomes (i.e., standardised beta coefficients) are well established (e.g., Pianta et al., 2014; Reeve & Lee, 2014). Yet

SPSS, the package used in the present analysis, does not make available standard error values that are associated with standardised beta coefficients, only the unstandardised B. To obtain standard errors that were associated with the standardised beta coefficient, I obtained a z-score for every variable so that the ‘unstandardised’ beta coefficients and associated standard error values could now be read as standardised values instead: these are presently reported as standardised beta coefficients and associated standard errors.

In summary, all the variables that will be analysed and reported in the Results section are in Table 7.10 below.

Table 7.10

List of all the variables that underwent statistical analysis

Analysis	Measure Type		Variable	Description
Frequency				
	Proportion	1	Student gaze	Fixations on students (i.e., ≥ 4 key frames)
		2	Student material	Gaze towards student learning materials
		3	Teacher material	Gaze towards teacher materials
		4	Other	Non-student and non-instructional gaze targets
Temporal				
	Duration per visit	5	Student gaze	Student fixations *and* scans
		6	Non-student gaze	Student materials, teacher materials, other
	Attractor	7	Rate of efficient gaze	How much an efficient gaze is used; attractor quantity
		8	Strength of efficient gaze	How strong the efficient gaze is; attractor strength
	Transition entropy	9	Gaze flexibility	Rate of gaze shift between students and non-students
	Dispersion	10	Strategic (in)consistency	How little gaze moves across the whole 'state space'
Scanpath				
	Single-IV SED	11	Within-expertise	Comparisons *without* culture controlled for
		12	Within-culture	Comparisons *without* expertise controlled for
		13	Across-expertise	Comparisons *without* culture controlled for
		14	Across-culture	Comparisons *without* expertise controlled for
	Dual-IV SED	15	Within-expertise	Comparisons *with* culture controlled for

		16	Within-culture	Comparisons *with* expertise controlled for
		17	Across-expertise	Comparisons *with* culture controlled for
		18	Across-culture	Comparisons *with* expertise controlled for
		19	Within sub-group	Comparisons within expertise + culture groupings
		20	Across sub-group	Comparisons across expertise + culture groupings
HMR				
	Stage 1	21	Class size	Number of students taught by each teacher
	Stage 2	22	Expertise	Teacher expertise category: expert or novice
	Stage 3	23	Culture	Teacher culture category: Hong Kong or UK
	Stage 4	24	Expertise × Culture	Interaction term between expertise and culture
	Stage 5	-	(Gaze variables)	Variables from frequency and temporal analyses

Note. All these variables were analysed for *attentional gaze* and for *communicative gaze*. This means that, 24 variables for each gaze type: in total, there were 48 variables. HMR = Hierarchical multiple regression.

8. CHAPTER EIGHT: RESULTS

The results for this thesis are now presented. Summary statistics will be reported first, in relation to one analytic approach at a time: frequency, temporal then scanpath analysis. Each research question will then be addressed by each analytic approach from both whole-sample and within-group analyses. Within each analytic approach, attentional gaze will be addressed first, followed by communicative gaze.

In terms of summary statistics, the first analytic approach to teacher gaze involved *frequency analysis*. Specifically, proportion measures of teacher gaze towards each visual target were explored in terms of expertise, cultural and culture-specific expertise differences. Table 8.1 shows the proportions of gaze that each teacher group directed at each target. Table 8.2 shows the beta regression statistics for attentional gaze and Table 8.3 shows beta regression statistics for communicative gaze.

Table 8.1

Descriptive statistics for teacher gaze proportions.

	Student		Student materials		Teacher materials		Other	
	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 8.2

Beta regression outcomes for attentional gaze proportions

		Effect 1					Effect 2					Effect 3				
	R^2	R^2	B	s.e.	t	*p*	R^2	B	s.e.	t	*p*	R^2	B	s.e.	t	*p*
Whole Sample		Expertise					Culture					Expertise × Culture				
Student	.42		.60	.12	5.07	<.001		.01	.12	.09	.93		.31	.23	1.33	.19
Student material	.07		.22	.21	1.05	.30		.28	.21	1.36	.18		.10	.42	.24	.82
Teacher material	.18		.39	.17	2.30	.03		.29	.17	1.72	.09		.32	.34	.94	.35
Other	.11		.28	.18	1.58	.12		.02	.18	.13	.90		.55	.35	1.58	.12
Within-Culture		Expertise (HK)					Expertise (UK)									
Student		.43	.75	.20	3.90	.001	.38	.45	.13	3.47	.003					
Student material		.02	.17	.30	.58	.57	.04	.28	.29	.94	.36					
Teacher material		.04	.22	.24	.92	.37	.20	.53	.24	2.22	.04					
Other		.19	.56	.26	2.18	.04	<.001	.009	.24	.04	.97					
Within-Expertise		Culture (Experts)					Culture (Novices)									
Student		.04	.14	.14	.96	.35	.04	.17	.18	.93	.36					
Student material		.06	.34	.30	1.12	.28	.03	.24	.29	.82	.42					

Teacher material		.01	.11	.25	.46	.66	.15	.43	.23	1.85	.08	
Other		.10	.32	.22	1.45	.16	.04	.24	.27	.88	.39	

Note. The R^2 in this analysis was a generalised R^2 relevant to beta regression, namely Cox-Snell R^2. In whole-sample analysis, the R^2 relates to all three regression terms; in within-group analysis, the R^2 relates only to one main effect per model.

Table 8.3

Beta regression outcomes for communicative gaze proportions

	R^2	Effect 1 R^2	B	s.e.	t	*p*	Effect 2 R^2	B	s.e.	t	*p*	Effect 3 R^2	B	s.e.	t	*p*
Whole Sample		Expertise					Culture					Expertise × Culture				
Student	.37		.59	.13	4.63	<.001		.11	.13	.84	.41		.20	.25	.78	.44
Student material	.14		-.55	.23	2.39	.02		.02	.22	.08	.93		.24	.46	.54	.60
Teacher material	.22		.49	.21	2.30	.03		.07	.21	.33	.74		.88	.42	2.09	.04
Other	.12		.03	.18	.15	.88		.09	.18	.49	.63		.79	.35	2.25	.03
Within-Culture		Expertise (HK)					Expertise (UK)									
Student		.42	.69	.18	3.81	.001	.29	.49	.18	2.77	.01					
Student material		.08	.42	.32	1.32	.20	.03	-.68	.32	2.10	.05					
Teacher material		.007	.10	.26	.39	.70	.19	-.94	.33	2.83	.01					
Other		.12	.36	.21	1.68	.11	.11	.43	.27	1.54	.14					
Within-Expertise		Culture (Experts)					Culture (Novices)									
Student		<.001	.01	.17	.07	.95	.06	.21	.19	1.10	.29					
Student material		.01	.16	.37	.44	.67	.004	.08	.27	.29	.78					

Teacher material		.18	.61	.31	2.00	.06	.05	.28	.28	1.01	.33	
Other		.09	.32	.24	1.34	.20	.14	.47	.26	1.84	.08	

Note. The R^2 in this analysis was a generalised R^2 relevant to beta regression, namely Cox-Snell R^2. In whole-sample analysis, the R^2 relates to all three regression terms; in within-group analysis, the R^2 relates only to one main effect per model.

The second analytic approach involved *temporal analysis*. My temporal analysis was based on State Space Grids (Hollenstein, 2013). Figure 8.1 displays the state space grid for all participants, thereby revealing general trends in teachers' didactic gaze, regardless of culture or expertise. By visual inspection, the most visited areas of the state space are address behaviour during focused gaze, interacting during focused gaze and straight talk during focused gaze. Talking also takes place often during teacher material gaze, as do refer to notes during teacher material gaze. Through an iterative winnowing procedure (Lewis et al., 1999), two regions were identified to be most universal among all teachers: namely, (1) interacting during focused gaze (or attentional student fixations) and (2) talking during focused gaze (or communication student fixations). Table 8.4 displays the mean cell durations, which were used to derive efficient teacher gaze (i.e., didactic gaze attractors).

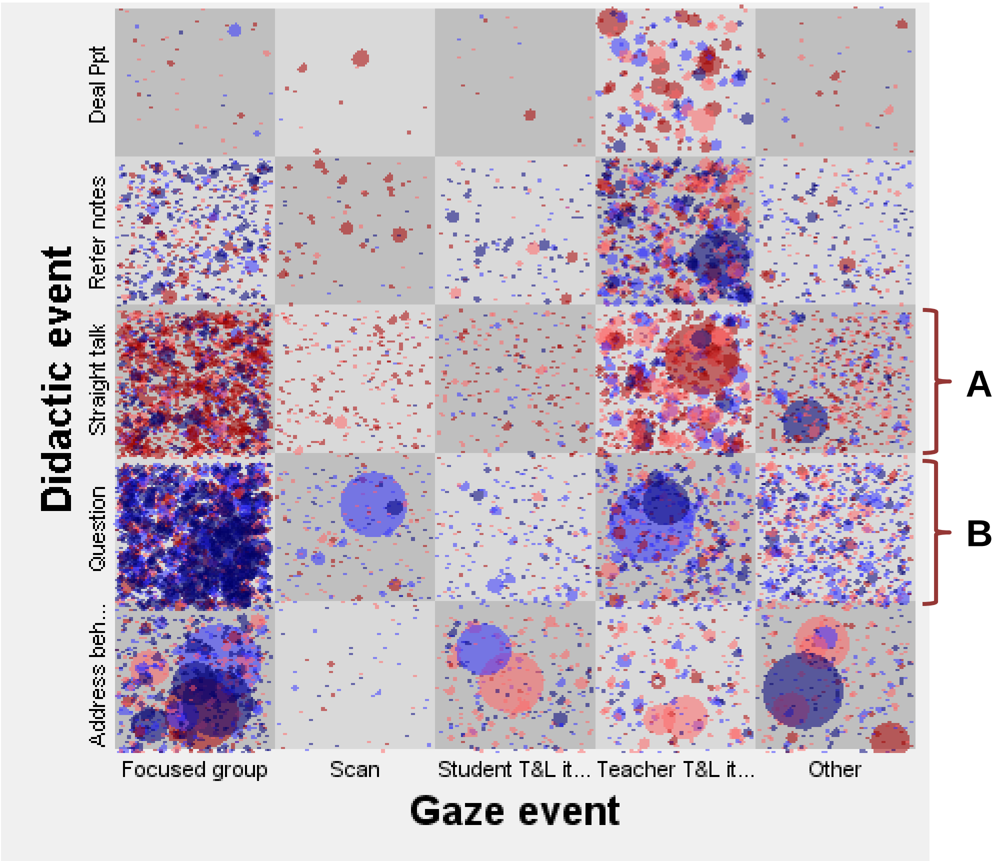


Figure 8.1. The state space grid of teachers' didactic gaze—with the collected data. Each node represents one visit; the size of the node shows the duration of that visit. Western teachers are in blue; Eastern teachers in red. Experts are in the darker shade; novices in the lighter shade. Row A represents communicative gaze, referred to in-text as 'lecturing'; row B represents attentional gaze, referred to in-text as 'interacting'.

Table 8.4

Mean Cell Duration Values for Efficient Gaze (Attractor) Selection

	Gaze behaviour				
Didactic event	Focused gaze	Scan	Student material gaze	Teacher material gaze	Other gaze
Address behaviour	48.68	2.98	18.00	13.10	22.61
Interacting	114.94	15.82	10.46	32.33	38.82
Talking	77.17	13.66	10.85	43.80	29.30
Refer to notes	24.47	4.63	5.48	44.51	11.30
Logistics	1.75	.84	.76	15.09	1.71

Note. Mean cell durations for each state space grid cell. These values were used for identifying 'attractors': that is, universally prevalent didactic gaze events. Note that these are not duration per visit values, which are used in all other—non-attractor—analysis.

The third analytic approach to teacher gaze involved *scanpath analysis*, or the comparison of gaze sequences. In particular, I made comparisons of the sequences of targets that teachers in different—expertise, culture and culture-specific expertise—groups looked at. All statistical analyses comprised of repeated measures ANOVA. Transformed values are explicitly identified when were used in statistical analyses; where unaddressed, original, untransformed values were used in statistical analyses. Untransformed values of descriptive statistics are reported throughout. Finally, for preliminary insight into the way teachers differ across sub-groups, qualitative comparisons of teacher scanpaths are reported in the last section of this part of the thesis.

To explore the importance of top–down scanpath guidance by teachers' experiences (i.e., expertise and culture), I first report analyses of intra- versus inter-individual scanpath similarities. My expectations of top–down guidance for teacher scanpaths in Hypothesis 1 were supported by intra- compared with inter-individual similarities, according analyses of logit-transformed values. Specifically, attentional intra-individual similarities were greater (*M* = .43) than inter-individual similarities (*M* = .38), $F(1,39) = 29.14$, $p < .001$, $\eta_p^2 = .43$. Likewise, communicative greater scanpath similarities were found in intra-individual (*M* = .40) than in inter-individual (*M* = .37) comparisons, $F(1,36) = 61.34$, $p < .001$, $\eta_p^2 = .63$. I therefore proceeded to explore the present top–down factors of interest, namely teacher expertise and culture.

A preliminary picture of *how* teachers differ across sub-groups was obtained by making qualitative comparisons between teacher scanpaths. For each teacher sub-group (i.e., expertise + culture, e.g., Hong Kong novices), these qualitative comparisons were obtained by generating the top ten most common gaze sequences of six. During analysis, a series of trials revealed that a sequence of six yielded the greatest difference between the most common (i.e., modal) and second (and/or third) most common scanpaths (for an example, see Figure 8.2 and Figure 8.3). The modal gaze sequence of six for each teacher sub-group will therefore now be shown in Table 8.5 for each, attention and communication.

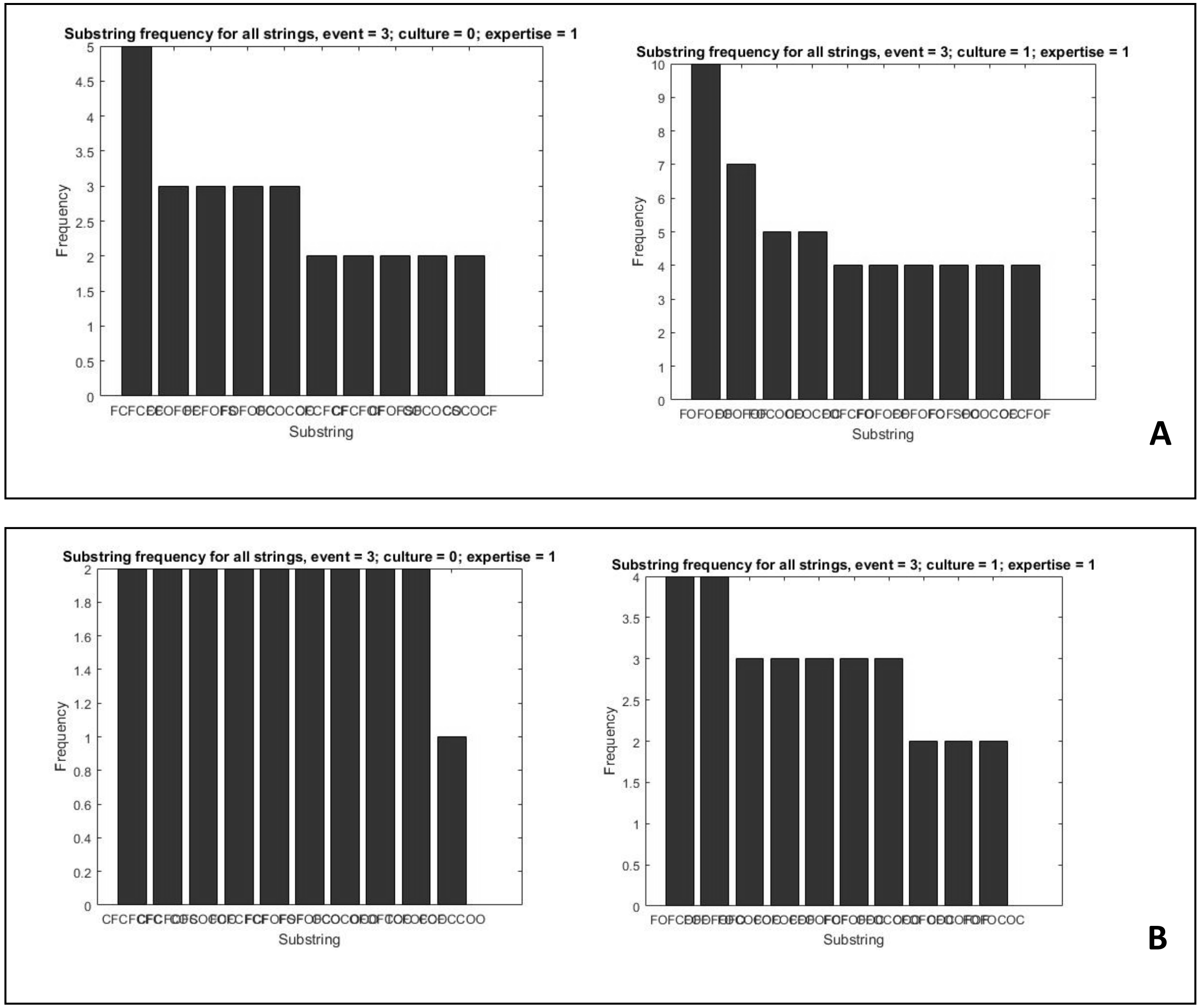


Figure 8.2. Difference between gaze sequence of six (Panel A) and seven (Panel B), in *attentional* gaze, each with Hong Kong experts (left) and UK experts (right). Note that the difference between the first and the subsequent bars are significantly greater in Panel A.

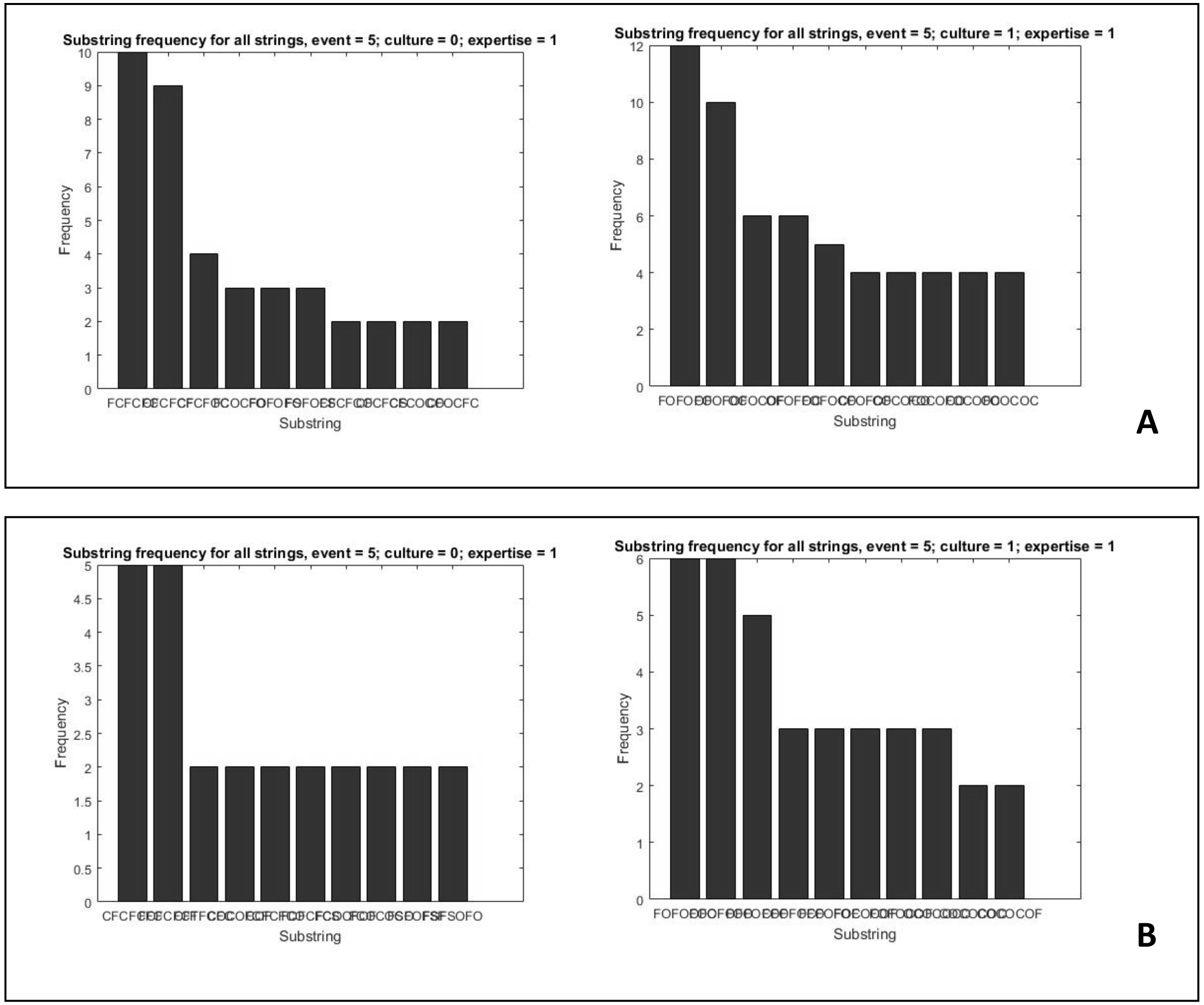


Figure 8.3. Difference between gaze sequence of six (Panel A) and seven (Panel B), in *communicative* gaze, each with Hong Kong experts (left) and UK experts (right). Note that the difference between the first and the subsequent bars are greater in Panel A.

Table 8.5

Modal scanpaths of six for each teacher sub-group

			Target number									
			1		**2**		**3**		**4**		**5**		**6**
Attention													
	HK												
		Expert	St. Fixation	→	St. Scan	→	St. Fixation	→	St. Scan	→	St. Fixation	→	St. Scan
		Novice	St. Scan	→	Other	→	St. Scan	→	Other	→	St. Scan	→	Other
	UK												
		Expert	St. Fixation	→	Other	→	St. Fixation	→	Other	→	St. Fixation	→	Other
		Novice	Other	→	St. Fixation	→	Other	→	St. Fixation	→	Other	→	St. Fixation
Communication													
	HK												
		Expert	St. Fixation	→	St. Scan	→	St. Fixation	→	St. Scan	→	Other	→	St. Scan
		Novice	Other	→	St. Scan	→	Other	→	St. Scan	→	St. Scan	→	St. Scan
	UK												
		Expert	St. Fixation	→	Other	→	St. Fixation	→	Other	→	St. Fixation	→	Other
		Novice	Other	→	St. Fixation	→	Other	→	St. Fixation	→	Other	→	St. Fixation

Note. The modal scanpath for each teacher sub-group. St. Fixation = Student Fixation; St. Scan = Student Scan

In spite of significantly greater within- than across-group scanpath similarities, most comparisons involve noticeably close scores. For example, the mean within-expertise similarity score for teacher attentional scanpaths was $M = .39$, which was compared with the across-expertise score of $M = .38$. Similarly, the mean within-expertise similarity score for teacher communicative scanpaths was $M = .39$, while the across-expertise similarity score was $M = .37$.

8.1. Research Question 1: What is Expert Teacher Gaze?

8.1.1. RQ1: Frequency Analysis

To identify the gaze targets that are most prioritised by experts regardless of culture, I analysed the proportions of classroom regions that teachers looked at during attentional gaze. Experts were compared with novices. Whole-sample beta regression analyses found expertise to significantly predict *attentional student gaze* proportions, $B = .60$, s.e. = .12, $t = 5.07$, $p < .001$, with experts using significantly more student gaze than novices overall. The role of expertise persisted to within-culture expertise (i.e., within-group) comparisons, with both Hong Kong, $B = .75$, s.e. = .19, $t = 3.90$, $p = .001$, and UK teachers, $B = .45$, s.e. = .13, $t = 3.47$, $p = .003$, using significantly more *attentional student gaze* proportions than novices. *Attentional teacher material gaze* was also predicted by expertise, $B = -.39$, s.e. = .17, $t = 2.30$, $p = .03$, with novices looking more at teacher materials than experts. However, expertise did not predict *attentional student material gaze* ($p = .30$) in whole-sample comparisons, or in within-group comparisons ($p_{HK} = .57$; $p_{UK} = .36$). Neither was *attentional other gaze* ($p = .12$) predicted by expertise in whole-sample comparisons. Expert teacher attentional gaze therefore involves higher proportions of student gaze and lower proportions of teacher material gaze. Figure 8.4 shows line graphs for the attentional gaze proportions of each participant group.

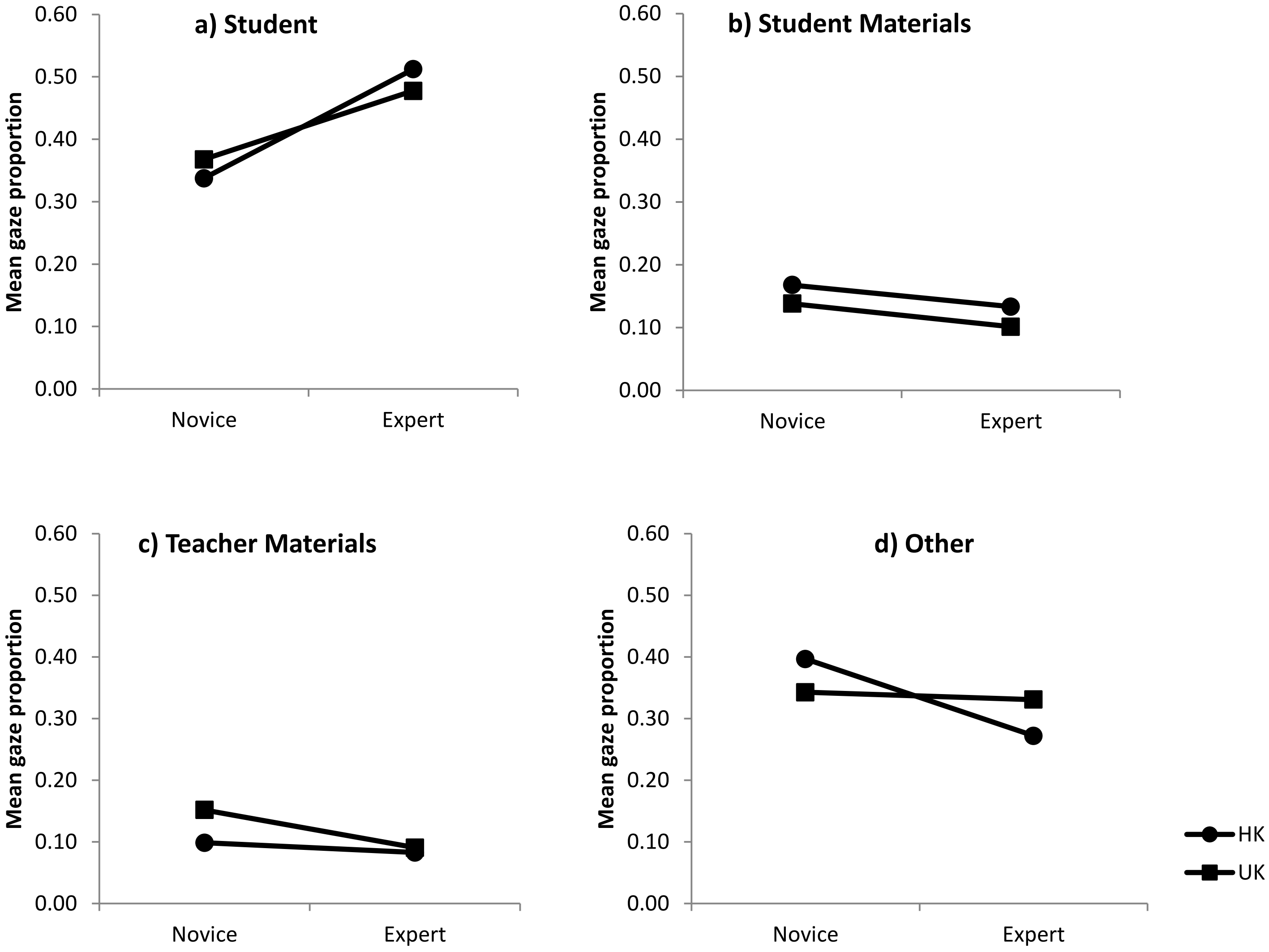

a) Student
b) Student Materials
c) Teacher Materials
d) Other
Mean gaze proportion
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Novice
Expert
HK
UK

Figure 8.4. 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*.

The same approach was taken to identify expert teacher communicative gaze regardless of culture. In whole-sample analysis, beta regression found expertise to significantly predict *communicative student gaze*, $B = .59$, s.e. = .13, $t = 4.63$, $p < .001$, with experts looking more at students than novices did. Within-culture expertise analysis reiterated these expertise differences among Hong Kong, $B = .69$, s.e. = .18, $t = 3.81$, $p = .001$, and UK teachers, $B = .49$, s.e. = .18, $t = 2.77$, $p = .01$. Whole-sample expertise differences were also found in *communicative student material gaze*, $B = -.55$, s.e. = .23, $t = 2.39$, $p = .02$, and *communicative teacher material gaze*, $B = -.49$, s.e. = .21, $t = 2.30$, $p = .03$, both of which were used more by novices than experts. *Communicative other gaze* was not significantly predicted by expertise in whole-sample ($p = .88$) or in within-group analyses ($p_{HK} = .11$; $p_{UK} = .14$). Together, as in attentional gaze, expert teacher gaze in communicative gaze involves higher proportions of student gaze and lower proportions of teacher material gaze. Unlike attentional gaze, expert teacher communicative gaze also involves significantly lower proportions of student material gaze. Figure 8.5 shows line graphs for the communicative gaze proportions of each participant group.

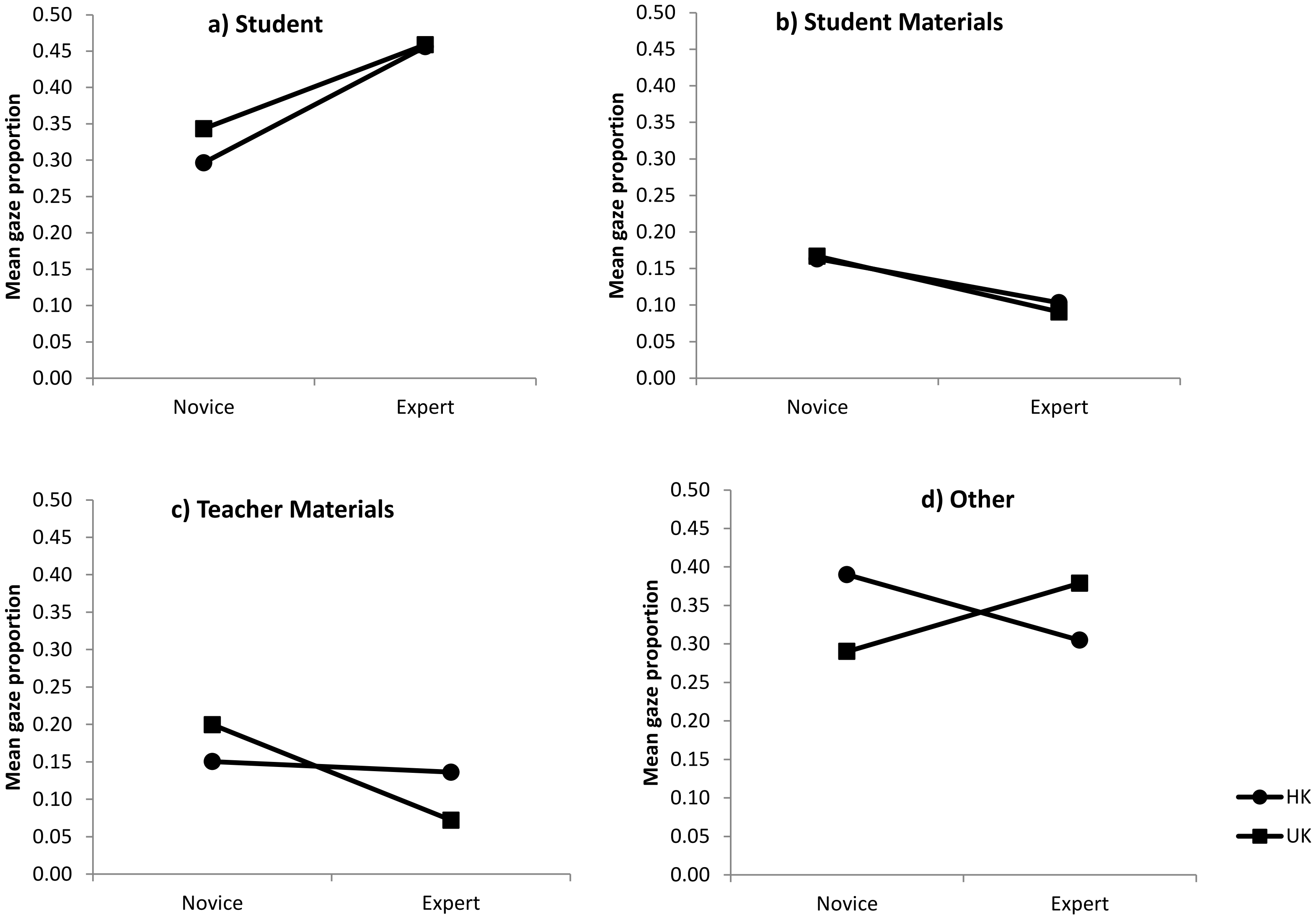

a) Student
b) Student Materials
c) Teacher Materials
d) Other
Mean gaze proportion
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Novice
Expert
HK
UK

Figure 8.5. Line graphs with teacher *communicative gaze proportions* for each participant group. For significance levels, see in-text reporting.

8.1.2. RQ1: Temporal Analysis

Temporal analyses were also conducted to explore the same research question of teacher attentional gaze: regardless of culture, how do expert teachers use their gaze in the classroom? Two perspectives were taken, the static and the dynamic perspective. From the static perspective, the two variables, *student gaze duration per visit* and *non-student gaze duration per visit.* Expertise was shown to be a significant predictor of these two variables together, according to MANCOVA in whole-sample analyses (Figure 8.6), $F(2,34) = 9.48$, $p = .001$, η_p^2=.36. When univariate ANCOVA analyses were run, it was *student gaze duration per visit* that experts used significantly more (M_{Expert} = 2.37s, M_{Novice} = 1.24s), $F(1,35) = 12.18$, $p = .001$, η_p^2 = .26, and not *non-student gaze duration per visit* ($p = .13$).

Within-group analyses of attentional gaze durations echoed these whole-sample analyses. Within-culture, expertise differences were near-significant among UK teachers, $F(2,16) = 3.44$, p = .06, η_p^2=.30, and fully significant among Hong Kong teachers (Figure 8.6), $F(2,16) = 6.80$, η_p^2= .46, $p = .007$, according to MANCOVA. In univariate analysis, it was again *student gaze duration per visit* that was significant according ANCOVA highlighted that both the UK, $F(1,17) = 4.61$, $p = .05$, η_p^2=.21, and Hong Kong, $F(1,17)$ = 7.43, $p = .01$, η_p^2=.30. Within-culture expertise differences in attentional non-student gaze were not significant among UK ($p = .19$) or Hong Kong ($p = .34$) teachers. In summary, expert teacher gaze involves attentional student gaze duration per visit, regardless of culture.

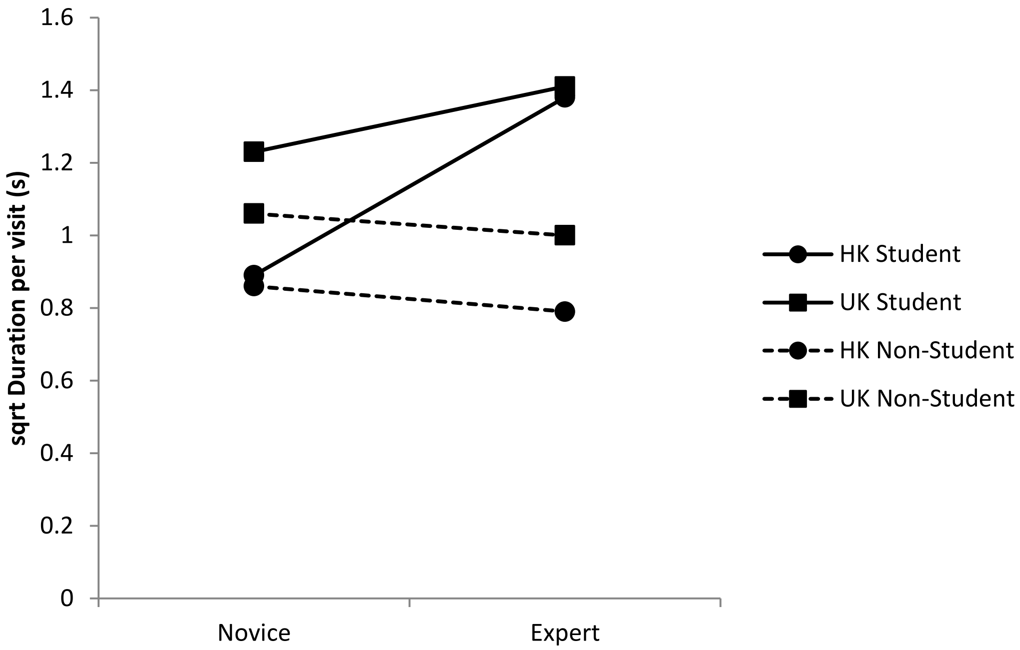


Figure 8.6. Teachers' student and non-student attentional gaze duration per visit. Expertise differences were significant overall but not culture or the expertise × culture interaction. Univariate differences were only significant for attentional student gaze.

The same approach was taken to explore expert teacher *communicative* gaze regardless of culture. This time, the dependent variables in analysis were *student gaze duration per visit* and *non-student gaze duration per visit* for communicative rather than attentional gaze (Figure 8.7). Additionally, covariate analysis assumptions were violated, as class size and the communicative gaze duration per visit variables were not correlated and heterogeneity of regression slopes was found. Given these violations of assumptions in covariate analysis, this specific analysis dispensed of class size as a covariate. Accordingly, MANOVA was conducted to reveal that, regardless of culture, expertise significantly predicted the two static communicative gaze variables, student and non-student gaze duration per visit, $F(2,35) = 11.66$, $p < .001$, η_p^2=.40. According to ANOVA, experts used longer *student gaze durations per visit* (M_{Expert}=1.51s; M_{Novice}=.77s), $F(1,36)$

= 9.08, p = .005, η_p^2=.20, and shorter *non-student gaze durations per visit* (M_{Expert}=.81s; M_{Novice}=1.65s), F(1,36) = 8.38, p = .006, η_p^2=.19.

Within-group analyses supported this to an extent. Expertise within-culture was a significant predictor of communicative teacher gaze among Hong Kong, F(2,17) = 8.96, p = .002, η_p^2=.51, and UK teachers, F(2,17) = 5.82, p = .01, η_p^2=.41, according to MANOVA. ANOVA revealed that Hong Kong experts (M = 1.66s) used significantly more communicative student gaze than novices (M = .66s), F(1,18) = 14.38, p = .001, η_p^2=.44, but not non-student gaze (p = .16). ANOVA revealed UK experts (M = .67s) to use significantly less communicative non-student gaze than novices (M = 1.55s), F(1,18) = 7.29, p =.02, η_p^2=.29, but not student gaze (p = .28). In general, expert teachers use longer communicative student gaze durations per visit and shorter non-student gaze durations per visit.

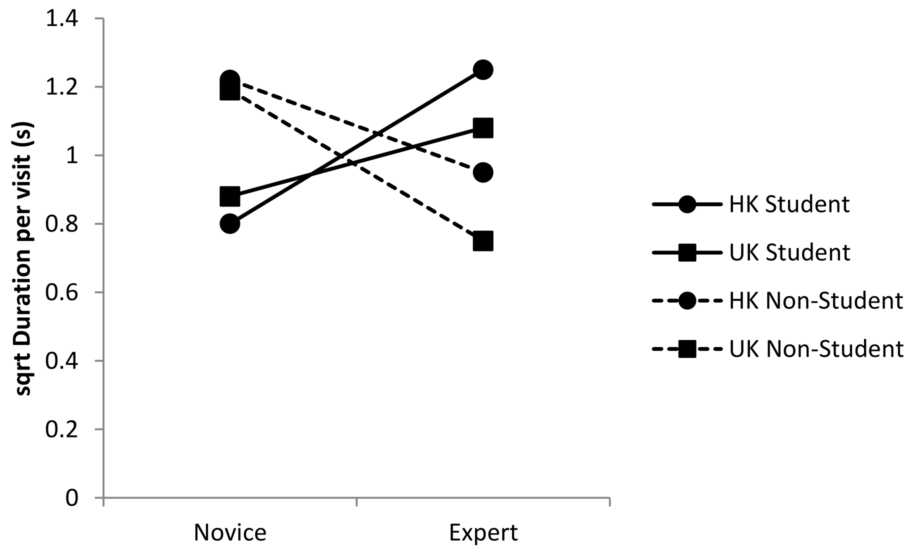


Figure 8.7. Teachers' mean communicative gaze duration per visit.

To explore more expertise features in teacher gaze, the dynamic perspective was taken to supplement the static perspective. Accordingly, gaze efficiency, flexibility and strategic consistency were explored. Expert teachers' gaze efficiency will now be addressed. Gaze efficiency variables consisted of *rate of gaze efficiency* (i.e., attractor presence or mean cell durations) and *strength of gaze efficien*cy (i.e., attractor strength or mean cell return time). In attentional gaze, expertise significantly predicted both gaze efficiency variables, $F(2,34) = 3.21$, $p = .05$, η_p^2=.16, in whole-sample analysis. In particular, it was *strength of attentional gaze efficiency* that expertise predicted in ANCOVA, $F(1,35) = 6.37$, $p = .02$, η_p^2=.15 (Figure 8.8), and not rate of efficiency (p = .31). Specifically, experts (M = 2.22s) showed stronger attentional gaze efficiency than novices (M = 3.00s).

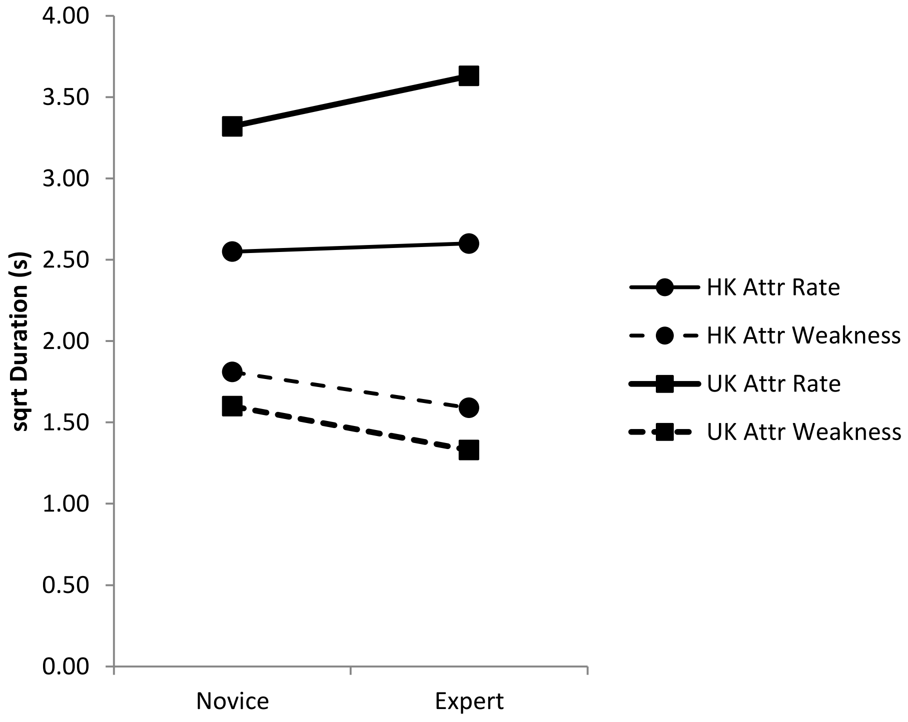


Figure 8.8. Attentional gaze efficiency among teachers (i.e., attractor rate and strength).

The same approach was taken to communicative gaze efficiency as attentional gaze efficiency, except heterogeneity of regression slopes was found between the communicative gaze efficiency variables and class size, resulting in the exclusion of class size as covariate. According to MANOVA, communicative gaze efficiency variables were significantly predicted by teacher expertise, $F(2,34) = 6.93$, $p = .003$, $\eta_p^2 = .29$ (Figure 8.9). Unlike attentional gaze efficiency, both rate, $F(1,35) = 13.65$, $p = .001$, $\eta_p^2 = .28$, and strength of communicative gaze efficiency, $F(1,35) = 8.55$, $p = .006$, $\eta_p^2 = .20$, were significantly predicted by teacher expertise according to ANOVA. Specifically, experts both displayed higher rates of ($M_{Experts} = 110.23$s; $M_{Novices} = 44.10$s) and stronger gaze efficiency (i.e., shorter return times; $M_{Experts} = 2.23$s; $M_{Novices} = 3.45$s) than novices. So whereas expert teacher gaze involved only stronger attentional gaze efficiency, experts used both higher rates and stronger communicative gaze efficiency.

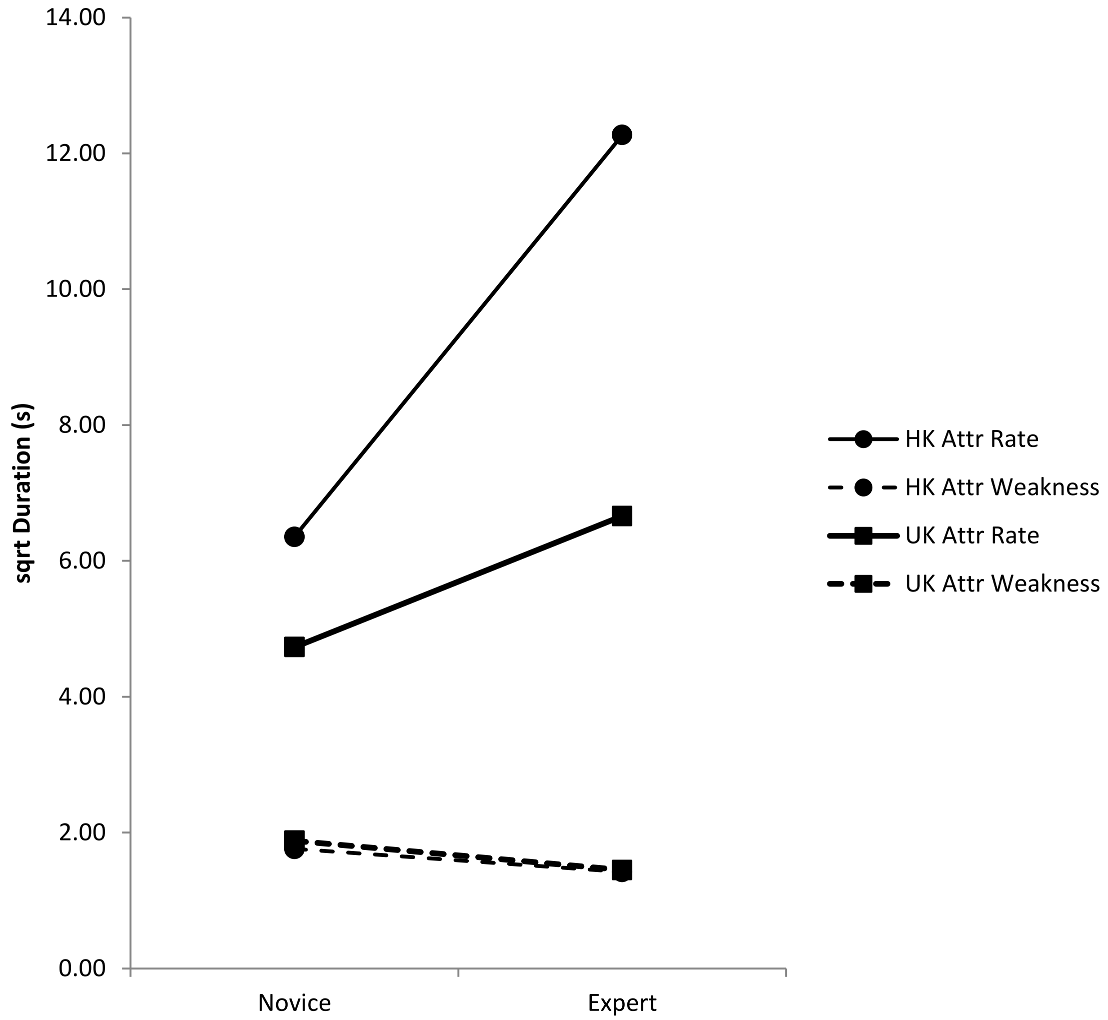


Figure 8.9. Communicative gaze efficiency among teachers (i.e., attractor rate and strength). UK expertise differences were not significant.

Another feature of expertise was explored using dynamic analysis, namely teacher gaze flexibility which was explored using the measure, transitional entropy. Attentional gaze flexibility was analysed without class size as covariate due to the heterogeneity of regression slopes between class size and attentional gaze flexibility. Expert teacher gaze involved significantly higher rates of attentional transitions between student and non-student regions among experts (M = 60.52) than novices (M = 32.92), according to ANOVA, F(1,36) = 6.91, p = .01, η_p^2= .16. See Figure 8.10.

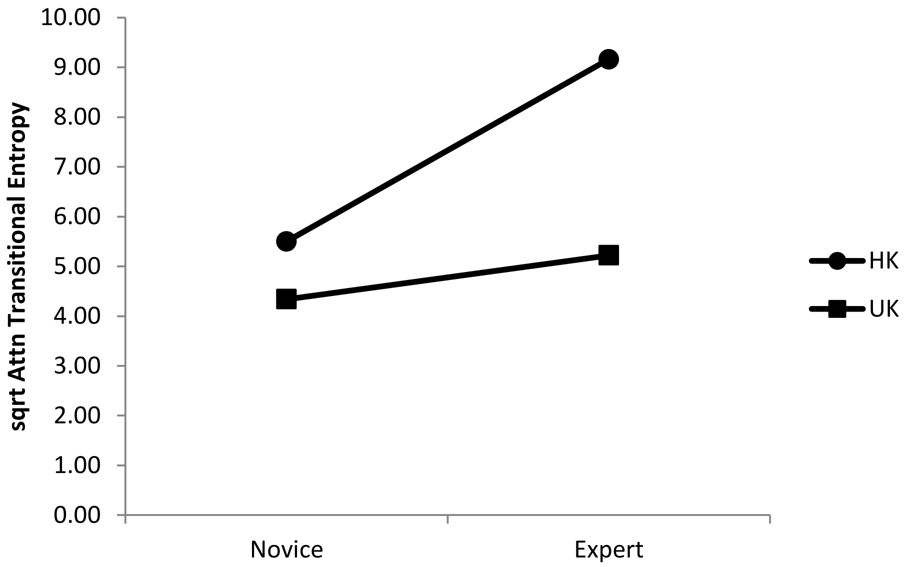


Figure 8.10. Teachers' attentional gaze flexibility (i.e., mean regional transition entropy).

Likewise, communicative gaze flexibility was explored (Figure 8.11), but now with class size as covariate. Unlike attentional gaze flexibility, expertise involved significantly less flexibility during communicative gaze (M_{Expert} =38.96; M_{Novice} = 54.08), according to whole-sample ANCOVA, $F(1,35) = 6.54$, $p = .02$, η_p^2=.16. Within-group analyses however found that, within-culture expertise differences were not significant in Hong Kong ($p = .69$) or the UK ($p = .18$).

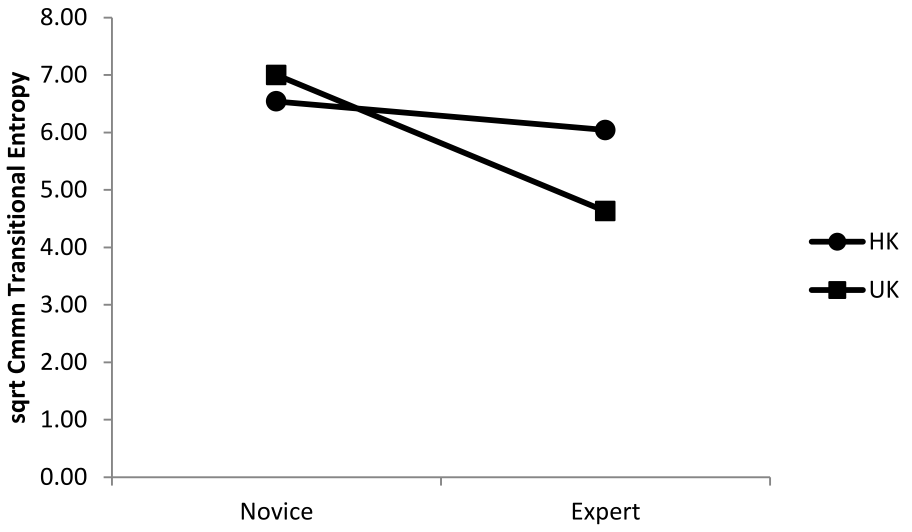


Figure 8.11. Teachers' communicative gaze flexibility (i.e., mean regional transition entropy). The expertise × culture interaction was not significant.

To further address expert teacher gaze patterns that pervade across cultures, the final dynamic feature of teacher expertise was strategic consistency. This aspect of expert teacher gaze relates not only to attentional and communicative gaze, but to the whole state space—which includes teacher gaze when addressing student behaviour (Figure 8.1, row 1 from the bottom), references to notes (Figure 8.1, row 4) and logistics (Figure 8.1, row 5). Thus, the whole state space grid is involved. Strategic consistency was explored using dispersion measures, where large dispersion values signified low strategic consistency. Regardless of culture, expert teacher gaze strategy was more significantly consistent (i.e., less dispersed) among experts (M = .83) than novices (M = .88), according to ANCOVA, $F(1,34) = 7.30$, $p = .01$, η_p^2=.18 (Table 8.6).

Table 8.6

Dispersion (i.e., inconsistency) of teacher gaze strategy in each teacher group.

	Dispersion (0-1)		sqrtDispersion		Class size	
	M	S.D.	*M*	S.D.	*M*	S.D.
HK						
Expert	.84	.07	.92	.04	33.90	4.20
Novice	.89	.04	.94	.02	33.60	3.50
UK						
Expert	.82	.10	.92	.03	21.90	6.33
Novice	.89	.03	.94	.01	20.80	7.05

Note. Although the expertise differences within each culture are comparable, it is likely that the differing class sizes accounts for only the UK expertise differences being significant and not those in Hong Kong.

8.1.3. RQ1: Scanpath Analyses

One final stage of analysis was used to address the question, what is expert teacher gaze: namely scanpath analysis. Single-IV comparisons showed attentional teacher scanpath similarity was significantly greater across (*M* = .40) than within (*M* = .39) *expertise*, $F(1,39) = 15.85$, $p < .001$. η_p^2=.29. In dual-IV comparisons, attentional teacher similarity scores became significantly more similar within (*M* = .39) than across (*M* = .38) *expertise*, $F(1,39) = 4.89$, $p = .03$, η_p^2=.11. In single-IV comparisons, communicative teacher scanpath similarity was greater across (*M* = .39) than within (*M* = .38) *expertise*, $F(1,39) = 35.16$, $p < .001$, η_p^2=.48. In dual-IV comparisons of reciprocal-transformed similarity values, communicative teacher scanpaths became more similar within (*M* = .39) than across (*M* = .37) *expertise*, $F(1,38) = 6.92$, $p = .01$, η_p^2= .15. Together, when culture was controlled for using dual-IV scanpath comparisons, teacher gaze was more similar when it was compared within expertise groups (e.g., expert vs. expert) than when comparisons were made across expertise groupings (e.g., expert vs. novice) in both attentional and communicative gaze.

8.2. Research Question 2: What is Cultural Teacher Gaze?

8.2.1. RQ2: Frequency Analysis

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 in whole-sample and in within-group analyses (Table 8.2); neither did culture predict any communicative gaze proportions (Table 8.3; all $p > .05$). Thus, cultural teacher gaze is not seen much in attentional or communicative gaze proportions, suggesting that teachers do not differ in their long-term classroom strategies according to culture.

8.2.2. RQ2: Temporal Analysis

To probe deeper into the question, what are cultural teacher gaze patterns, temporal analyses were conducted. Static temporal analysis was run using gaze durations per visit as dependent variables, namely *student gaze duration per visit* and *non-student gaze duration per visit*. Culture in attentional teacher gaze significantly predicted the two outcome variables, according to MANCOVA in whole-sample analysis (Figure 8.6, $F(2,34) = 4.37$, $p = .02$, $\eta_p^2 = .21$, with UK teachers ($M = 1.48$s) using significantly longer student gaze durations per visit than Hong Kong teachers ($M = 2.14$s), according to ANCOVA, $F(1,35) = 8.31$, $p = .007$, $\eta_p^2 = .19$. Cultural differences were not significant in attentional non-student gaze durations per visit ($p = .11$) during whole-sample ANCOVA analysis. Culture did not predict attentional gaze durations per visit in within-group analysis among experts ($p = .63$) or novices ($p = .07$), according to MANCOVA.

Nonetheless, whole-sample analysis showed that UK teachers are culturally characterised to use more student gaze than Hong Kong teachers during attentional gaze.

The same research question was asked of *communicative* durations per visit (Figure 8.7). That is, does teacher gaze differ across cultures in communicative *student gaze durations per visit* and *non-student gaze duration per visit*? In this analysis, class size was removed as covariate because it did not correlate with the DVs and heterogeneity of regression slopes was found. Culture did not predict communicative gaze durations in whole-sample (p = .64) or in within-group MANOVA analysis (p_{Expert} = .33; p_{Novice} = .79). Thus, culture only predicts attentional gaze durations and not communicative gaze durations.

The role of culture was then explored in dynamic features of teacher expertise. First, teacher gaze efficiency was analysed, namely *rate of gaze efficiency* (i.e., attractor presence or mean cell durations) and *strength of gaze efficien*cy (i.e., attractor strength or mean cell return time). Culture significantly predicted attentional gaze efficiency, according to MANCOVA in whole-sample analysis, $F(2,34) = 3.34$, $p = .05$, η_p^2=.16. In fact, culture predicted both rate (M_{HK} = 7.02s; M_{UK} = 12.40s), $F(1,35) = 4.86$, $p = .03$, η_p^2= .12, and strength of gaze efficiency (M_{HK} = 2.99s; M_{UK} = 2.27s), $F(1,35) = 5.86$, $p = .02$, η_p^2= .14, according to whole-sample ANCOVA (Figure 8.8). Within-group analysis, however, did not show culture to be a significant predictor of attentional gaze efficiency among UK (p = .13) and Hong Kong (p = .27) teachers, according to MANCOVA.

The role of culture in communicative gaze efficiency was also explored. Since heterogeneity of regression slopes was found between class size and communicative gaze efficiency variables (i.e., rate and strength of gaze efficiency), class size was excluded as covariate. In communicative gaze, culture predicted gaze efficiency according to

MANOVA , $F(2,34) = 5.02$, $p = .01$, η_p^2=.23, with Hong Kong teachers showing higher *rates of gaze efficiency* (M = 111.76s) than UK teachers (M=42.58s), $F(1,35) = 7.82$, p = .008, η_p^2=.18, according to whole-sample ANOVA. Univariate cultural were not significant in *strength of gaze efficiency* (p = .61; Figure 8.9) in whole-sample analysis of communicative gaze.

Culture was then explored as a predictor of the next dynamic feature of expertise, namely teacher gaze flexibility. Gaze transition entropy was the dependent variable. In exploring culture's prediction of attentional gaze flexibility, class size was dropped as a covariate because heterogeneity of regression slopes was found between class size and attentional gaze transition. In running the analysis, culture significantly predicted teachers' attentional gaze transitions (Figure 8.10), with Hong Kong teachers (M = 67.09) transitioning more than UK teachers (M = 26.36), $F(1,36) = 8.76$, p = .005, η_p^2 = .20, according to whole-sample ANOVA. On the other hand, culture did not predict communicative gaze flexibility (p = .20), according to ANCOVA (Figure 8.11).

The final dynamic trait of teacher expertise was strategic consistency, as measured by dispersion. Culture was not found to predict strategic consistency in whole-sample analysis (p=.90), or in within-group analysis among experts (p = .90) or novices (p = .98; Table 8.6).

8.2.3. RQ2: Scanpath Analysis

Does teacher gaze differ across cultures on a sequential level? To address this question at one further level of analytic depth, scanpath comparisons were made within and across cultural groupings. In single-IV comparisons, attentional scanpaths were more similar when compared within (M = .39) than across (M = .38) *culture*, $F(1,39) = 5.70$. p = .02, η_p^2=.13, according to analyses of square-root transformed values. In dual-IV comparisons, *culture* ceased to differ at this point (p = .08). Communicative scanpaths accorded Hypothesis 2, being more similar within (M = .39) than across (M = .37) *cultures*, F(1,38) = 8.30, p = .006, η_p^2= .18, according to analyses of reciprocal-transformed values. In dual-IV comparisons, scanpaths also remained significantly more similar within (M = .39) than across (M = .38) *culture,* once similarity scores were reciprocal-transformed, F(1,38) = 3.98, p = .05, η_p^2= .10. Whereas attentional teacher gaze only differed across cultures in single-IV comparisons, culture differentiated communicative teacher gaze in both single- and dual-IV scanpath comparisons. Culture may be more important in communicative than attentional scanpaths.

8.3. Research Question 3: What is Culture-Specific Teacher Gaze?

8.3.1. RQ3: Frequency Analysis

The third research question asked of teacher gaze was what the culture-specific expert patterns are. Gaze proportions were first explored through frequency analysis using beta regression. The expertise × culture interaction did not significantly predict proportions of attentional *student gaze* (p = .19), *student material gaze* (p = .82), *teacher material gaze* (p = .35), or *other gaze* (p = .12), in whole-sample analysis. Within-group analysis showed that *attentional teacher material gaze* changed with expertise among UK teachers, B= -.53, s.e. = .24, t = 2.22, p = .04, but not among Hong Kong teachers(p = .37). On the other hand, *attentional other gaze* changed with expertise among Hong Kong teachers, B= -.56, s.e. = .26, t = 2.18, p = .04, but not UK teachers (p = .97; see Figure 8.4). Thus, teachers' attentional gaze towards *teacher materials* and *other* targets in the classroom revealed some culture-specific expertise.

The same process was employed to identify culture-specific expert teacher gaze proportions in communicative gaze using beta regression. Like attentional gaze, the expertise × culture interaction did not predict communicative *student gaze* (p = .44) or *student material gaze* (p = .60). Unlike attentional gaze, the expertise × culture interaction significantly predicted *teacher material gaze, B* = .88, s.e. = .42, t = 2.09, p = .04, and *other gaze*, B = .79, s.e. = .35, t = 2.25, p = .03 (Figure 8.5) in whole-sample analysis. In within-group analysis, UK experts used significantly less *communicative student material gaze* than UK novices, B= -.68, s.e. = .32, t = 2.10, p = .05, but not Hong Kong experts (p = .20). Likewise, UK experts used significantly less *communicative teacher material gaze* than UK novices, B= -.94, s.e. = .33, t = 2.83, p = .01, but not Hong Kong experts (p = .70). Hong Kong experts used near-significantly more *communicative teacher material gaze* than UK experts, B= .61, s.e. = .31, t = 2.00, p = .06, whereas cultures did not differ among novices (p = .33). UK-specific expertise in communicative gaze involved less student material and teacher material gaze, whereas Hong Kong specific expertise involved more teacher material gaze.

8.3.2. RQ3: Temporal Analysis

The question of culture-specific expert teacher gaze was once again explored using temporal analysis. Both the static and dynamic perspectives were employed, with static analysis involving student gaze and non-student gaze durations per visit as outcome variables. The expertise × culture interaction was not significant in predicting outcome variables in *attentional* gaze durations per visit, according to whole-sample MANCOVA (Figure 8.6; p = .80). This interaction term was not significant in predicting *communicative* gaze durations per visit either, according to whole-sample MANOVA (Figure 8.7; p = .49) in which class size was removed as covariate due to violated covariate assumptions.

As with the preceding research questions, the dynamic perspective was now used to explore *how* teachers use their gaze in accordance with culture-specific expertise. Attentional *gaze efficiency* variables (i.e., rate and strength) were not significantly predicted by the expertise × culture interaction in whole sample MANCOVA analysis ($p = .77$), but within-group analysis showed culture-specific expertise among experts, $F(2,15) = 3.89$, $\eta_p^2 = .34$, $p = .04$, if not novices ($p = .60$). Among experts, UK experts ($M = 1.84$s) displayed *stronger* attentional gaze efficiency than Hong Kong experts ($M = 2.60$s), $F(1,16) = 8.04$, $\eta_p^2 = .33$, $p = .01$, according to ANCOVA, but culture did not differentiate *rate* of gaze efficiency among experts ($p = .24$).

The same approach was taken with the communicative gaze efficiency variables (i.e., rate and strength; Figure 8.9), though with class size excluded as covariate due to heterogeneity of regression slopes. The expertise × culture interaction did not significantly predict communicative gaze efficiency variables ($p = .13$), according to the whole-sample MANOVA. Within-group MANOVA, however, showed Hong Kong teachers to significantly with differ in communicative gaze efficiency, $F(2,17) = 6.99$, $p = .006$, $\eta_p^2 = .45$, whereas UK experts only differed near-significantly from UK novices ($p = .06$). Specifically, Hong Kong experts ($M = 165.18$s) showed higher *rates of gaze efficiency*, $F(1,18) = 9.71$, $p = .006$, $\eta_p^2 = .35$, but not *strength of gaze efficiency* ($p = .07$), than Hong Kong novices ($M = 58.34$s), according to within-group ANOVA. Within-group analyses also showed cultural differences among experts, $F(2,16) = 8.34$, $p = .003$, $\eta_p^2 = .51$, but not novices ($p = .64$). Specifically, Hong Kong experts ($M = 165.18$s) to use higher *rates* of communicative gaze efficiency (i.e., greater attractor presence) than UK experts ($M = 55.29$s), $F(1,17) = 9.32$, $p = .007$, $\eta_p^2 = .35$, but strength of gaze efficiency did not differ according to culture ($p = .91$), according to ANOVA.

The role of culture-specific expertise in the second dynamic feature of teacher expertise, *gaze flexibility*, was explored using gaze transition measures. Because heterogeneity of regression slopes was found between class size and attentional gaze transition (i.e., transitional entropy during attention), this specific analysis dispensed of class size as a covariate. The expertise × culture interaction was not significant (p = .12) in predicting attentional flexibility during whole-sample analysis. However, within-group analysis found Hong Kong experts (M = 92.79) to display more attentional gaze flexibility than Hong Kong novices (M = 43.38), F(1,18) = 5.99, p = .03, η_p^2=.25—an expertise difference not found among UK teachers (p = .32; Figure 8.10). Hong Kong experts (M = 90.79) also showed greater gaze flexibility than UK experts (M = 30.25), F(1,18) = 13.99, p = .001, η_p^2=.44: this within-expertise cultural difference not found among novices (p = .41).

Culture-specific expertise was also explored in communicative gaze flexibility. The expertise × culture interaction was not a significant predictor (p = .11), according to ANCOVA in whole-sample analysis (Figure 8.11). Nonetheless, Hong Kong experts (M = 44.47) were significantly more flexible than UK experts (M = 33.45), F(1,18) = 5.84, p = .03, η_p^2= .26, according to ANCOVA, while novices revealed no cultural differences (p = .83). Taken together, it appears that expertise specific to Hong Kong (or East Asia) involves attentional and communicative gaze flexibility.

Culture-specific expertise was explored in one final dynamic feature, namely strategic consistency. The expertise × culture interaction was not a significant predictor (p = .79; Table 8.6), according to whole-sample ANCOVA. Within-groups, UK experts (M = .82) were significantly more consistent than UK novices (M = .88), F(1,16) = 4.55, p = .05, η_p^2= .22, while Hong Kong teachers did not show significantly different strategic consistency to their novices (p = .09), but according to ANCOVA (see Table 8.6).

8.3.3. RQ3: Scanpath Analysis

In the final stage of asking whether expert teacher gaze culture-specific, scanpath comparisons were made. In dual-IV comparisons, culture significantly combined with expertise to generate the greatest similarity in teacher attentional scanpaths, $F(1,39)$ = 11.91, p = .001, η_p^2= .23, with significantly greater similarity among scanpaths from the same (M = .39) than across (M = .37) sub-groups. Culture combined with expertise with near-significance in communicative gaze, such that communicative scanpaths were more similar within (M = .39) than across (M = .37) sub-groups, $F(1,38)$ = 3.83, p = .06, η_p^2= .09, according analyses of reciprocal-transformed values. Thus, the greatest differences in teachers' gaze sequences are generated when teachers differ in both expertise *and* culture, in contrast to when teachers belong in the same expertise and culture.

8.4. Research Question 4: How Does Teacher Gaze Relate to Teacher Interpersonal Style?

The fourth and final analytic approach to teacher gaze involved teacher interpersonal style. Both teachers' expertise and cultural groupings and teachers' gaze measures were analysed as predictors of teacher interpersonal style. Attentional and communicative gaze was added in separate hierarchical regression models for each predictor, expertise, culture and culture-specific expertise. Results from hierarchical regression analyses will be reported according to the research questions of the present thesis. This means that for each, attentional and communicative gaze, teacher expertise (Stage two) will be reported first, then culture (Stage three), which is followed by the expertise × culture interaction (Stage four). As an exception to the results format so far, teacher gaze variables will be reported as predictors for the first time: first attentional gaze variables (Stage five), then communicative gaze variables (Stage five). The dependent variables were teacher interpersonal style (DV1) , agency (DV2) and communion (DV3). Table 8.7 below presents the descriptive statistics for each DV. The statistical significance of prediction by each, expertise and culture, will be reported alongside the other IVs in the hierarchical regression reports that follow.

Table 8.7

Teacher overall interpersonal style, agency and communion for each teacher group.

		Interpersonal style				Agency				Communion			
Culture	Expertise	*M*	*SD*	Min	Max	*M*	*SD*	Min	Max	*M*	*SD*	Min	Max
HK	Expert	.52	.20	.23	.88	.40	.20	.15	.82	1.30	.33	.73	1.68
	Novice	.41	.16	.12	.63	.26	.11	.07	.41	1.52	.20	1.11	1.77
	All	.46	.19	.12	.88	.33	.17	.07	.82	1.41	.29	.73	1.77
UK	Expert	1.32	.34	.99	2.08	.81	.15	.67	1.11	1.59	.15	1.38	1.87
	Novice	.97	.28	.41	1.45	.62	.15	.30	.83	1.48	.19	1.21	1.80
	All	1.15	.35	.41	2.08	.71	.18	.30	1.11	1.54	.18	1.21	1.87

Note. The above values are unstandardised, whereas standardised values (i.e., z-scores) were used for analyses below. Each dimension, agency and communion, ranges between -2.6 and +2.6; interpersonal style is agency × communion.

8.4.1. RQ4: Expert Interpersonal Style

With regard to attentional gaze, hierarchical multiple regression revealed that at stage two, *expertise* contributed significantly to predicting teacher interpersonal style (TIS; i.e., agency × communion), accounting for ΔR^2=.11, $F(1,37) = 6.34$, $p = .02$ of the variance in TIS (Figure 8.12).

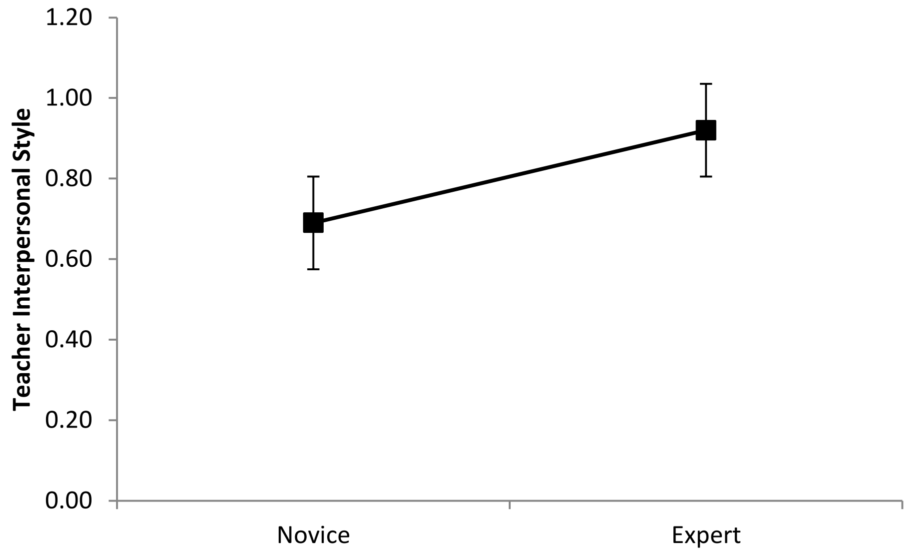


Figure 8.12. The role of teacher expertise in predicting teacher interpersonal style, as rated by students.

Hierarchical multiple regression revealed that at stage two, *expertise* contributed significantly to predicting teacher agency, accounting for ΔR^2=.16 of the variance in agency, $F(1,37) = 8.65$, $p = .006$ (Figure 8.13).

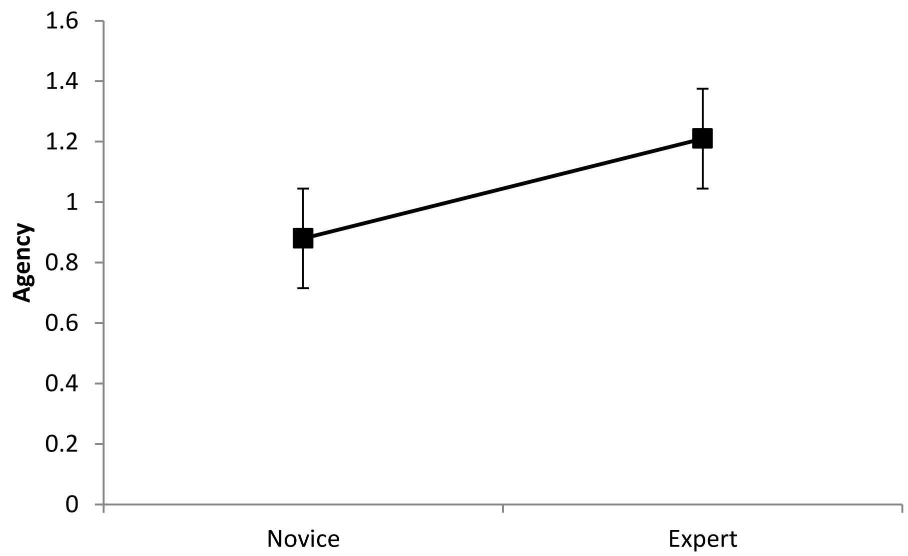


Figure 8.13. The role of teacher expertise in predicting teacher agency, as rated by students.

Hierarchical multiple regression revealed that at stage two, *expertise* did not contribute significantly to predicting teacher communion, accounting only for ΔR^2=.008 of the variance in agency (p = .59). The hierarchical regression table for teacher interpersonal style during attention is below (Table 8.8).

Table 8.8

Hierarchical regression model for teacher interpersonal style during attentional gaze.

	$\bar{R}^2$	ΔR^2	β	s.e.	t	p
Stage 1	.20	.22 **				
Student age			-.47	.14	-3.26	.002
Stage 2	.30	.11 *				
Student age			-.52	.14	-3.84	<.001
Expertise			.34	.14	2.52	.02
Stage 3	.67	.36 ***				
Student age			-.16	.11	-1.43	.16
Expertise			.28	.09	3.04	.004
Culture			.70	.11	6.55	<.001
Stage 4	.68	.02				
Student age			-.14	.11	-1.34	.19
Expertise			-.11	.29	.39	.70
Culture			1.10	.30	3.72	.001
Expertise × Culture			.57	.40	1.45	.16
Stage 5	.70	.05				
Student age			-.15	.12	-1.30	.20
Expertise			.05	.32	.16	.87
Culture			1.05	.31	3.38	.002
Expertise x Culture			-.43	.40	-1.06	.30
sqrtAPpervisit			-.09	.19	-.45	.66
sqrtANPpervisit			-.21	.12	-1.76	.09
sqrtTEntropy			-.15	.12	-1.24	.23
SGProp			.13	.20	.68	.50

Note. The DV was teacher interpersonal style. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$ for ΔR^2 (R-squared change)

With regard to communicative gaze, hierarchical multiple regression revealed that at stage two, *expertise* contributed significantly to predicting teacher interpersonal style (TIS; i.e., agency × communion), accounting for ΔR^2=.10, F(1,36) = 5.23, p=.03, of the variance in TIS (Figure 8.12). Hierarchical regression revealed that at stage two, *expertise* contributed significantly to predicting teacher agency, accounting for ΔR^2=.15 of the variance in agency, F(1,36) = 7.45, p = .01 (Figure 8.13). Hierarchical multiple regression revealed that at stage two, *expertise* contributed significantly to predicting teacher communion, accounting for ΔR^2=.01 (p = .51) of the variance in communion. The hierarchical regression table for teacher interpersonal style during communication is below (Table 8.9).

Table 8.9

Hierarchical regression model for teacher interpersonal style during communicative gaze.

	$\bar{R}^2$	ΔR^2	β	s.e.	t	p
Stage 1	.19	.21 **				
ZStudent_age			-.45	.14	-3.17	.003
Stage 2	.28	.10 *				
ZStudent_age			-.51	.14	-3.70	.001
Zexpertise			.32	.14	2.29	.03
Stage 3	.66	.37 ***				
ZStudent_age			-.15	.11	-1.39	.17
Zexpertise			.27	.10	2.84	.007
Zculture			.69	.11	6.37	<.001
Stage 4	.66	.02				
ZStudent_age			-.14	.11	-1.31	.20
Zexpertise			-.09	.29	-.32	.75
Zculture			1.07	.31	3.50	.001
ZExC			-.53	.41	-1.31	.20
Stage 5	.69	.06				
ZStudent_age			-.11	.11	-.96	.35
Zexpertise			.03	.30	.11	.91
Zculture			1.17	.30	3.93	<.001
ZExC			-.62	.39	-1.59	.12
ZsqrtCPpervisit			-.20	.18	-1.11	.28
ZsqrtCNPpervisit			.28	.12	2.36	.03
Zcmmn_SGProp			.14	.19	.73	.47
Zcmmn_sqrtSMatProp			.15	.10	1.45	.16

Note. The DV was teacher interpersonal style. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

8.4.2. RQ4: Cultural Interpersonal Style

With regard to attentional gaze, *culture* at stage three explained an additional ΔR^2=.36 of variance in TIS, which was a significant change in R^2 (ΔR^2), $F(1,36)$ =42.89, $p < .001$ (Figure 8.14).

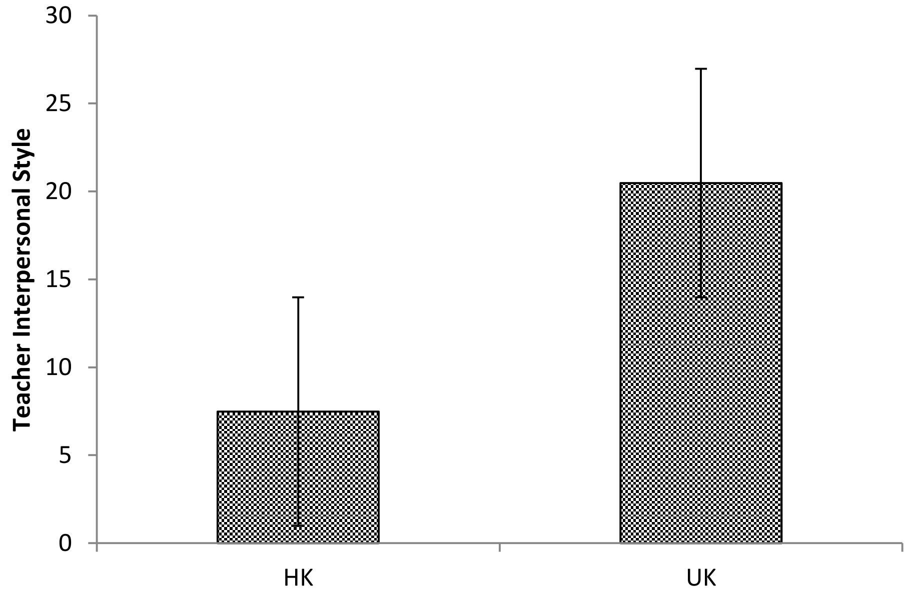


Figure 8.14. Cultural differences in ratings of teachers' interpersonal style overall (i.e., agency × communion). Bar labelled HK represented Hong Kong.

Introducing *culture* at stage three explained an additional ΔR^2=.35 of variance in agency, which was a significant change in R^2 (ΔR^2), $F(1,36)$ = 32.21, $p < .001$ (Figure 8.15).

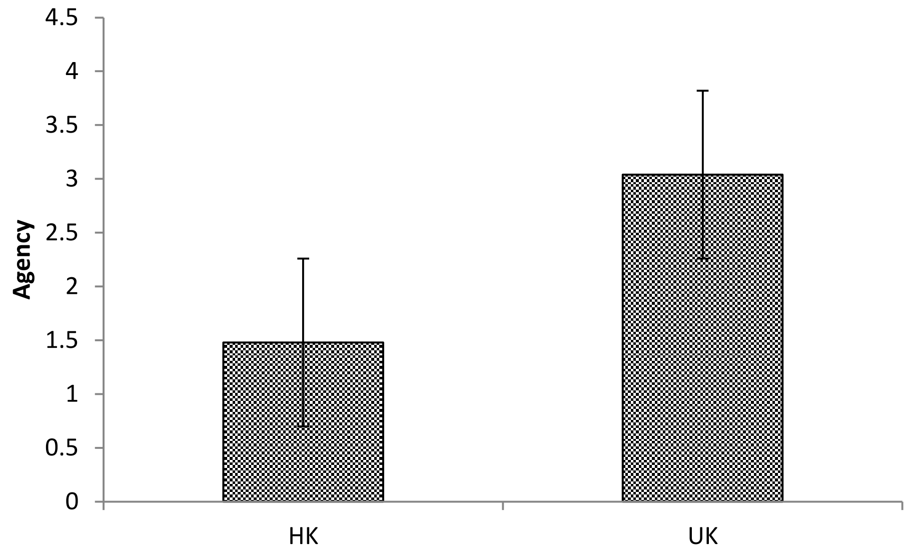


Figure 8.15. Cultural differences in ratings of teachers' agency. Bar labelled HK represented Hong Kong.

Introducing *culture* at stage three explained an additional ΔR^2=.03 of variance in teacher communion, which was not a significant change in R^2 (p = .27). The hierarchical regression table for teacher agency during attention is below (Table 8.10).

Table 8.10

Hierarchical regression model for teacher agency during attentional gaze.

	$\bar{R}^2$	ΔR^2	β	s.e.	t	p
Stage 1	.14	.16 *				
ZStudent_age			-.40	.15	-2.67	.01
Stage 2	.28	.16 *				
ZStudent_age			-.46	.14	-3.36	.002
Zexpertise			.40	.14	2.94	.006
Stage 3	.67	.35 **				
ZStudent_age			-.10	.11	-.89	.38
Zexpertise			.35	.10	3.56	.001
Zculture			.69	.11	6.18	.000
Stage 4	.63	.002				
ZStudent_age			-.10	.12	-.85	.40
Zexpertise			.22	.31	.70	.49
Zculture			.82	.32	2.60	.01
ZExC			-.19	.42	-.45	.66
Stage 5	.67	.09				
ZStudent_age			-.122	.12	-.99	.33
Zexpertise			.325	.35	.94	.36
Zculture			.815	.34	2.38	.03
ZExC			-.033	.45	-.073	.94
ZsqrtANPpervisit			-.260	.11	-2.28	.03
Zattn_sqrtTentropy			-.220	.14	-1.57	.13
Zattn_SGProp			.576	.41	1.42	.17
Zattn_sqrtSMatProp			.369	.30	1.24	.23
Zattn_sqrtTMatProp			.356	.23	1.59	.12
Zattn_sqrtOtherProp			.520	.46	1.13	.27
ZDur_sqrtQuesFocG			-.238	.15	-1.56	.13

Note. The DV was teacher agency. * $p \leq .01$, *** $p < .001$ for ΔR^2 (R-squared change)

With regard to communicative gaze, introducing *culture* at stage three explained an additional ΔR^2=.37 of variance in TIS, which was a significant change in R^2 (ΔR^2), $F(1,35) = 40.62$, $p < .001$ (Figure 8.14). Introducing *culture* at stage three explained an additional ΔR^2=.36 of variance in agency, which was a significant change in R^2 (ΔR^2), $F(1,35) = 36.14$, $p < .001$ (Figure 8.15). Introducing *culture* at stage three explained an additional ΔR^2=.03 (p = .31) of variance in communion. The hierarchical regression table for teacher agency during communication is below (Table 8.11).

Table 8.11

Hierarchical regression model for teacher agency during communicative gaze.

	$\bar{R}^2$	ΔR^2	β	s.e.	*t*	*p*
Stage 1	.13	.15 **				
ZStudent_age			-.38	.15	-2.57	.01
Stage 2	.26	.15 **				
ZStudent_age			-.45	.14	-3.22	.003
Zexpertise			.38	.14	2.73	.01
Stage 3	.63	.36 ***				
ZStudent_age			-.10	.12	-.87	.39
Zexpertise			.34	.10	3.39	.002
Zculture			.69	.11	6.01	<.001
Stage 4	.62	.001				
ZStudent_age			-.10	.12	-.83	.41
Zexpertise			.23	.32	.73	.47
Zculture			.80	.33	2.44	.02
ZExC			-.16	.44	-.37	.72
Stage 5	.67	.08 *				
ZStudent_age			-.05	.11	-.45	.66
Zexpertise			.43	.31	1.40	.17
Zculture			.91	.31	2.94	.006
ZExC			-.24	.41	-.59	.56
ZsqrtCPpervisit			-.14	.13	-1.11	.28
ZsqrtCNPpervisit			.27	.12	2.33	.03
Zcmmn_sqrtSMatProp			.22	.11	2.05	.05

Note. The DV was teacher agency. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

8.4.3. RQ4: Culture-Specific Expert Interpersonal Style

With regard to attentional gaze, introducing the *expertise* × *culture* interaction at stage four explained a further ΔR^2=.02 of TIS variance (*p* = .16). Introducing the *expertise* × *culture* interaction at stage four did not explain significantly more variance in teacher agency (ΔR^2=.002, *p* = .66). Introducing the *expertise* × *culture* interaction at stage four explained significantly more variance, ΔR^2=.11, F(1,35) = 4.96, p = .03 (Figure

8.16). The hierarchical regression table for teacher communion during attention is below (Table 8.12).

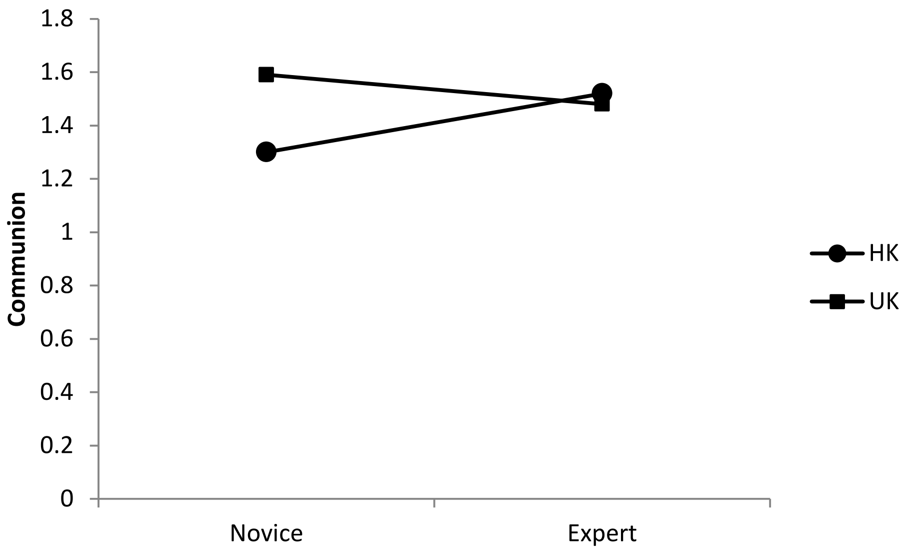


Figure 8.16. Culture-specific teacher *communion*, according to students' QTI ratings.

Table 8.12

Hierarchical regression model for teacher communion during attentional gaze.

	$\bar{R}^2$	ΔR^2	β	s.e.	t	p
Stage 1	.02	.05				
ZStudent_age			-.22	.16	-1.40	.17
Stage 2	.006	.008				
ZStudent_age			-.21	.16	-1.29	.21
Zexpertise			-.09	.16	-.54	.60
Stage 3	.01	.03				
ZStudent_age			-.10	.19	-.53	.60
Zexpertise			-.11	.16	-.65	.52
Zculture			.21	.19	1.12	.27
Stage 4	.11	.11*				
ZStudent_age			-.07	.18	-.39	.70
Zexpertise			-1.12	.48	-2.33	.03
Zculture			1.24	.49	2.50	.02
ZExC			-1.47	.66	-2.23	.03
Stage 5	.12	.15				
ZStudent_age			-.081	.20	-.41	.68
Zexpertise			-1.16	.55	-2.13	.04
Zculture			1.32	.57	2.31	.03
ZExC			-1.59	.72	-2.21	.04
ZsqrtAPpervisit			-.28	.30	-.92	.37
Zattn_SGProp			-1.21	.66	-1.84	.08
Zattn_sqrtSMatProp			-.93	.50	-1.87	.07
Zattn_sqrtTMatProp			-.81	.37	-2.21	.04
Zattn_sqrtOtherProp			-1.54	.77	-2.00	.06
ZDur_sqrtQuesFocG			.31	.22	1.39	.18

Note. The DV was teacher communion. * $p \leq .05$

With regard to communicative gaze, introducing the *expertise* × *culture* interaction at stage four explained a further ΔR^2=.02 of TIS variance (p = .20). Introducing the *expertise* × *culture* interaction at stage four did not explain significantly more variance in teacher agency (ΔR^2=.001, p = .72). Introducing the *expertise* × *culture* interaction at stage four explained significantly more variance, ΔR^2=.11, F(1,34) = 4.51, p = .04 (Figure

8.16). The hierarchical regression table for teacher communion during communication is below (Table 8.13).

Table 8.13

Hierarchical regression model for teacher communion during communicative gaze.

	$\bar{R}^2$	ΔR^2	β	s.e.	*t*	*p*
Stage 1	.02	.05				
ZStudent_age			-.21	.16	-1.33	.19
Stage 2	.005	.01				
ZStudent_age			-.20	.16	-1.19	.24
Zexpertise			-.11	.17	-.66	.51
Stage 3	.006	.03				
ZStudent_age			-.10	.19	-.51	.62
Zexpertise			-.12	.17	-.73	.47
Zculture			.19	.19	1.03	.31
Stage 4	.10	.11 *				
ZStudent_age			-.07	.18	-.38	.71
Zexpertise			-1.11	.49	-2.26	.03
Zculture			1.21	.51	2.37	.02
ZExC			-1.44	.68	-2.12	.04
Stage 5	.08	.08				
ZStudent_age			-.06	.19	-.317	.75
Zexpertise			-1.29	.56	-2.30	.03
Zculture			1.50	.58	2.59	.02
ZExC			-1.82	.74	-2.45	.02
ZsqrtCPpervisit			-.69	.42	-1.66	.11
Zcmmn_SGProp			.68	.47	1.46	.16
ZDur_sqrtTalkFocG			.33	.31	1.07	.29
ZRT_sqrtTalkFocG			.54	.33	1.64	.11

Note. The DV was teacher communion. * $p \leq .05$

8.4.4. RQ4: Attentional Interpersonal Gaze

Adding teacher attentional gaze variables at stage five explained an additional ΔR^2=.05 of the variance in Teacher Interpersonal Style (p = .19). When the four attentional gaze variables were added to the regression model, the only near-significant predictor was durations of teacher gaze towards non-students, β= -.21, s.e. = 12, t = -1.76, p = .09. TIS thus improves with decreasing attentional non-student gaze (Figure 8.17).

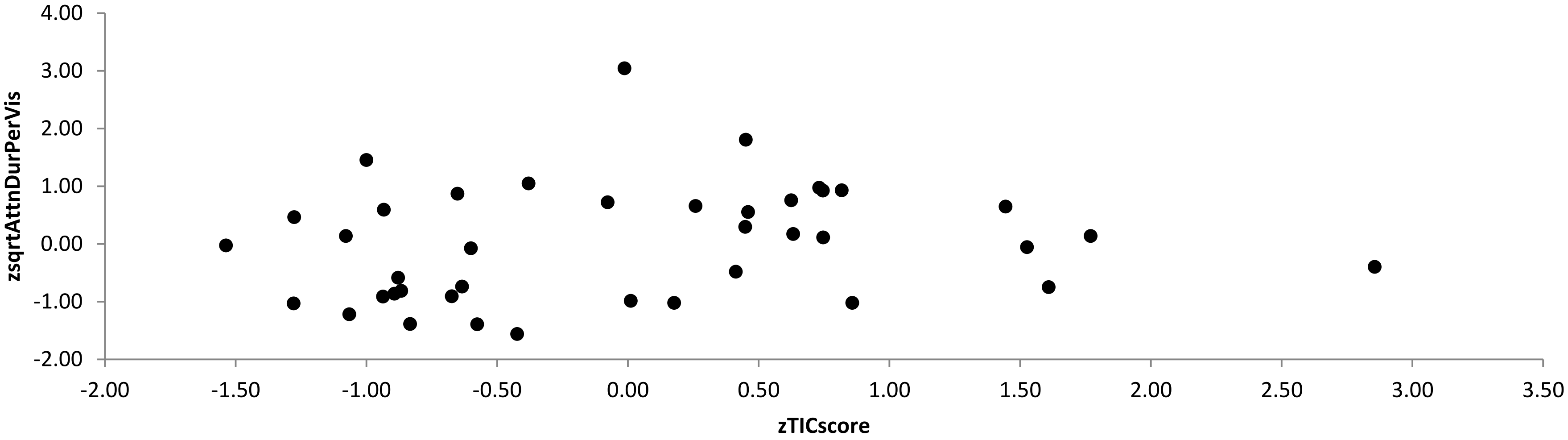


Figure 8.17. Teacher non-student attentional gaze as predictor of teacher interpersonal style overall (TIS; agency × communion) represented by a scattergraph. Each data points represent an individual teacher's TIS.

Adding teacher attentional gaze variables at stage five explained an additional ΔR^2=.09 of the variance in agency (p = .21). When the seven attentional gaze variables were added to the agency regression model, the most important predictors were durations of non-student gaze, β= -.26, s.e. = .11, t = -2.28, p = .03. Agency improves as attentional non-student gaze decreases (Figure 8.18).

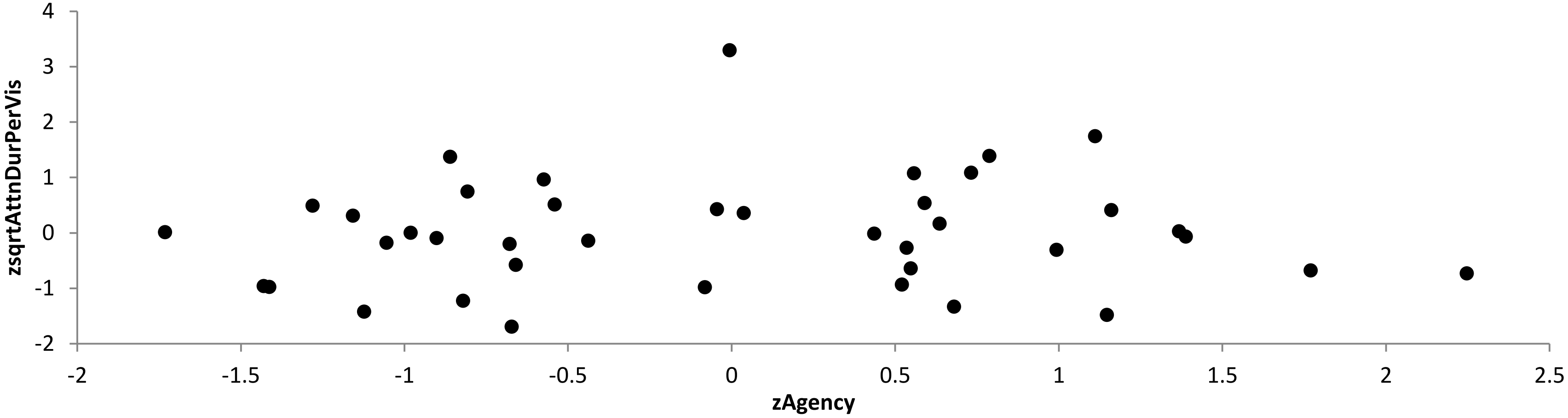


Figure 8.18. Teacher non-student attentional gaze as predictors of teacher agency represented by a scattergraph. Each data points represent an individual teacher's agency.

Finally, adding teacher attentional gaze variables at stage five explained an additional ΔR^2=.15 of the variance in communion (*p* = .39). When the six attentional gaze variables were added to the communion regression model, the proportion measures were most relevant. Proportions of teacher material gaze significantly predicted teacher communion, β= -.81, s.e. = .37, *t* = -2.21, *p* = .04. Near-significant predictors were proportions of other gaze, β= -1.54, s.e. = .77, *t* = -2.00, *p* = .06, proportions of student material gaze, β= -.93, s.e. = .50, *t* = -1.87, *p* = .07, and proportions of gaze at student, β= -1.21, s.e. = .66, *t* = -1.84, *p* = .08. Communion improves as attention towards students increases and non-student targets decrease (Figure 8.19).

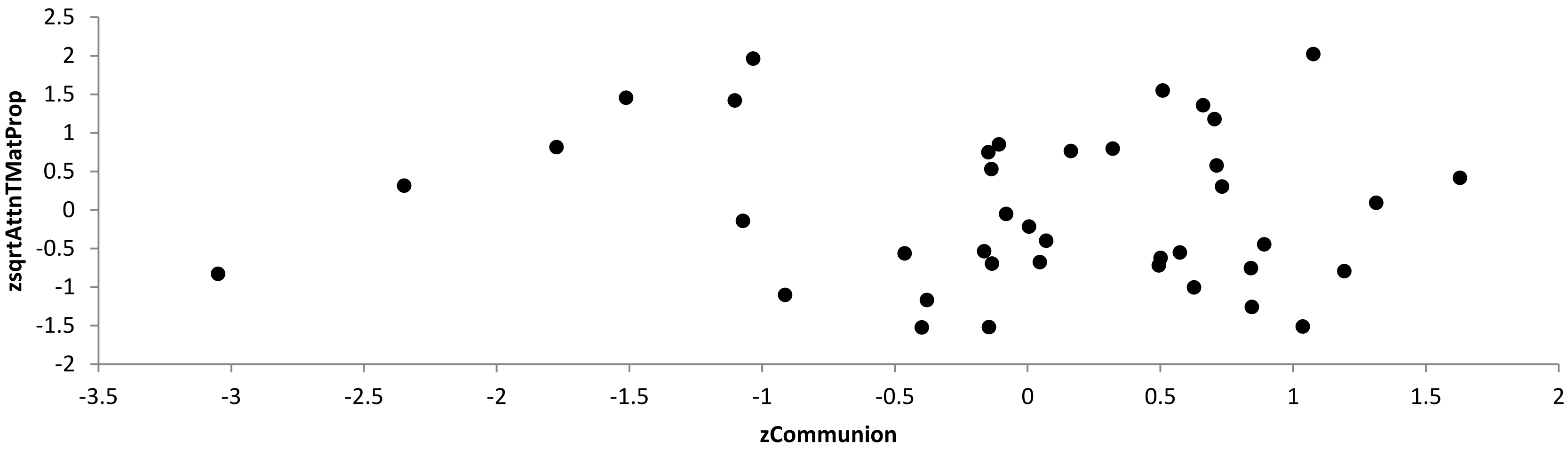


Figure 8.19. Teacher attentional gaze at teacher materials as predictors of teacher communion represented by a scattergraph. Each data points represent an individual teacher's communion.

8.4.5. RQ4: Communicative Interpersonal Gaze

Adding teacher *communicative* gaze variables at stage five explained an additional ΔR^2=.06 of the variance in communicative TIS (p = .16). When the four communicative gaze variables were added to the regression model, durations of teacher gaze towards non-student targets was the only significant predictor, β= .28, s.e. = .12, t = 2.36, p = .03 (Figure 8.20).

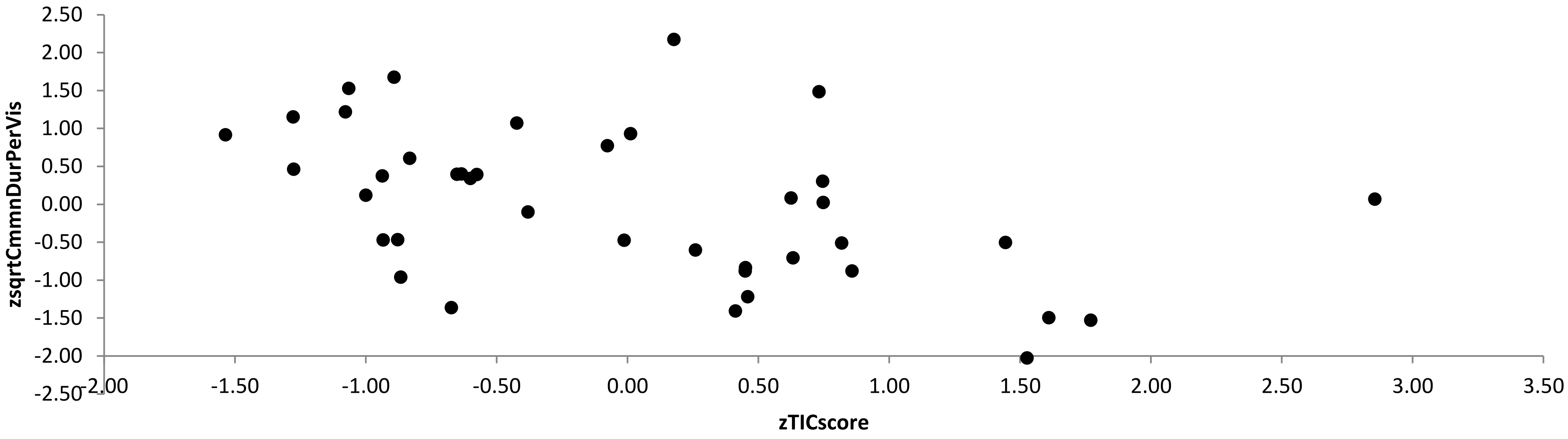


Figure 8.20. Relationship between teacher communicative gaze durations towards non-student targets and teacher interpersonal style (i.e., agency × communion) represented by a scattergraph. Each data points represent an individual teacher's TIS.

Adding teacher communicative gaze variables at stage five explained an additional ΔR^2=.08 of the variance in teacher agency, F(1,31) = 2.90, p = .05, which was a significant change. When the three communicative gaze variables were added to the agency regression model, durations of non-student gaze was a significant predictor, β= .27, s.e. = .12, t = 2.33, p = .03, as were proportions of student material gaze, β= .22, s.e. = .11, t = 2.05, p = .05 (Figure 8.21).

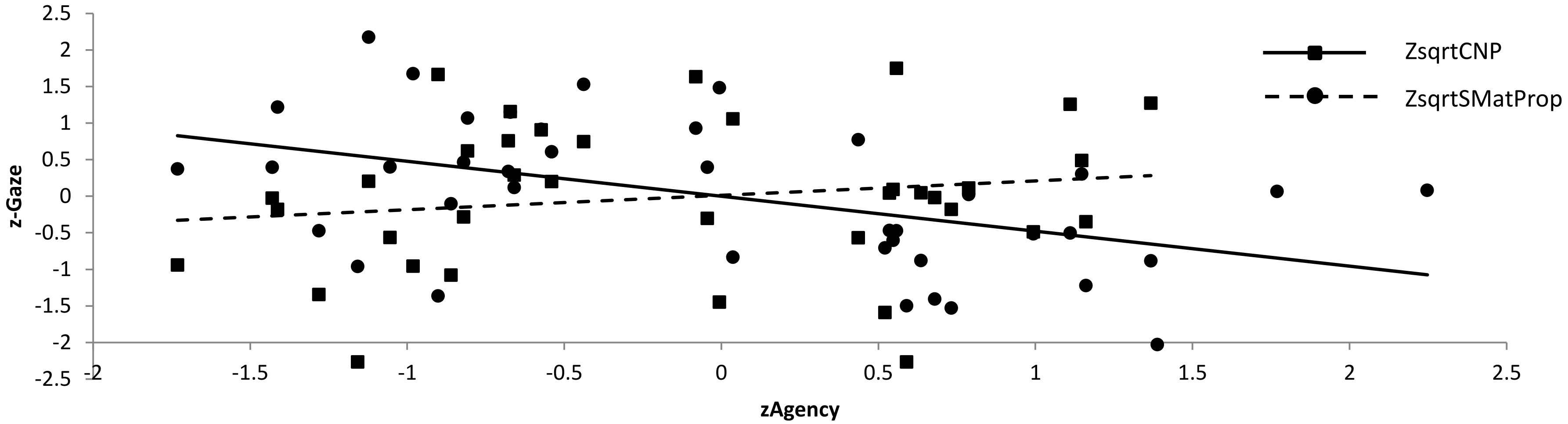


Figure 8.21. Relationship between teacher communicative gaze (i.e., durations of gaze towards student and proportion of gaze towards student materials) and teacher agency. This is a scattergraph with trendlines added to highlight where non-student communicative gaze durations (ZsqrtCNP) data points are and where student material gaze proportions (ZsqrtSMatProp) data points are. The data points represent each individual teacher's agency.

Adding teacher communicative gaze variables at stage five only explained an additional ΔR^2=.08 of the variance in teacher communion (p = .53). When the four communicative gaze variables were added to the communion regression model, no variables predicted communion significantly (p = .11 to .29).

8.5. Summary of Results

8.5.1. Research Question 1: What are Expert Teacher Gaze Patterns, Regardless of Culture?

During both attentional and communicative gaze,

- Experts use higher proportions and longer durations of student gaze
- Experts use lower proportions of teacher material gaze
- Experts have greater strength of gaze efficiency
- Experts have greater gaze flexibility
- Teacher scanpaths are more similar within than across expertise

During only communicative gaze,

- Experts use lower proportions of student material gaze
- Experts use shorter durations of non-student gaze
- Experts show higher rates of gaze efficiency

Additionally, strategic consistency is greater among experts than novices.

8.5.2. Research Question 2: What are the Cultural Differences in Teacher Gaze?

- The *rate* of gaze efficiency was culture-specific. That is, UK teachers used significantly higher rates of efficient attentional gaze (i.e., attentional student fixations) whereas Hong Kong teachers used significantly higher rates of efficient communicative gaze (i.e., communicative student fixations).

- UK teachers used longer attentional student gaze durations than Hong Kong teachers
- UK teachers showed significantly greater *strength* attentional gaze efficiency than Hong Kong teachers
- Hong Kong teachers have greater attentional gaze flexibility
- Communicative scanpaths were more similar within than across cultures

8.5.3. Research Question 3: What are Culture-Specific Expert Teacher Gaze Patterns?

During both attentional and communicative gaze,

- UK experts use lower proportions of teacher material gaze than UK novices
- Hong Kong experts use lower proportions of other gaze than Hong Kong novices
- Hong Kong experts show greater gaze flexibility than UK experts
- Scanpaths are more similar within than across expertise + culture sub-groups

During only attentional gaze,

- UK experts show greater *strength* of attentional gaze efficiency than Hong Kong experts
- Hong Kong experts show greater attentional gaze flexibility than Hong Kong novices

During only communicative gaze,

- UK experts use lower proportions of student material gaze than UK novices
- The expertise × culture interaction significantly predicts proportions of teacher material gaze and other gaze
- Hong Kong experts show higher rates of communicative gaze efficiency compared with Hong Kong novices and compared with UK experts

Additionally, strategic consistency was greater among UK experts compared with UK novices: an expertise difference not found among Hong Kong teachers.

8.5.4. Research Question 4: How Does Teacher Gaze Relate to Teacher Interpersonal Style?

Both attentional and communicative gaze predict teacher interpersonal style: as non-student gaze durations per visit increase, teacher interpersonal style ratings decrease.

Attentional gaze also predicts:

- Teacher agency. That is, teacher agency ratings decrease as non-student gaze durations per visit increase.
- Teacher communion, which is lowered by increasing proportions of student gaze, student material gaze, teacher material gaze, and other gaze.

Communicative gaze also predicts:

- Teacher agency, which increases with proportions of student material gaze and non-student gaze durations per visit.

9. CHAPTER NINE: DISCUSSION

The discussion on this thesis will address each research question in turn. Each research question will be answered from one analytic approach at a time, before a general discussion of the research question is presented. Accordingly, teacher gaze belonging to experts across cultures will be discussed, followed by culture-specific teacher gaze. Next, culture-specific expertise will be addressed. Interpersonal aspects of teacher gaze will then be examined. Finally, a discussion will be made on the limitations of the present thesis as well as recommended implications of the research conducted.

9.1. Research Question 1: What is Expert Teacher Gaze?

9.1.1. RQ1: Analysis-Based Discussion

In frequency analysis, teacher gaze toward students and teacher materials indicated universal teacher expertise in both attentional and communicative gaze. In both cognitions, experts looked more at students and novices looked more at teacher materials. Given that proportion measures are established to reflect the deliberate priorities of an individual (e.g., Brandstätter et al., 2006), students can be inferred as expert teachers' priority whereas teacher materials are novice teachers' priority. The importance that expert teachers are presently shown to give to students corresponds with teacher effectiveness literature. Namely, a student-centred approach to teaching 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). Expert teachers are also characterised by concern for factoring student needs into their own curriculum delivery (Livingston & Borko, 1989) and when they observe their colleagues' teaching (Wolff et al., in press). In terms of teacher communicative gaze, expert teachers are more aware of and take greater advantage of the innate teaching 'resources' in natural pedagogy (Csibra & Gergely, 2009; Farroni, Massaccesi, Menon & Johnson, 2007). They also deliberately place importance—more than novices do—on their connection with students (Sidelinger & Booth-Butterfield, 2010; Turman & Schrodt, 2006), which they achieve through a variety of non-verbal, immediacy behaviours including eye contact.

Whereas experts focus on students' classroom experiences according to frequency analysis, novice teachers prioritise teaching and learning materials. This priority, among novices, given to teachers' materials during attentional gaze reflects the information novices need that they have yet to familiarise with; during communicative gaze, it reflects the importance novices are conveying to students of their materials (e.g., on-screen projections). my finding echoes preceding research, which highlight the preoccupation with written plans and teaching materials that characterises novices (Livingston & Borko, 1989). Indeed, novice teachers have a legacy of holding onto their planned procedures, regardless of unforeseen student needs and events (Berliner, 2004). The priority of subject matter over student experiences is an attribute typical of novice teachers (Schemp, Tan, Manross & Fincher, 1998).

In temporal analyses of both attention and communication, student-centredness among experts was shown by significantly longer durations of teacher gaze directed at students compared with that of novices. Moreover, the most efficient gaze type was student-oriented fixation in both attention and communication. Correspondingly, expert teacher gaze was more flexible and their strategy was more consistent than novices'. As outlined in Hypothesis 1, expertise differences in teacher gaze were significant: attentional gaze durations demonstrated expert teachers' priority (e.g., Mackworth & Bruner, 1970) of students' classroom experience over and above other aspects of classroom instruction (Reeve, 2009; Schemp et al., 1998). Correspondingly, communicative gaze durations towards students were significantly longer among experts than novices—and novices conversely looked longer at non-student targets than experts. Communicative gaze duration analyses thus highlighted expert teachers' awareness and application of natural pedagogical mechanisms (Csibra & Gergely, 2009) and efficient demonstration of communicative intent (Frith & Frith, 2012). As in other professions, the present analyses have demonstrated that expertise in teaching also involves stronger efficiency (cf. van Merriënboer et al., 2002), flexibility (cf. Bilalić et al., 2008) and strategic consistency (cf. Chase & Ericsson, 1982).

Scanpaths were more similar within than across teacher expertise which suggested that the cognitive model for teacher scanpaths changes with expertise. While classroom teaching by nature necessitates top–down control, this process grows in dominance as the teacher develops expertise. Whereas novice teacher gaze is significantly more likely to be distracted by salient yet task-irrelevant classroom events (e.g., bright shoe laces), expert teacher gaze is guided by pedagogical principles developed over time (e.g., areas surrounding disruptive behaviour, Wolff et al., 2015). As teachers develop professionally, their cognitive model itself is also likely to become more efficient, containing only the most task-relevant features in time. Educational and expertise researchers unite in the suggestion that automatisation comes with expertise. Automatisation means that top–down control continues but is decreasingly demanding, as any developing professional (Taatgen, 2005)—including the teacher—continually reduces conscious decision-making to the absolute core of their task requirements and no more (Feldon, 2007; van Merrienboer et al., 2002). This development is reflected in teachers' ability to, with growing knowledge and expertise, predict, pre-empt and control classroom events (Livingston & Borko, 1989). Teachers also demonstrate a general lifestyle of greater efficiency, outside the classroom, compared with novices (Borko & Livingston, 1989). Just as gaze behaviour increasingly reflects task-relevant strategy outside the classroom

(Haider, Frensch & Joram, 2005), so teacher increasingly restrict their gaze to the most task-relevant classroom regions (van den Bogert et al., 2014).

9.1.2. RQ1: General Discussion

Teacher expertise was shown through every gaze measure in this thesis. Experts looked more at students in both attentional and communicative parts of teaching, as shown by their gaze proportions and durations. Experts displayed greater behavioural efficiency (through higher rates and strength of attractors, i.e., efficient, relevant gaze use) and strategic consistency (through lower dispersion) by employing student-oriented gaze significantly more than novices. Experts demonstrated greater student-centred flexibility through higher rates of gaze transitions. Teacher gaze sequences were significantly more similar when comparisons were made within than across expertise, as revealed by scanpath analysis.

Student-centredness is the crux of effective teacher gaze. Experts direct more *attentional* gaze towards students because they are relevant (Charness et al., 2001), important (Foulsham & Kingstone, 2012), most interesting (Mackworth & Morandi, 1967), most complex (Chisholm et al., 2008). Experts direct more *communicate* gaze towards students because they are the target audience of pedagogical messages—just as adults do in shared attention with infants and guide their newborn 'students' through their 'curriculum' regarding the world (Farroni et al., 2006; Frith & Frith, 2012). It is likely that, before every non-person gaze target of pedagogical relevance, teachers are making eye contact with students, in keeping with gaze following procedures (Böckler et al., 2014). Moreover, from teachers' attentional gaze in particular, it can be argued that expert teachers' gaze reveals that the wider importance of student-centredness, beyond teacher gaze direction, transcends cultures. The present proportion measures (Brandstätter et al., 2006) and scanpath analyses (Llewellyn-Thomas, 1968) supporting this pattern further demonstrate the priority that students are to expert teachers. That is, the fact that experts in the present study used more student gaze than any other gaze not only shows that effective classroom teaching involves looking primarily at students but also—and more importantly—that students take centre stage in teacher *cognition* itself. Such a conclusion regarding effective teacher cognition coincides with teachers' reports of using student-centred teaching in both East Asian and Western contexts (Sang et al., 2009, cf. Tondeur et al., 2009). Teachers with both cultural backgrounds also emphasise the centrality of knowing and caring for—or a rapport with—their students (Bryan et al., 2007). Chinese teachers speak of passion for their students' wellbeing in and out of the classroom; Australian and American teachers describe this aspect in terms of getting to know and establishing students' sense of their teachers' awareness of their personality and interests. Correspondingly, student engagement has been underscored among both Australian (and American) and Chinese samples (Bryan et al., 2007). In all, the present thesis gives resounding support to classroom observation systems such as CLASS (Pianta, La Paro & Hamre, 2008) that measure teacher effectiveness in terms of the behaviour, engagement, and productivity of *students* rather than teachers.

In support of Sternberg's prototype of expertise (Sternberg & Horvath, 1995), teachers in the present thesis excelled in their gaze flexibility. Expert vision usually involves higher transition rates between gaze targets (Gray, Hope, Sangster & Lindstedt, 2015), especially where task-relevant gaze targets are concerned (Sharma, Jermann, Nüssli & Dillenbourg, 2012) and between those that differ more in nature (Pande, Shah & Chandrasekharan, 2015) as was the case in the present transition analysis (i.e., between student and non-student regions). The present expert gaze flexibility additionally supports the flexibility that teachers have in general. The present expert teachers' visual flexibility relates to the greater flexibility with which experts perform their tasks in general. For example, chess experts are responsive to each situation, whereby developments on a chess board consistently trigger chess experts to amend their game plan to select a optimal effective response to the opponent's manoeuvre (Saariluoma, 1992). Similarly, medical experts more readily apply higher-order knowledge to identify alternatives to initial, more questionable diagnostic possibilities (Boshuizen & Schmidt, 1992). Likewise, expert teachers' visual flexibility seems to be an extension of the generally automatic way in which teachers are increasingly able to perform their tasks as they advance in expertise (Glaser, 1990). Indeed, expert flexibility reveals that they promptly adjust their lesson (Livingston & Borko, 1989)—or task performance (Patel, Arocha & Kaufmann, 1994)—plans according to wider priorities which, for teachers, are student needs and unplanned classroom events (e.g., Luft, 2001).

Another prototype of expertise (Sternberg & Horvath, 1995) that also emerged in the present study was efficiency. Just as experts make situation-appropriate decisions at a higher rate (Haider & Frensch, 1996; Haider et al., 2005) and are generally resilient against potential gaze targets that are irrelevant to their task performance (Starkes & Ericsson, 2003), so expert teachers displayed greater gaze efficiency by using significantly more classroom-relevant gaze than novices. The present experts demonstrated efficiency by showing greater 'stickiness' (Hollenstein, 2013)—or strength of efficient (i.e., relevant) gaze—during both attention and communication, whereas the same region of the state space was less sticky (i.e., weaker) among novices, whose gaze behaviour had yet to stabilise (Fogel, 2006). From the dynamic systems perspective, the efficient gaze types that have emerged from the present data constitute the most frequently occurring (Lewis, Zimmerman, Hollenstein & Lamey, 2004) behaviour among teachers which typifies—or represents—the essence of what gaze entails. Specifically, attentional and communicative focused gaze towards students are the preferable behaviours (Thelen & Ulrich, 1991) or 'habits' (Lewis et al., 2004) of classroom teaching and which should be less prevalent among teachers who are undergoing a transition period (i.e., novices). By focusing on classroom-relevant gaze during both attention and communication, the present expert teachers showed that they had reached the stage where cognitive load is minimised as they perform their task in as automatised a fashion as possible (Anderson, 1982, 1987, 2000; Feldon, 2007).

The final prototypic trait of expertise that was revealed in the present thesis among expert teachers was their strategic consistency. Experts across cultures demonstrated strategic consistency by showing significantly lower dispersion across the state space of teacher gaze as a whole. That is, novices used a significantly wider range of gaze types than experts when all gaze types (i.e., gaze occurring as teachers addressed student behaviour, questioned students, talked to students, referred to learning materials, carried out logistical tasks) were considered. This consistency in gaze strategy echoes Cortina’s finding that expert teachers used significantly more of one type of gaze—namely student-directed—than novices (Cortina et al., 2015). Consistent gaze strategy had also been highlighted in cognitive mapping research, where experts resorted to a singular, persisting problem-solving strategy more promptly and enduringly: this strategy was reflected both in experts’ lower gaze count and their manual problem-solving process (i.e., what participants moved and where during the cognitive mapping task; Dogusoy-Taylan & Cagiltay, 2014). The present finding coincides with extant literature highlighting strategic consistency as a core feature of professional expertise, too (Ericsson, 2006). For example, chess masters use consistent strategies to aid their memorisation (Chase & Ericsson, 1982). In dynamic systems terms, expert teachers operate with constructive ‘rigidity’ (Granic & Hollenstein, 2003), with behaviours that expert teachers are prepared to employ significantly more restricted than those among novice teachers.

9.2. Research Question 2: What is Cultural Teacher Gaze?

9.2.1. RQ2: Analysis-Based Discussion

Frequency analysis of teacher gaze revealed no cultural gaze patterns in attentional or communicative gaze. Temporal analysis, however, showed that UK teachers looked more at students than Hong Kong teachers during attentional gaze. This finding coincides with the sense, from previous literature, that student-centred teaching is more of a Western priority (e.g., Bryan et al., 2007; Reeve, 2009), whereas East Asians prioritise subject content (e.g., Leung, 2013; Myers et al., 1998). UK teachers also displayed more (i.e., stronger) efficient attentional gaze than Hong Kong teachers, where focused gaze (or fixations) at students was the priority, while Hong Kong teachers were more flexible in their attentional gaze. These findings sit together coherently: since UK teachers have a clear, single priority—to conduct student-centred teaching—attentional efficiency in using the relevant gaze type (i.e., student fixation) is needed to implement this cultural value. On the other hand, Hong Kong teachers have additional priorities alongside student-centredness, namely students' development in content knowledge: it follows that Hong Kong teachers would need more flexible gaze, as they transition more regularly between the comparably important targets that are students and learning materials.

In terms of scanpath analyses, communicative scanpaths were significantly more similar within culture suggesting that, on its own, culture plays a significant role in shaping scanpaths. This finding corresponds with previous literature in three ways. First, culture has been documented to shape verbal communication. For example, communication in some regions is characteristically high-context, whereas it is typically low-context in others (e.g., Gudykunst et al., 1996; Kim et al., 1998). Although culture does not necessarily dictate that a whole setting is one or the other, this literature highlights a broader likelihood that communication can involve contrasting approaches according to culture. That culture significantly predicts communicative scanpaths additionally corresponds with its importance in non-verbal behaviour, such as gestures. Gestures make opposing signals, depending on the culture (Archer, 1997; Kita, 2009). Gestures are also expansive or minimal, depending on culture (Efron, 1941; Ekman, 1973; Friesen, 1972). Moreover, specific gestures exist within specific cultures that are taboo or denote politeness (Kita, 2009). Classroom gaze, in particular, has only been documented to transmit positive signals regardless of culture (McCroskey et al., 1996). However, the impact and importance of this varies across cultures. That is, East Asian learners feel less of a need for teachers to exercise immediacy, which includes the use of gaze (Neuliep, 1997). There is the added risk of inadvertently using too much eye contact, which is unwelcome in East Asian classrooms (e.g., Cheng & Borzi, 1997). Indeed, there is direct evidence from outside the classroom that eye contact in East Asian settings holds a significantly greater risk of being interpreted negatively than in Western settings (e.g., Akechi et al., 2013).

9.2.2. RQ2: General Discussion

In general, culture played a greater role in attentional than communicative gaze. Cultural differences were only significant in attentional gaze *durations* towards students, with British teachers looking significantly more at students than Hong Kong teachers did. Additionally, cultural differences were only significant in attentional gaze *transitions* (or flexibility), with Hong Kong teachers transitioning at a higher rate than British teachers did. One possible explanation for the East Asian attentional flexibility is the holistic approach to perception (Nisbett & Miyamoto, 2005). Hong Kong teachers may have been moving their attention across the classroom more extensively with the relationship between students in mind, to gauge the overall state of the learning in the whole class, just as East Asian populations tend to be relationship-driven when they view stimuli containing multiple features (Kitayama et al., 2003; Norenzayan et al., 2002). A second potential explanation is the lower likelihood on average that a student would make a contribution in response to teacher questioning in East Asian settings compared with that in Western settings. Indeed, East Asians typically employ silent reflection during learning rather than active vocal participation (Kennedy, 2002; Wozniaková, 2015). Moreover, the teacher takes centre-stage more in East Asian classrooms (Bryan et al., 2007; Leung, 1995, 2013) and students might, in turn, be less ready to play an influential role.

The only instance where cultural differences were greater in communication than in attention was in scanpath comparisons. Teachers' gaze sequences were significantly more similar within than across culture during communication, but not during attentional parts of teaching. It seems that gaze sequences matter more during communication than during attention. Perhaps gaze sequences play a more significant role in communicative than attentional gaze due to the pointing function of teachers' communicative gaze. That is, the precise sequences of where the teacher leads students to look at during shared attention (Baron-Cohen, 1995) matters more during instructive, pedagogical, communicative parts of lessons, echoing the importance of precise gaze sequences for successful gaze following (Senju & Csibra, 2008)—including direct gaze (or eye contact) preceding the target of educational interest (Böckler et al., 2014). According to the present scanpath analysis, the sequence of classroom regions that teachers are guiding student attention to will differ in keeping with cultural priorities. Specifically, qualitative sub-string analysis suggests that only Hong Kong teachers used scanning gaze as a consistent part of their gaze sequences: scanning gaze towards students was completely absent among UK teachers. Hong Kong teachers may be sustaining their scanning gaze towards students to maintain their authority throughout their straight talk towards students as per Confucian (Leung, 2013) and collectivistic (Hofstede, 1986) tradition. Hong Kong teachers may also compensating for the shorter durations of fixation (i.e., focused) gaze towards students—due to the lower optimal duration of eye contact (e.g., Akechi et al., 2013; Cheng & Borzi, 1997)—by maintaining eye contact in a milder fashion, namely through scanning gaze. This thesis has thus emphasised the importance of delineating between communicative and attentional gaze (see Section 6.1. Gaze Events in Focus, Attentional and Communicative Gaze).

Where cultural differences occur in both attentional and communicative teacher gaze is in gaze efficiency. Teachers use higher rates of efficient attentional gaze in the UK; teachers use higher rates of efficient communicative gaze in Hong Kong. This finding however is likely an artefact of the differences in which attentional—or questioning, student-driven—teaching takes place in each culture. That is, Western classrooms are more likely to use student-led learning, whereas teacher-led learning is more prevalent in East Asian settings (e.g., Leung, 1995). Additionally, given that attentional gaze is typically related to passive cognition (Glaholt & Reingold, 2011; Land & Hayhoe, 2001) and the present UK teachers use more attentional gaze suggests that they take a more passive role to enable a student-led dynamic to the lesson (Bryan et al., 2007). In contrast, it may be that the higher rates of communicative gaze among corresponds with the way Hong Kong—and East Asian—teachers generally take a more active and dominant role in the classroom.

9.3. Research Question 3: What is Culture-Specific Expert Teacher Gaze?

9.3.1. RQ3: Analysis-Based Discussion

In frequency analyses, no cultural effects were found, but culture-specific expertise was identified in both attentional and communicative teacher gaze. In attentional gaze, East Asian non-expertise was demonstrated through greater use of *other gaze,* while Western European non-expertise was displayed by higher rates of *teacher material gaze.* It seems East Asian novices give misplaced priority to non-instructional gaze targets, whereas Western Europeans do so with their own materials. This cultural difference in novicehood—or, for experts, culturally developed priority—may be related to cultural differences in classroom priorities. East Asian education prioritises subject content (Leung, 2013), whereas Western European education prioritises the learner's experience and progress (Huang, Li & He, 2010). Expertise differences in each context are thus greatest on the gaze target that directly relates to their cultural nuance.

In frequency analyses of communicative gaze, expertise was demonstrated through culturally different uses of *teacher material gaze*. While experts in both settings used less teacher material gaze than their novices, the Western European expertise difference was notably greater than that among East Asian teachers. This finding thus extends Yamamoto and Imai-Matsumura's (2013) absence of expertise differences in attentional gaze to communicative gaze, using my East Asian sample. Additionally, East Asian experts used more communicative gaze at *teacher materials* than their Western European counterparts, suggesting that the East Asian priority of subject learning (Leung, 2013) is expressed in experts' communication as well as their attention. The lower optimal proportion of *student gaze* in East Asian classrooms (McCroskey et al., 1996) may also be reflected in this culture-specific priority for non-student gaze targets.

In temporal analyses, the prevalence of *attentional* gaze towards student revealed cultural differences. While both UK and Hong Kong experts used more student gaze than their novices, UK teachers used significantly more student gaze than their Hong Kong counterparts. This finding emphasises the importance given to students' experiences in Western classrooms (e.g., Castejón & Martínez, 2001), which is distinguished from the East Asian importance of classroom regions other than, or in addition to, student. Confucian thinking prioritises striving towards virtue (Li, 2005); collectivism means each student should concede to the wider good (Li, 2002, 2003). Moreover, East Asian students can be expected to be less expressive (Averill et al., 2001; Uchida & Kitayama, 2009), making them less complex and informative as attentional targets (Loftus & Mackworth, 1978) than their Western counterparts.

According to temporal analyses, the most task-relevant—therefore efficient—gaze differed across cultural settings. In turn, the rate at which each efficient gaze type was used significantly differed between experts of differing cultures. Specifically, efficient gaze in the UK involved attentional fixations on students, whereas efficient gaze in Hong Kong was communicative fixations on students. Furthermore, although experts in both cultures displayed stronger gaze efficiency in both attention and communication, experts in the UK used significantly stronger attentional gaze efficiency than experts in Hong Kong, while Hong Kong experts used higher rates of communicative gaze efficiency than UK experts. Cultural differences in ‘efficient gaze’ echoes cultural differences in prevalent teaching styles. Whereas Western education value student-led classrooms, East Asian teachers are more likely to have structured lessons that emphasise teacher responsibility (or teacher-centredness, Bryan et al., 2007). Moreover, whereas Western teachers value and excel in general pedagogical knowledge, East Asian teachers excel in subject- and pedagogical content knowledge (König et al., 2011; Zhou et al., 2006). East Asian learning typically involves a larger quantity and variety of tasks for students, per session, than that for their Western counterparts (Perry, 2000; Stevenson & Lee, 1995), which highlights subject-centredness arising from the East Asian pursuit of content knowledge. Given the cultural differences in emphases regarding classroom instruction, it was not surprising that what teachers—especially experts—considered to be efficient gaze behaviour differed across cultures.

In temporal analyses, Western expertise was revealed to involve greater strategic consistency in teacher gaze. This analysis has thus provided support for previously documented East–West differences in strategic consistency (i.e., lower dispersion; e.g., Imbo & Le Fevre, 2011). Contrary to my expectations, however, it was the Western expert–novice gap that was larger than the Eastern one. Indeed, strategic consistency seems to be a Western mark of teacher expertise. This finding resonates with—and sheds cultural light onto—Cortina et al.'s (2015) finding, that expert teachers in their Western sample distributed their gaze more evenly across the classroom than novices did. One reason for the absence of expertise differences in strategic consistency in the East could be due to collectivist values. Specifically, novices can be exercising uncertainty avoidance (Hofstede & Bond, 1988) by keeping unconventional strategies to the minimum. Equally, Imbo's notion of Eastern strategic stickiness may be at work, where experts and novices alike constrain their practices solely to those that have been promoted and are widely accepted.

In temporal analyses, East Asian expertise was shown to involve greater gaze flexibility in both attention and communication. Hofstede (1986) addresses the collectivist lack of status differences. It may thus be that 'uncertainty avoidance' drives Eastern teachers, where lower-status individuals avoid contradicting their higher-status seniors. Thus, the hitherto absence of Eastern expertise differences (Yamamoto & Imai-Matsumura, 2013) in teacher gaze may be explained by Eastern novices' culture-specific ambition to directly emulate experts'—or seniors'—classroom practice. My results suggest that conventional, static measures of teacher attention may in fact be a culturally-inappropriate approach to exploring Eastern expertise. Rather, it is dynamic flexibility, between relevant gaze behaviours, that distinguishes experts from among the Eastern teacher population. Related, cultures with gestural taboos move other body parts more to compensate for the lack of the prohibited gesture (Kita, 2009). In the same way, Eastern experts may be compensating for their culturally limited duration of extended eye contact by using more transitions. More transition in turn allows Eastern experts to obtain the same amount of information, overall, as if they used continuous eye contact in the way that Western expert teachers can.

In scanpath analyses, both attentional and communicative gaze differed most when teacher scanpath similarity within sub-groups was compared with that across sub-groups. This corresponds with the way effective teaching is characterised differently, depending on the culture. Whether the teacher strives for teacher- or student-led (Bryan et al., 2007), dialogic (Bryan et al., 2007), achievement-oriented (Leung, 2013) or individually reflective (Wozniaková, 2015) learning depends on the culture in which learning takes place. Indeed, expert teachers' tacit (i.e., practical) skill is more developed, enabling them to add more consistently and successfully take culture-specific values (Rubin, 1989) and classroom preferences (McLeod et al., 2004) into account.

Moreover, culture on its own failed to predict attentional scanpaths. Culture may therefore only be relevant to teacher attentional scanpaths when it is combined with expertise. If culture is regarded as a bottom–up factor, the present finding suggests that the *combined influence* of bottom–up with top–down processes are notably significant to teacher attentional gaze to the extent that, without expertise (which is top–down), culture would not have a role to play in teacher attentional scanpaths. One classroom-specific implication would be that classroom scenarios are only recognised as relevant—and gazed at accordingly—by experts when viewed in context of their cultural meanings. Hoftstede (1986) addresses precisely these differences. A teacher in the UK (an individualist setting) may consider silent learners to be a concern, whereas this would be normal in Hong Kong (a collectivist setting) since students expect to speak only when they are personally invited to do so. Related, intellectual disagreement between teacher and student in the UK would be normal, whereas in Hong Kong this is a concern since it violates the classroom harmony.

Regarding scanpath analyses, attentional gaze is documented to be shaped by an interplay between bottom–up and top–down processes outside the classroom. The role of an interaction between bottom–up (including culture) and top–down processes has been documented regarding attentional gaze in particular. Bottom-up visual features additionally *interact* with top-down processes to determine the destination of every gaze transition (Schütz, Braun & Gegenfurtner, 2011). Specifically, Schutz et al.'s (2011) review proposed that recognition and action goals interact with object (rather than feature; cf. Wichmann et al., 2010), motion-oriented (cf. Berryhill, Chiu & Hughes, 2006), plans of action in physical behaviour (cf. Hayhoe & Ballard, 2005), and during target selection (for where to act upon next, cf. Najemik & Geisler, 2005). For example, image regions are more likely to be gazed at if they are cognitively attractive, such as when they have semantic informativeness (Loftus & Mackworth, 1978). In further demonstration of the interaction between bottom–up and top–down processes, the first gaze targets of both healthy and visual agnosia (patients) observers were disposed towards salient targets initially, before top–down control took over—the more of which the observer had, the more comprehensive this top–down influence (which was measured by intra-observer consistency; Mannan, Kenard & Hussain, 2009). Humphreys, Riddich and Price (1997) demonstrated the interaction of top–down with bottom–up guidance in of gaze when they demonstrated that object identification (naming) fails, in spite of the presence of semantic knowledge. Moreover, Humphreys suggests that visual information is used—and shapes gaze direction—not only at the initial stages of object recognition (i.e., in a linear, additive, serial fashion), but also participates later on in the process (in an interactive manner). Thus while intra-individual consistencies exist in scanpaths implying top–down guidance, the features of the viewed stimulus also influence which target is viewed next (Noton & Stark, 1971). Human gaze sequences are thus guided both by inward 'priorities' and outward situational properties.

9.3.2. RQ3: General Discussion

Culture plays a significant role in defining what teacher expertise is in *both attentional and communicative gaze*. Both attentional and communicative gaze find British expert gaze comprising of lower teacher material gaze proportions; both gaze types find Hong Kong expert gaze entailing fewer 'other' gaze proportions and greater flexibility. In correspondence to the cultural preferences for classroom learning, the occurrence (rate and/or strength) of efficient gaze in each cultural group also the in-culture mark of expertise: attentional fixations on students constitutes British expertise; communicative fixations on students is Hong Kong expertise. Indeed, both attentional and communicative gaze sequences were more similar among teachers of the same expertise *and* cultural grouping than among teachers of different expertise and culture.

Together, it is clear that much visual expertise in teaching is culture-specific. The cultural dependency of teacher expertise resounds with the nature of expertise elsewhere, in skill acquisition (Sternberg, 2004, 2014) and in professional (e.g., see Furrer, Liu & Sudharshan, 2000, for customer service; Holroyd, Cheung, Cheung, Luk & Wong, 1998, for nursing; Westermeyer, 1987, for clinical diagnosis)—not least teacher (e.g., Berliner, 2001; Correa et al., 2008)—expertise. Sternberg (2014) argues that needs and priorities differ dramatically with culture. Whereas explicit knowledge regarding parasitic illness only needs to be just above chance level in the United States, absolute accuracy regions where such issues are prevalent such as Kenya. In Western regions, the strongest employee candidates are those with the highest qualifications; in other regions, the strongest employee candidates are instead those who have undergone apprenticeships in relevant vocations. In Western regions, those with the highest intelligence remain in education the longest; on the contrary, in Zanzibar, the brightest children were withdrawn from school the earliest. In all, Sternberg (2014) argues that the measure for effectiveness or expertise can be orthogonal across cultures and therefore entirely depends on the value each culture places on each behaviour. In the same way, the present thesis resoundingly sets forth the cultural dependency of what constitutes effective (i.e., expert) or ineffective teacher gaze.

Some culture-specific expertise was found only in *attentional* gaze. British experts showed significantly stronger attentional gaze efficiency than Hong Kong experts, while communicative gaze efficiency showed no culture-specific expertise. Attentional gaze flexibility also revealed culture-specific expertise, with expertise differences only found among Hong Kong teachers. One unified explanation can reasonably account for both these findings on culture-specific aspects of attentional expertise. There is an overarching cultural difference in ‘stickiness’ (Hollenstein, 2013): namely, it seems that stability in the type of gaze employed is a sign of expertise in the UK, whereas flexible and responsive teacher gaze takes precedence in Hong Kong. Thus, from Sternberg and Horvath’s (1995) prototype of expertise, different cultures thus *emphasise* different modules in each respective paradigm of effective teacher gaze. Western classrooms emphasise the efficiency (i.e., use of only the most relevant behaviour) and consistency aspects of teacher expertise; East Asian classrooms emphasise the flexibility aspect of teacher expertise. The Western experts’ emphasis on efficiency and consistency coincides with the wider value upheld by Western culture. In support, research literature on the development of efficiency on a political (Okun, 2015), economic (Farrell, 1957; Schmitz, 1999; Tabellini, 2010), sociological (Bolter, 1984; Finnemore, 1996) and educational (Neave, 1988; Aikenhead, 2001) level of Western society are most accessible. A quick survey of Western values soon brings home the much-prized process of isolating principles and protocols that are supreme in their rate of bringing about desired outcomes and should therefore be complied with in utmost consistency. In contrast, the East Asian emphasis on flexibility coincides with the general, ongoing aversion and risk of too much eye contact (Alston & He, 1997; Cheng & Borzi, 1997) and so East Asian experts unsurprisingly exercise more flexibility with where they are prepared to look in the classroom. Moreover, flexibility and readiness to attend to alternatives to the present (e.g., gaze) target coincides with the East Asian (or Confucian, Leung, 2013) minimisation of the individual and emphasis on the collective whole in general (Gill, Kharas & Bhattasali, 2007; Stiglitz, 1996). Gaze flexibility as East Asian expertise facilitates holistic perception (Nisbett & Miyamoto, 2005) and therefore coincides with associated cultural values (Hofstede, 1986; Triandis, 1989).

Some culture-specific expertise was also found in *communicative* gaze which was absent in attentional gaze. Namely, UK expertise involves a lower proportion of gaze towards student materials. This is likely to be due to student work being an aspect of classroom learning, in one moment, positively valued and pursued by East Asians and minimised and secondary among Western educators—who give more primacy to students' classroom processed and experiences (Correa et al., 2008; Huang et al., 2010). That is, since student work is of primary importance in East Asia, expertise differences among Hong Kong teachers are likely to have collapsed, with both experts and novices looking just as much at student materials as a result of the dominance of student content knowledge development (Leung, 2013). Additionally, the rate of efficient gaze only differed in communicative gaze when compared across expertise among Hong Kong teachers and across cultures among experts.

9.4. Research Question 4: How Does Teacher Gaze Relate to Teacher Interpersonal Style?

Universally expert interpersonal style was found in both attentional and communicative gaze, such that experts are rated to have greater agency than novices in both cultures. If agentic behaviour is the exercise of power and control, as opposed to communing behaviour which relates to the teacher–student harmony, then agentic behaviour may always be more urgently relevant in any classroom around the world, given the centrality of a well-managed classroom as a foundation for effective learning and other less urgent dynamics such as teachers' demonstration of understanding. That is, a well-structured classroom in which students know what is required of them is foundational before other aspects of classroom processes and relationships become relevant. A structured classroom is achieved through 'directing' teacher behaviour: once the lesson's expectations and direction is established, then both teacher and students are ready for communing experiences, as students begin taking responsibility and performing their classroom tasks. Preceding literature supports this notion, that agentic teacher behaviour takes precedence over communing teacher behaviour, for successful classroom learning. Close, or communing, teacher–student dynamics are only one of several classroom management features. Other aspects of classroom management include teacher understanding of current research thinking on effective teaching, the use of such instructional methods, techniques for student organisation, and effective handling of disciplinary problems (Jones, 1996). Indeed, much of classroom management research relates to the classroom control and organisation rather than the socio-emotional connection between teachers and students, associated with the communion dimension of the QTI. For example, classroom management research has highlighted the way clear verbal directions (i.e., highly agentic teacher behaviour) result in significantly better student behaviour than contrary teacher expressions (Brophy & Good, 1970). Likewise, student achievement has been correlated with stronger management skills among teachers (Good & Grouws, 1977) and frequent lesson transitions involving teacher communications of classroom expectations (Soar & Soar, 1979). Expert teachers also spend significantly more time spelling out classroom behavioural expectations than novices (Evertson & Emmer, 1982), which is directing and agentic behaviour.

Teacher culture was associated with teachers' overall interpersonal style (i.e., agency × communion) on its own and when interacting with expertise during both attentional and communicative parts of instruction. Specifically, British teachers were rated more highly in their interpersonal style than Hong Kong teachers overall. Meanwhile, it was experts scored higher on interpersonal style in the UK, but it was novices who scored higher in Hong Kong. In other words, expertise increases with interpersonal style in the UK but decreases with interpersonal style in Hong Kong. It appears that interpersonal style is a mark of British expertise whereas it is a sign of novicehood in Hong Kong. Related, communion is predicted solely by the moderation between expertise and culture, whereby British experts scored higher than British novices in communion, while Hong Kong experts scored *lower* than Hong Kong novices on the same dimension. There is clearly an orthogonal relationship between culture and communion, which might explain the cultural differences in 'expert interpersonal style' overall.

The likely explanation for lower levels of communion in Hong Kong is the lower inclination among East Asians towards communing relationships. As high-context learners (Morishima, 1981), East Asian learners prefer to be less verbally (or directly) involved during classroom discussions as reflected by their communication anxiety (Zhang, 2005)—especially with their teachers, who are figures of authority. Indeed, power distance is valued in East Asian (or collectivist) classrooms (Hofstede, 1986) and is implemented at a higher rate among East Asians than in Western classrooms (Lu, 1997). Moreover, it is easier to get communion 'wrong' among East Asian than Western learners, as a negative impact is significantly more likely with increasing immediacy among East Asians (e.g., on learning outcomes; Neuliep, 1997). It is therefore unsurprising that Hong

Kong experts in the present study were more restrained with their immediacy than their UK counterparts.

Expertise in teacher agency also demonstrated some culture-specificity in that, like those in the UK, teachers in Hong Kong demonstrated expertise by showing greater agency. While the two cultures thus paralleled in expert–novices differences, however, overall levels of agency were lower in Hong Kong than in the UK such that both experts and novices displayed lower levels of agency than their British counterparts. Hong Kong students may require less agency from their teachers because East Asian learning is typically more reflective (Hefferman, Morrison, Basu & Sweeney, 2010; Jin & Cortazzi, 2006; Kennedy, 2002) and less interpersonally involved (Leung, 1995;Wozniakova, 2015; Zhang, Huang & Zhang, 2005) than Western classrooms. It may be that East Asian students are more self-regulated than Western students (e.g., Purdie & Hattie, 1996), which coincides with the Confucian priority of virtuous behaviour over expression of the mind (Cheng, 1996; Li, 2005). In other words, East Asian students might display the same rate of disruption, but with a lower maximum in correspondence with their lower levels of classroom involvement in general (Biggs, 1996). Indeed, the way a collectivist (inter-dependent) student regards others in the classroom will be markedly different from the way an individualist (independent) does so. The collectivist perspective of others in the classroom is that they are part of one unit, or community, in which harmony should excel. The individualistic perspective of others in the classroom is that they are fellow candidates at best, even opponents, in the academic race, making confrontation and competition acceptable—even culturally endorsed (Li, 2003).

To move onto considering the relationship between teacher gaze and teacher interpersonal style, I begin by addressing attentional gaze. In attentional gaze, teachers' interpersonal style improved as teachers looked more at students. Specifically, the more teachers looked away from non-student areas, the better students' ratings of their interpersonal style was. In communicative gaze, the opposite pattern was true: the more teachers looked *toward* non-student areas, the better their interpersonal style.

Longer attentional gaze durations reflect greater importance placed on the viewed target (e.g., Mackworth & Bruner, 1970). The gaze target is also shown to be deeply processed (Kuperman et al., 2008) and to possess greater complexity than its counterpart (Chapman & Underwood, 19988). As expected, teacher interpersonal style improved with decreasing non-student *attentional* gaze durations. The inverse of non-student targets—namely, students—can in turn be inferred as the prioritised classroom regions. Student-centred teaching has thus been highlighted as positively associated with stronger interpersonal teaching style. This finding echoes classroom climate research, which has long emphasised the benefits of student-centred (or autonomy-supportive) teaching styles for student motivation (Diseth & Samdal, 2014; Reeve et al., 2004). When teachers adopt and sustain an approach to the classroom which gives students control and centre stage, teachers are giving students room to exercise self-determination (or intrinsic motivation). In turn, self-regulation is more likely (Burman et al., 2015; Pintrich et al, 1994), deeper learning can take place (Ciani et al., 2011; Vansteenkiste et al., 2004) and learner persistence is increased (Lee et al., 2010; Pelletier et al., 2001; Ratelle et al., 2007).

The finding regarding communicative, however, was contrary to expectations. That is, converse to attentional gaze, longer durations of *communicative* gaze towards non-student regions are related to improving teacher interpersonal style. This finding was unexpected, given that interpersonal connection has long been reported to increase as eye contact increases in educational research. For example, expert teachers place more importance on immediacy behaviours—which include eye contact with students—than novices do (Turman & Schrodt, 2006). Correspondingly, teachers have higher credibility

(Johnson & Miller, 2002) and seem more validating (Kerssen-Griep & Witt, 2012) when they gaze more towards their students. Whereas teachers' interpersonal style in one culture might have improved with eye contact while it declined in another culture, the present analysis has controlled for culture and suggests that, regardless of culture, teacher interpersonal style declines with eye contact.

The function of teacher gaze—other than to achieve immediacy and warm connection—is likely to be at work. One explanation is that teacher gaze universally conveys threat more than anticipated. There is a family of vision research that regards eye contact in evolutionary terms, where direct gaze is understood as a competitive and survival device. This tradition highlights how the eyes are integral to facial and emotional expression—a role consistency seen among primates in general (Andrew, 1963a, 1963b; Jolly, 1972). A whole catalogue of emotions is universally shown among primates through consistent eye shapes in conjunction with surrounding facial features (van Hoof, 1967). For example, relaxation is characterised by eyes being in neutral position with the iris only partially exposed, whereas alertness is shown through fully opened eyes. Of particular relevance are dominance and submission signals, with dominance being shown by the level (unraised) head supplemented by level eye direction, and submission shown through raised head and eyes (Perrett & Mistlin, 1991). In support, superior members of a primate community are typically those *receiving* attention and central to others' gaze (Chance, 1967). In parallel, teachers may have rank-order importance in the classroom, which means students should be looking at them consistently rather than the other way around. The present study may thus have tapped into the dominance signals of teacher gaze rather than the immediacy, communing and warm properties of eye contact with students.

A second explanation is that effective use of the referential triangle (Tomasello, 2000) through gaze shifts (Senju & Csibra, 2008) is a significant contribution to an optimal interpersonal style. This finding coincides with the way humans are born with the expectation to learn through adult gaze (Farroni et al., 2004)—a central learning resource that directs the audience attention to the relevant source of information (Brooks & Meltzoff, 2002). Indeed, human learners persist in giving importance to teacher gaze direction until adulthood (e.g., Böckler et al., 2014). Effective use of 'shared attention' (Baron-Cohen, 1995) is not surprisingly what students expect from teachers, even when they are not rating teachers' pedagogical performance, but addressing socio-emotional efficacy that is their interpersonal style. During information-giving parts of lessons, then, the 'pointing' role (Findlay, Brown & Gilchrist, 1997; Findlay & Gilchrist, 1998) of teacher gaze has a more significant role than expected.

The natural pedagogy function of teacher gaze thus matters in the classroom, such that It may thus be deduced that students expect teachers to use their gaze for instruction and in relation to classroom resources; they do not solely require eye contact from teachers. The introduction to this thesis did address the pedagogical role of adult gaze among humans. In natural pedagogy, gaze following occurs among humans, whereby the learner (or child) uses the gaze of the teacher (or adult) to discover properties of objects in the world (Csibra & Gergely, 2009): this attention sharing structure is known as the referential triangle (Tomasello, 2000). Preceding (and presently cited) literature emphasise the importance of direct gaze (Farroni et al., 2004), but the present analysis highlights the importance of averted gaze—directed at pedagogically relevant areas (cf. Hains & Muir, 1996) rather than irrelevant (i.e., 'other' or non-instructional non-student attentional) gaze targets. Therefore, beyond eye contact, teachers' effective use of shared attention has presently emerged to be unexpectedly important in maintaining an effective teacher interpersonal style. Indeed, human learners persist in giving importance to teacher gaze direction until adulthood (e.g., Böckler et al., 2014). Thus, effective use of 'shared attention' (Baron-Cohen, 1995) is not surprisingly what students expect from teachers, even when they are not rating teachers' pedagogical performance, but addressing socio-emotional efficacy that is their interpersonal style. Teachers' use of gaze following is relevant and important during communicative—that is, information-giving and instructive—parts of lessons.

To move onto considering the relationship between teacher gaze and teacher agency, I again begin by discussing attentional gaze. In attention, teacher agency is significantly associated with shorter durations of gaze towards non-student regions. From this finding, I can inversely infer that teacher agency improves with increasing durations of teacher gaze towards students. Teachers thus display greater agency when they operate in a student-centred way, giving importance (e.g., Mackworth & Bruner, 1970) to students while seeking information and responses from them. Indeed, durations of teacher attentional gaze direction is a sure way for students to gauge their teacher's priorities, since visual attention is involuntary by nature: that is, it would not be possible for teachers to deliberate manipulate where they look when they are using attentional gaze, due to the intensive nature of gaze behaviour—in one second, a number of gaze shifts can take place which can hardly be consciously employed (Glaholt & Reingold, 2011). Rather, attentional gaze is very much guided by the overarching task—or priority—at work (Land & Hayhoe, 2001), such that the internal and genuine priorities of a teacher are 'betrayed' by their gaze (Yarbus, 1967; De Angelus & Pelz, 2009). Furthermore, since attentional selectivity increases with task complexity (Glaholt, Wu, & Reingold, 2010)—and teaching is widely recognized to be a high-complexity profession (e.g., Berliner, 2001; Feldon, 2007)—I can be confident that students can make accurate judgements of their teachers' priorities. If a teacher truly takes a student-centred approach to teaching, then their attentional gaze will reveal so. In turn, student-centred teaching results in the teacher agency: a finding supported by preceding research outside of eye-tracking. For example, teachers are rated to be more credible when they display more immediacy behaviours, including gaze at students (Johnson & Miller, 2002; Kerssen-Griep & Witt, 2012).

In communication, teacher agency is significantly associated with greater durations of gaze toward non-student regions and higher proportions of teacher gaze towards student materials. From this finding, it can be concluded that the use of gaze following enhances teacher influence, as teachers direct students' gaze towards students' tasks. The primary purpose of teachers' communicative gaze is therefore to lead students in carrying out learning tasks, using their own (i.e., teachers') gaze shifts and re-direction (Senju & Csibra, 2008). Natural pedagogy (Csibra & Gergely, 2009) is thus central to classroom communicative gaze and occurs through shared attention (Baron-Cohen, 1995) between teachers and students. In correspondence with the prevailing function of adult gaze being to identify learning opportunities for the children (Vrijj et al., 2006), teachers most often identify students' tasks as their primary avenues for learning opportunities.

The primacy of communicative clarity for teacher agency during teacher communicative gaze relates to the importance of teacher clarity. Instructors achieve teacher clarity when they keep students' misunderstanding of their intentions and messages to the minimum (Chesebro, 1999; Eisenberg, 1984). This is achieved through maintaining a focus on classroom areas that are subject-specific (Livingston & Borko, 1990; Lundqvist et al., 2008) and that relate closely to learning goals (Chesebro, 2003; Lundqvist et al., 2008; Seidel et al., 2005). In particular, explanations around learning materials—such as student materials in the present thesis—will be detailed (Leinhardt, 1989). The QTI conceptualisation of teacher agency is that it is an interpersonal dimension. Correspondingly, teacher clarity is also conceptualised as a relational variable by its leading scholars (e.g., Eisenberg, 1984). For example, clear teachers have been distinguished from unclear teachers as those who give individualised help to students, explains then gives students thinking time, and both instructs what students should do *and* explains how students should go about their task (Bush, Kennedy & Cruickshank, 1977). Such student perceptions of teacher clarity are intrinsically interpersonal (or relational) in nature (Civikly, 1992). Teacher clarity is thus a key aspect of teacher interpersonal style and the present thesis highlights non-verbal behaviours, such as gaze direction, to play a role in shaping teachers' communicative clarity.

Finally, to move onto considering the relationship between teacher gaze and teacher communion, I once again discuss attentional gaze first. Teacher gaze only relates to teacher communion during attention. Specifically, teacher communion improves with decreasing proportions of non-student gaze, including teacher materials, student materials, other gaze targets. Even though attentional gaze is conventionally automatic (e.g., Glaholt & Reingold, 2011), that *proportion* gaze measures are those significantly related to teacher communion highlights the active role teachers play in their communing gaze. That is, since proportion measures reflect ongoing, deliberate strategies (or policies) that a teacher is using (Bröder & Schiffer, 2003; Glöckner & Betsch, 2008), the present finding suggests that teachers are actively implementing a set of priorities (Brandstätter et al., 2006) in order to achieve higher communion with their students.

It makes intuitive sense that highly communing teachers are those that are deliberately aiming to foster a student-centred environment, given that students are unlikely to make contributions as requested by teachers if teachers' behaviour towards them do not make them comfortable and confident. Indeed, there is cross-cultural consensus that student-centredness—that is, conveying the importance of students and their contribution—is critical and conducive to classroom experiences and involvement (Bryan et al., 2007; Sang et al., 2009, cf. Tondeur et al., 2009). There is much evidence for the importance of student-centredness to students' emotional security (Harslett et al., 1999) and subjective sense of relevance to classroom proceedings (Opdenakker & van Damme, 2006). The link between teachers' communing behaviour and a positive classroom climate is intuitive and well-established (Brackett, Reyes, Rivers, Elbertson & Salovey, 2011): students both feel more at home and comply with teacher requests (or expectations) more when teachers are more communing. In addition, students with higher communication anxiety (e.g., apprehension of answering teachers' questions) will display greater non-immediacy in the classroom (O'Mara, Allen, Long & Judd, 1996): this gap between anxious students and classroom goings-on can be closed by teachers when they, themselves, exercise immediacy towards students such as through increased eye contact and attention towards student areas—thereby giving the importance to student contribution. In support, teacher immediacy (e.g., gaze towards students) is correlated with reduced student anxiety (Ellis, 1995, 2004), student motivation (Frymier, 1993) and even peer connectedness (Sidelinger & Booth-Butterfield, 2010).

9.5. Limitations

9.5.1. Limitation 1: Generalisability

Generalisability was a potential limitation to the present study. Ours was a relatively small sample (i.e., 40 teachers), with only a few schools. In each sub-group of teachers, there were only ten participants. While this is sort of sample size is large compared to most glasses eye-tracking studies (e.g., MacDonald & Tatler, 2015) and comparable with others (e.g., Cortina et al., 2014), it is still a relatively small sample size for drawing population-wide conclusions about effective teaching practice. I therefore ran a post-hoc power analysis for the sample size used in this thesis. Post-hoc power analysis was conducted using G*Power (Erdfelder, Faul & Buchner, 1996) for the MANOVA prediction of attentional student and non-student gaze duration per visit by expertise and culture, the statistical power using our effect size observed (η_p^2= .36) and sample size (N = 40) was determined to be β=.99, which satisfied the standard β=.80 power requirement. Indeed, noteworthy and significant gaze patterns were found for every research question, expert, cultural and culture-specific expert teacher gaze. On balance, it was likely that the present sample size was sufficient for the research questions asked.

For cultural conclusions, my UK teachers were sampled with a younger age group than my Hong Kong teachers, bringing generalisations from the Western findings into question. Moreover, its colonial past and multi-cultural demography has meant that Hong Kong has been used as a bi-cultural sampling population (e.g., Hong, Morris, Chiu and Benet-Martínez, 2000)—even for comparisons with ‘more Chinese’ participants recruited from the People’s Republic of China (e.g. Ralston, Gustafson, Elass, Cheung & Terpstra, 1992). My Hong Kong sample may thus be insufficiently characteristic of East Asian teachers, reflecting less culture-specific attentional and communicative gaze patterns than desirable. Future research into East Asian teacher gaze might therefore consider using a less bi-cultural sample population.

9.5.2. Limitation 2: Control

Mine was a highly naturalistic study. Other than Cortina et al. (2015), no published research on teacher expertise has brought eye-tracking into the classroom itself. However, limitations of real-world research apply to the present paper. Contrary to what is possible in laboratory studies, the precise nature of the ‘teacher-centred’ activity that I sampled could not be standardised across all participants for us to derive gaze patterns in relation to exactly the same instructional processes. Moreover, research in real schools will be affected by the restrictions of school life: the time of day, school calendar and school profile will all impinge on sampled classroom events. Yet, this study took an opportunity to investigate teachers' attentional gaze in greater detail than in the past (cf. Cortina et al., 2015) and pioneered investigations into communication through teacher gaze. Because of the inevitable range of didactic acts that real-world teaching will involve, cognitive strategy could also be explored—which would not have been possible in the laboratory. In any case, by adding class size variations into my statistical analyses, I have gone some way to ensuring that teachers in my sample are comparable, apart from the expertise and cultural differences that I have deliberately put in place.

9.5.3. Limitation 3: Student Learning

A third limitation is that, while we know how expert teachers differ from novices, I do not have direct measures of student learning. I therefore cannot ascertain if the present expertise differences result in improved student learning. Though Palmer et al.'s (2005) criteria for expert teachers are associated with superior student performance, I have not analysed the correlation between expert teachers' gaze with their students' learning outcomes. It will therefore be informative if future research will obtain measures of student outcomes to clarify the relationship between teacher gaze and student learning.

9.5.4. Limitation 4: Peripheral Vision

Peripheral vision is likely to have affected the present teacher gaze data. First, there is the matter of covert attention, which is the shift of mental focus without movement of the eye. Covert attention has been demonstrated through the rapid serial visual presentation (Weichselgartner & Sperling, 1987). In this procedure, sequences of 25 numbers were shown within 800 milliseconds, a time period impossible for deliberate eye movements. Meanwhile, participating adults were to look for a target number. The target was either a number outlined by a square or one that was highlighted *and* outlined by a square. Once the number sequence disappeared, participants were to the first four numbers that they could remember from the sequence. The target number was always remembered, but so were the numbers surrounding the target. Thus both deliberate and non-deliberate attention has been shown while the eyes remain stationary. Neurological research further supports covert attention when animals are looking towards the opposite direction to the visual field location whose neurons are firing (Treue & Maunsell, 1996). Other than these studies evidencing involuntary, non-deliberate peripheral awareness, research has also shown the possibility of voluntary, deliberate peripheral 'vision'. That is, judgements can be made regarding unattended regions. In support, undergraduates were able to make correct—and significantly more accurate—judgements on whether a line appearing in peripheral vision was vertical or horizontal (Hunt & Kingstone, 2003; see also Moore & Egeth, 1997; Yeshurun & Carrasco, 1998).

The second way in which peripheral vision is problematic to the present thesis is that experts are known to excel in their recruitment of peripheral attention. The argument for expert holistic perception that experts use significantly more advanced and efficient search strategies that recruit peripheral awareness (Gegenfurtner et al., 2011; Kundel et al., 2007). This expert ability to use peripheral vision has been described as an exceptional 'visual span' that puts experts at an advantage for speedy information processing (Reingold et al., 2001). The present data about expert gaze behaviour is therefore at least uncomprehensive of everything experts do with their classroom gaze. There is even the risk that some crucial attentional manoeuvres are overlooked by using only overt measures of teacher attention.

9.5.5. Limitation 5: Temporal Analysis

It seems immediately relevant to discuss the gaze and didactic categories that I have used. The analyses in this part of the thesis are limited to five didactic behaviours and five gaze behaviours. Clearly, this is not comprehensive for both behavioural streams. Evidence is in my coding process itself, where I had applied more than five codes for the didactic behaviours that I collapsed for analysis (see 2.4.1 and 2.4.2). Indeed, five codes for gaze behaviours is also a limited reflection of the range of behaviour types that one can look at in the classroom. Yet, the nature and purpose of extended gaze at one student is likely very different from sequences of extended gaze at whole groups of students at a time. On the other hand, it can be argued that five of each, didactic and gaze behaviours, in one state space has created a relatively large state space compared with other state space grid studies carried out across the disciplines (e.g., Dishion, Nelson, Winter & Bullock, 2004; Granic & Lamey, 2002; Murphy-Mills, Bruner, Erickson & Côté, 2011). Thus, my state space was very much an attempt at balancing between a parsimonious and an authentic representation of real-world teacher gaze.

9.5.6. Limitation 6: Gaze Efficiency Analysis

Attractor presence (i.e., how much a teacher used the most classroom-relevant gaze type, or the 'rate of efficient gaze') was problematic for drawing extensive conclusions. This is because the mean duration of each the two most popular teacher gaze type is not a standardised (or relativized) by further accounting for the frequency of the gaze event. The interpretation of teachers' differences using this measure was therefore confined by the overall differences in the prevalence of this measure in each group. In the present research, Hong Kong teachers used more communicative teaching overall, in turn leading to them using more communicative gaze, which in turn meant they used more of the communicative attractor—namely communicative fixations on students. The same logic applied to British teachers with regard to attentional fixations on students. Unlike the duration per visit analysis in which I could state with certainty when one culture used one gaze behaviour more than another, gaze efficiency analysis was constrained by the cultural 'defaults' of didactic approaches (i.e., attentional or questioning in the UK; communicative or teacher-talk dominant in Hong Kong). I could never claim, in absolute terms, that teachers in Hong Kong were *more efficient* during communicative gaze, for example: rather, I could only identify name the gaze type that constituted Hong Kong teachers' 'efficient gaze', and likewise with UK teachers.

9.5.7. Limitation 7: Scanpath Analysis

The present sequential analyses provide additional support to the overarching suggestion in my thesis, that teacher expertise and classroom culture are important factors of teachers' use of gaze. Overall, these scanpath comparisons have demonstrated at a more detailed level. However, the present decision to analyse only event-based differences without accounting for duration may have been problematic. The analysis process highlighted that strings for communicative gaze, in particular, were too short to be included in the scanpath comparisons. By taking duration into account in the manner of ScanMatch (Cristino et al., 2010) might have resulted in communicative strings becoming adequate in length, as teachers may have viewed each respective gaze target for longer durations during communication than for attentional purposes. Nevertheless, to include indications of duration within each scanpath would reduce the variety of targets (or behaviours) contained within each string-of-ten. The present analysis reflected the present author's decision to prioritise exploring behavioural variation over duration-related insight. Subsequent scanpath analyses to this one can certainly include duration: it will be interesting to see whether the influences of teacher expertise and culture change and how duration information might add to (and detract from) the presently reported findings.

The similarity scores in the present thesis were, in themselves, very close to each other which can raise questions regarding the 'true' similarity shift according to expertise (or culture): does sharing expertise or culture 'truly' make teachers more similar in their scanpaths? Yet, extant similarity scores in the literature are comparable (e.g., Foulsham & Underwood, 2008), which suggests that the present similarity scores follow conventions in scanpath analysis to provide an adequate basis for drawing conclusions.

Finally, the decision to make ten the minimum number of gaze behaviours in each scanpath was not reached through a systematic statistical process. Nonetheless, this decision was supported by two considerations. The first was methodological, as the present author was motivated to move beyond the two-region transition analysis (Part II, State Space Grid analysis) to factor in sufficient variation within one string of teacher gaze and make further structural analyses worthwhile. Again, previous scanpath researchers have also used ten as the minimum string length (Humphrey & Underwood, 2009). The second reason for analysing strings of ten gaze behaviours was theoretical. That is, within-string variation needed to reflect the complexities of teaching, so that other preceding scanpath analyses involving strings of less than ten (i.e., five, Freeth, Foulsham & Chapman, 2011) did not seem appropriate. I therefore stand by my decision to analyse strings of ten gaze behaviours in the present scanpath analyses, although a statistically systematic route for identifying the optimal scanpath length should be explored.

9.5.8. Limitation 8: Hierarchical Regression Analysis

The present analysis involved hierarchical regression which has elucidated the relationship between teacher gaze and teacher interpersonal style, as rated by students. However, it would be interesting to find a multilevel structural equation modelling (MSEM) solution to explore the direction of relationships between the variables of interest, teacher expertise, culture, gaze and interpersonal style. The teacher sample required for SEM analysis would be five to ten participants (cases or observations; i.e., teachers in this study) per parameter (Kline, 2011): the present study has ten teachers per sub-group (i.e., expertise + culture, e.g., I have ten UK experts) which makes it adequate for more advanced analysis by Kline's convention. Others have suggested that in fact 50 cases are needed or even 200 cases, depending on family of multilevel that I ultimately use (e.g., modelmaximum likelihood vs. weighted least squares with adjusted means, Hox & Maas, 2001; Hox, Maas & Brinkhuls, 2010; Maas & Hox, 2005). For a more flexible solution, a Bayesian approach can be taken, where sample requirements are more lenient (e.g., Markov Chain Monte Carlo, Ferrari, Carrol, Gustafson & Riboli, 2008; Geyer & Johnson, 2012; Gelman, Carlin, Stern & Rubin, 2014).

9.6. Implications

9.6.1. Implication 1: Culturally Relevant Teacher Education

A number of contributions and commendations arise from this paper. One implication from this thesis relates to teacher education development. I echo the advice of preceding studies making cultural comparisons in education: East Asian teacher training curricula need to be more culturally embedded than it is at present (Leung, 2014; Nguyen, Elliott, Terlouw & Pilot, 2009; Zhou, Lam & Chan, 2012). On the basis of the present connection between culture and communicative gaze, East Asian teacher development programmes might reduce direct application from Western teaching practice and draw more from teachers' own cultural environment.

9.6.2. Implication 2: Teacher Interpersonal Gaze

Teacher interpersonal style, conceptualised as the interplay between agency and communion, is relevant across cultures. Where culture is significant in teacher–student relationship is the *degree* of agency—Western teachers need to exercise more agency than East Asians—and communion, with teacher effectiveness involving more of it in the West and less of it in East Asia. Indeed, a communing teacher interpersonal style is not only less beneficial to students in East Asia (Neuliep, 1997), but it can more easily become inappropriate and unwelcome (Cheng & Borzi, 1997). Teacher professional development programmes should therefore take cultural paradigms into account before making recommendations on the way teachers should behave towards students. While teachers will likely develop culturally appropriate manners for their context, as experts have in the present study, culturally attuned training can lessen the rate of unsuccessful interactions for beginning teachers. Since teacher–student relationships matter greatly to teachers (Klassen, Perry & Frenzel, 2012), culturally appropriated training on interpersonal behaviour can in turn heighten novice teachers' baseline motivation and self-efficacy and result in higher persistence rates in the profession.

While teacher gaze significantly predicts students' perceptions of teachers' interpersonal style, the only predictive relationship in combination with teacher expertise and culture is between communicative gaze and teacher agency. Teacher gaze seems therefore to be most important during communicative parts of teaching and most beneficial to the improvement of teacher agency. In application, teacher professional development curricula can perhaps relate teacher gaze most directly to the leading, influential and authoritative—agentic—aspect of a teacher's demeanour. Given that gaze following (Senju & Csibra, 2008) seems to be the crux of successful teacher agency, teachers should try to maximise the significance of their gaze in leading students through material and task instructions.

9.6.3. Implication 3: Teacher Gaze for Research Focus

Future research into teacher gaze might focus on *fixations* and *student-oriented gaze* in priority over other gaze types available. The support from this thesis is found in the identification, through attractor analysis (i.e., winnowing), that it is teachers' fixations on students during attention and communication that are relevant to teacher analysis. In fact, 'scanning' gaze events were the earliest to be sifted out during the winnowing process. Indeed, the potential error due to limited data quality means that student-oriented saccades are in fact much limited in reliability and validity: that is, it is problematic to infer that a teacher is looking at a student during gaze that can only be coded as saccades rather than fixations because there is quite a chance that the ‘saccades’ identified from eye-tracking glasses technology are an artefact of measurement error and a limit sampling rate. In assessing a journal submission based on part of this thesis, a reviewer highlighted this very issue: “The separation between ‘gaze scan’ and ‘focused gaze’ may not come from functional use of eye gaze, but the quality of eye-tracking data. If the calibration was wrong or the data quality was low, it generates more scattered tracking which could be interpreted as ‘gaze scan’” (Anonymous Reviewer, 2015).

9.6.4. Implication 4: Multiple Analytic Perspectives on Eye-Tracking Data

The present thesis has highlighted the benefits of taking multiple approaches from both, static and dynamic traditions, to identify good teaching practice, especially teacher gaze. If only conventional—static—comparisons were made in teachers’ attentional gaze, then the Eastern marker of expert teacher gaze would not have been identified. Through flexibility analyses, Eastern expert–novice differences have been uncovered in the dynamic interaction between the student-oriented and non-student-oriented gaze behaviours, during teacher–student interacting (i.e., teacher attention). An implication from this thesis is therefore that more dynamic analyses of effective teacher behaviour should be used on eye-tracking data, as a supplement to continued static, aggregated measures. In particular, there is much scope in exploring analytic techniques that have typically been applied to dyadic interaction research, which can be adapted to dual behavioural stream research as I have done with the State Space Grid technique (Lewis et al., 1999) in this thesis.

Already, the present research has pointed towards a number of further analyses that should be conducted with the present data. To expand on the scanpath comparisons in a quantitative rather than qualitative manner (as in the present thesis), I will be exploring lag sequential analysis (Bakeman & Gottman, 1997; Cress & Hesse, 2013; Markell & Asher, 1984) which will enable me to identify the *way*—as well as the extent (as in scanpath comparisons) to which—teachers differ in their ‘cycles’ of gaze during different didactic acts (e.g., attention/questioning vs. communication/talking). I will compare gaze sequences of five during each, attention and communication, according to teacher expertise and culture. That is, do teachers who share a cultural setting using significantly more similar gaze cycles than those from differing cultural settings—and how do teachers in one cultural setting typically look? Namely, what are the typical gaze cycles (or sequences) of teachers in each cultural setting? As mentioned briefly above, this work would be adapting a technique dominated by interaction research, exploring two behavioural streams (i.e., didactic and gaze of the same teacher) rather than two individuals (e.g., the same behaviour from teacher and student, Erickson, Côte, Hollenstein & Deakin, 2011).

Cross-recurrence quantification analysis (CRQA) is another technique that can be extended from interaction observational research (e.g., Shockley, Santana & Fowler, 2003) to relate teacher gaze with other teacher behaviours. In fact, CRQA has already been quite widely used in eye-tracking research, not least in visual expertise (Vaidyanathan, Pelz, Alm, Shi & Haake, 2014) and gaze during social interaction (Ho, Foulsham & Kingstone, 2015; Richardson & Dale, 2005). In keeping with the extension existing techniques for deeper insight into teacher gaze, however, I would not be exploring when two people look at the same region and how much, as in conventional CRQA (e.g., Richardson & Dale, 2005). Rather, I would be looking at how teacher gaze during each, attention and communication, coincides with the simultaneous speech acts (or events or regions), to make possible the exploration of the relationship between what teachers look at and what they say.

Finally, just as varying analytic approaches to teacher gaze yields differing insight into the role of expertise and culture, so the variation of teacher interpersonal style analysis should shed new light onto the relationship between teacher gaze and teachers' interpersonal style. To go beyond the present static measures of teacher interpersonal style, the next step would be to apply an observational coding scheme to teachers' interpersonal behaviour, quantifying it on a moment-to-moment basis. To do this, Joystick analysis would be used which involves a computer joystick coding each individual teacher's interpersonal behaviour within the QTI circumplex framework (e.g., Pennings et al., 2014). Indeed, Joystick analysis is well established in relation to the Interpersonal Theory on which the QTI is based (Sadler, Ethier, Gunn, Duong & Woody, 2009; Sadler, Woody, McDonald, Lizdek & Little, 2015). This approach is possible even with the present eye-tracking data, according to some pilot coding work that I have done alongside an established QTI-Joystick researcher, Heleen Pennings. It would therefore be feasible and appropriate to use the Joystick technique for dynamic measures of teachers' interpersonal behaviour, in order to map 'teacher interpersonal gaze'.

10. CHAPTER TEN: CONCLUSION

The present thesis explored an important channel of human learning, namely teacher gaze. This research demonstrated that the role of adult gaze in human learning extends into the classroom in the form of teacher gaze, such that gaze is a notable aspect of effective teaching, or teacher expertise. Regardless of culture, expert teacher gaze prioritises students, is flexible and strategically consistent when compared with novice teacher gaze. Culturally, expert teachers in the UK show greater strategic consistency than novices and lower rates of teacher material gaze. In Hong Kong, expert teachers show greater gaze flexibility than novices and lower rates of ‘other’ (i.e., non-instructional and non-student) gaze. Thus, gaze not only indicates teachers’ expertise but also their cultural context. Additionally, when teacher expertise and culture have been taken into account, teachers’ overall interpersonal style and their agency are found to increase as attentional non-student gaze durations decrease and as communicative non-student gaze durations increase. Teacher communion is only predicted by teacher attentional gaze.

Conceptually, the present research has highlighted that student-oriented gaze is an especially relevant factor in teacher expertise and that culture is an important factor that can change the content of expert teacher gaze. Methdolologically, the present research has demonstrated the value of employing multiple analytic perspectives to build a comprehensive understanding of expert teacher gaze. By combining static with dynamic analyses, *what* expert teachers look at is corroborated across analytic perspectives. By conducting dynamic analyses in particular, it is possible to uncover *how* expert teachers organise their gaze, or the processes of teacher gaze. Together, it is contended that the present research makes significant conceptual and methodological contributions to the investigation of expert teacher gaze in the real-world.

Appendices

Appendix 1

QTI questionnaire for UK students

STUDENT QUESTIONNAIRE

This questionnaire asks you to describe the behaviour of your teacher. This is NOT a test. Your opinion is what is wanted.

On the next few pages you'll find 48 sentences about the teacher. For each sentence circle the number corresponding to your responses. For example:

	Never				Always
This teacher expresses himself clearly	0	1	2	3	4

If you think that your teacher always expresses himself/herself clearly, circle the 4. If you think your teacher never expresses himself/herself clearly, circle the 0. You also can choose the numbers 1, 2 and 3 which are in between. If you want to change your answer cross it out and circle a new number. Please use both sides of the questionnaire. Thank you for your cooperation.

Teacher's name_______________Year__________ My gender________Predicted grade/level_____________

	Never				Always
1. This teacher talks enthusiastically about her/his subject.	0	1	2	3	4
2. This teacher trusts us.	0	1	2	3	4
3. This teacher seems uncertain.	0	1	2	3	4
4. This teacher gets angry unexpectedly.	0	1	2	3	4
5. This teacher explains things clearly.	0	1	2	3	4
6. If we don't agree with this teacher we can talk about it.	0	1	2	3	4
7. This teacher is hesitant.	0	1	2	3	4

8. This teacher gets angry quickly.	0	1	2	3	4
9. This teacher holds our attention.	0	1	2	3	4
10. This teacher is willing to explain things again.	0	1	2	3	4
11. This teacher acts as if she/he does not know what to do.	0	1	2	3	4
12. This teacher is too quick to correct us when we break a rule.	0	1	2	3	4
13. This teacher knows everything that goes on in the classroom.	0	1	2	3	4
14. If we have something to say this teacher will listen.	0	1	2	3	4
15. This teacher lets us boss her/him around.	0	1	2	3	4
16. This teacher is impatient.	0	1	2	3	4
17. This teacher is a good leader.	0	1	2	3	4
18. This teacher realizes when we don't understand.	0	1	2	3	4
19. This teacher is not sure what to do when we fool around.	0	1	2	3	4
20. It is easy to pick a fight with this teacher.	0	1	2	3	4
21. This teacher acts confidently.	0	1	2	3	4
22. This teacher is patient.	0	1	2	3	4
23. It's easy to make a fool out of this teacher.	0	1	2	3	4
24. This teacher is sarcastic.	0	1	2	3	4
25. This teacher helps us with our work.	0	1	2	3	4
26. We can decide some things in this teacher's class.	0	1	2	3	4
27. This teacher thinks we cheat.	0	1	2	3	4
28. This teacher is strict.	0	1	2	3	4
29. This teacher is friendly.	0	1	2	3	4
30. We can influence this teacher.	0	1	2	3	4
31. This teacher thinks we don't know anything.	0	1	2	3	4
32. We have to be silent in this teacher's class.	0	1	2	3	4
33. This teacher is someone we can depend on.	0	1	2	3	4
34. This teacher lets us fool around in class.	0	1	2	3	4
35. This teacher puts us down.	0	1	2	3	4

36.This teacher's tests are hard.	0	1	2	3	4
37.This teacher has a sense of humour.	0	1	2	3	4
38.This teacher lets us get away with a lot in class.	0	1	2	3	4
39.This teacher thinks we can't do things well.	0	1	2	3	4
40.This teacher's standards are very high.	0	1	2	3	4
41.This teacher can take a joke.	0	1	2	3	4
42.This teacher gives us a lot of free time in class.	0	1	2	3	4
43.This teacher seems dissatisfied.	0	1	2	3	4
44.This teacher is severe when marking papers.	0	1	2	3	4
45.This teacher's class is pleasant.	0	1	2	3	4
46.This teacher is lenient.	0	1	2	3	4
47.This teacher is suspicious.	0	1	2	3	4
48.We are afraid of this teacher.	0	1	2	3	4

Appendix 2

QTI for Hong Kong students

師生互動行為問答卷 (QTI)

Wei, den Brok & Zhou (2009)

本問答卷不是請你評估你的教師，只是請你描述你的教師的行為。本問答卷沒有正確或錯誤的答案。 我們需要的是你的看法。

本問答卷包含 48 個對教師的陳述。對每一個陳述你需要選擇你的教師的實際行。比如：

這位教師把事情解釋得很清楚。 0　1　2　3　4

如果實際行為你選4，那就是說這位教師總是把事情解釋得很清楚。

學校__________________ 教師____________________ 班級______________

教師的行為

		從不				總是
1.	這位教師充滿熱情地談論教學內容。	0	1	2	3	4
2.	這位教師信任我們。	0	1	2	3	4
3.	這位教師似乎不太肯定。	0	1	2	3	4
4.	這位教師會出人意料地發脾氣。	0	1	2	3	4
5.	這位教師把事情解釋得很清楚。	0	1	2	3	4
6.	如果我們與這位教師見解不同，我們可以討論。	0	1	2	3	4
7.	這位教師很猶豫。	0	1	2	3	4
8.	這位教師很容易發脾氣。	0	1	2	3	4
9.	這位教師吸引我們的注意。	0	1	2	3	4

10. 這位教師願意把事情再解釋一遍。	0	1	2	3	4
11. 這位教師表現出無所適從的樣子。	0	1	2	3	4
12. 當我們犯錯的時候，這位教師急於糾正我們。	0	1	2	3	4
13. 這位教師對教室裡發生的事無所不知。	0	1	2	3	4
14. 如果我們要說什麼，這位教師願意傾聽。	0	1	2	3	4
15. 這位教師聽我們的指揮。	0	1	2	3	4
16. 這位教師不耐心。	0	1	2	3	4
17. 這位教師是一位好領導。	0	1	2	3	4
18. 當我們不懂的時候，這位教師看得出。	0	1	2	3	4
19. 當我們不認真的時候，這位教師不知如果應對。	0	1	2	3	4
20. 很容易同這位教師起沖突。	0	1	2	3	4
21. 這位教師很有信心。	0	1	2	3	4
22. 這位教師有耐心。	0	1	2	3	4
23. 愚弄這位教師很容易。	0	1	2	3	4
24. 這位教師喜歡諷刺人。	0	1	2	3	4
25. 這位教師在我們做作業的時候幫助我們。	0	1	2	3	4
26. 在這位教師的班裡，我們可以決定一些事情。	0	1	2	3	4
27. 這位教師認為我們抄襲。	0	1	2	3	4
28. 這位教師很嚴厲。	0	1	2	3	4
29. 這位教師很友好。	0	1	2	3	4
30. 我們可以影響這位教師。	0	1	2	3	4
31. 這位教師認為我們什麼都不懂。	0	1	2	3	4
32. 在這位教師的班裡我們必須保持安靜。	0	1	2	3	4
33. 這位教師是我們可以依賴的人。	0	1	2	3	4
34. 這位教師允許我們在上課時胡鬧。	0	1	2	3	4
35. 這位教師打擊我們。	0	1	2	3	4
36. 這位教師的考試很難。	0	1	2	3	4
37. 這位教師有幽默感。	0	1	2	3	4
38. 這位教師不太處罰我們。	0	1	2	3	4
39. 這位教師認為我們不能把事情做好。	0	1	2	3	4
40. 這位教師的標准很高。	0	1	2	3	4
41. 可以同這位教師開玩笑。	0	1	2	3	4
42. 這位教師在課上給我們很多自由時間。	0	1	2	3	4

43. 這位教師看上去不滿意。	0	1	2	3	4
44. 這位教師改作業時很嚴。	0	1	2	3	4
45. 上這位教師的課很愉快。	0	1	2	3	4
46. 這位教師對學生很寬容。	0	1	2	3	4
47. 這位教師疑心很重。	0	1	2	3	4
48. 我們怕這位教師。	0	1	2	3	4

問卷調查結束。謝謝你！

Appendix 3

Teacher consent form (inc. cultural questions)

Student experiences of teaching styles

Teacher Consent Form

Researchers from the University of York are conducting a project investigating the relationship between teaching style and learner experiences.

I have read and understood the information given to me about the study and give my permission for ……………………………………(subject name) class to take part.

I have been informed about the aims and procedures involved in this research. I reserve the right to withdraw my class or any child if I think it is necessary at any point during the research and up to two weeks after the final assessment period. I understand that the information gained will be anonymous and that my students' names and the school's name will be removed from any materials used in this research.

Signed …………………………………………………………… (Teacher)

Print Name……………………………………………………

Demographic Details

This information is voluntary and is for monitoring purposes only. This section is designed so that we can monitor the diversity of participants who have contributed to our study.

1. Background Information

Date:						
Age:			**Gender:**	Male ☐		Female ☐
Ethnicity:	White ☐	Asian ☐	Black ☐	Chinese ☐	Mixed ☐	Other ☐

2. Class level: (year group)

3. Teaching subject:

4. Any disability you would like to disclose? (optional)

Identity Details

1. Below is a list of statements describing your mindset as a <u>person</u>. Please rate **<u>all</u>** of the following items on how important they are to you in your life, with 0 being "not important at all" and 6 being "most important".

If a co-worker gets a prize, I would feel proud.	
I'd rather depend on myself than others.	
It is important that I do my job better than others.	
Parents and children must stay together as much as possible.	
It is my duty to take care of my family, even when I have to sacrifice what I want.	
I rely on myself most of the time; I rarely rely on others.	
The well-being of my co-workers is important to me.	
Competition is the law of nature.	

2. Please select ***one*** of the following, as a description of your culture.

☐ European

☐ Middle Eastern

☐	South Asian	☐	East Asian
☐	Black American	☐	White American

3. Finally, please answer the following questions.

Where were you born?	
Where were your parents born?	
Where were your grandparents born?	

Appendix 4

Teacher experience form

Student experiences of teaching styles

Teacher Experience Details

Thank you for contributing your teaching and class to our study with the University of York UK. Please complete the following questionnaire. After this, you will be fully debriefed on the study details and your data as well as the research findings will be forwarded to your school, if you are interested.

1. How many years have you worked as a teacher? Please include your year(s) in training.

2. What, if any, professional memberships do you have? Please include your professional teaching qualification, if you have that.

3. What have been your average observational ratings, if you have had that?

5. ***For researcher to complete.***
   School designation for participant:

If you are interested in seeing the analysis of your data and/or would like to know our study's findings, please provide your email.

Participant email address: ____

Appendix 5

State Space Grid formulae

Formula1. Winnowing formula, for attactor (i.e., efficient gaze) identification.

$$Heterogeneity\ (H_{j)} = \frac{\Sigma\left(Observed_i - Expected_j\right)^2 / Expected_j}{\#\ Cells_j}$$

Formula 2. Transitional entropy formula for gaze flexibility.

$$P = \frac{\#\ A - B\ transitions}{\#\ \Sigma\ transitions\ from\ A}$$

$$Entropy = \Sigma(P_i \times \ln\left(\frac{1}{P_i}\right))$$

Formula 3. Dispersion calculation, for gaze strategic consistency.

$$Dispersion = 1 - \frac{(n\Sigma\left(\frac{d_i}{D^2}\right) - 1}{n - 1}$$

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