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Practices of Science Teachers: Evidence from Teacher Noticing

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Abstract: Teacher noticing patterns offer insights into in-the-moment decisions and actions of teachers that have a direct impact on students' learning. However, research on differences between novice and expert teachers' vision in lessons remain limited. Using a mobile eye-tracker, we collected and analyzed data from two science teachers. Findings showed that the expert teacher focused her attention on relevant information across the classroom, while the novice teacher's attention was restricted to specific problematic areas. As a work-in-progress, this paper provides valuable insights that we can build onto existential work for further studies.

Keywords: Teacher noticing, Eye tracking, Expert-novice differences

1. Introduction and Background

This is a study that leveraged the affordances of eye-tracking glasses to reveal teacher noticing patterns as lessons are conducted. Teacher noticing patterns are nuanced and predictive about teachers' in-the-moment decisions and actions (Mason, 2002), which have a direct impact on students' learning. However, existing research on teacher noticing has primarily focused on mathematics education with many studies highlighting the differences between novice and expert teachers (Star & Strickland, 2008; Erickson, 2011). To deepen our understanding of noticing patterns between novice and expert teachers in science teaching and learning, we observe what teachers pay attention to during classroom instructions, record videos of classroom scenes during instruction, and use the corresponding recorded video segments as concrete reference points for reflective dialogues among novice teachers, experienced teachers, and the researchers.

This study consists of two phases, namely, the implementation of a method to collect and analyze teacher noticing patterns via eye-tracking and the recording of classroom scenes, followed by interviews with teachers to elicit their thoughtful responses to the routined uncertainty that is encountered in classrooms as they reviewed video segments selected by the researchers. The eye-tracking research literature shows a variety of measures to investigate various aspects of a teacher's classroom practices for different subjects, such as the attention of pre-service teachers (Stuermer, Seidel, Mueller, Häusler, & Cortina, 2017) using fixation frequency and duration; and visual perception of classroom scenes and viewing strategies (Wolff, Jarodzka, van den Bogert, & Boshuizen, 2016) using fixation dispersion average and Area of Interests (AOI) revisits.

With regard to the use of reflective dialogue, most researchers have been relying on after-the-event recall and reflection, particularly Video-Stimulated Recall (VSR), a method that involves interviewing teachers as they watched video-recorded segments of their classroom instruction (Sturtz & Hessberg, 2012). Through this method, teachers will be able to gain insights into the unarticulated thinking and decision-making processes that effective teachers engage in while conducting instruction (Martinelle, 2018). Our research attempts to innovate methodologically by integrating the presentation of eye-tracking statistics and noticing patterns alongside the presentation of the videos so as to trigger teachers' unarticulated thinking and corroborate these with objective statistical cues.

This study reports the first phase of a larger study, which consists of data collection procedures, choice of measures, and the method to analyze eye-tracking and video data of classroom lessons. In order to identify differences in noticing patterns among novice and experienced teachers for reflective dialogue, we ask the following research question: "Do expert teachers and novice teachers differ in where they look during science teaching?"

2. Data Collection and Processing

The data for this study is collected from practicing teachers who teach secondary level students in Singapore. These teachers underwent formal pedagogic training and practicum before they entered into the teaching service. Teachers recruited in the study teach science and are classified either as an expert or novice, based on their years of experience and their appointment by the school. The literature on teacher competency showed that competency develops within the first few years of teaching, and five to seven years of experience allows teachers to build up sufficient skill and knowledge to be an expert (Berliner, 2004). In our context, a novice teacher within public schools is a beginning teacher who generally has three or fewer years of experience. An expert teacher will either be a senior or lead teacher with about a decade or more years of experience. We focus on teachers' instructions on similar topics in classrooms so that a fair comparison can be made about their noticing.

The expert and novice teachers were asked to mount an eye-tracker on their heads during data collection. The eye-tracker is able to record a video from the teacher's point-of-view with two embedded cameras monitoring the pupils of the teacher's eyes to interpolate the teacher's gaze point onto what the teacher sees in the actual classroom. This information and a series of video data were acquired and stored using D-Lab data acquisition software. The data is then run through a gauntlet of processes, including the calculation of glances, determination of fixations, and elimination of blinks and fly-throughs before it is ready for interpretation.

3. Method and Initial Results

Upon processing the data, we generated (1) a point-of-view (POV) video footage, which we refer to as the POV video in this paper, and (2) a set of eye-tracking statistics that is generated from the POV video. To interpret the data and make meaningful conclusions from the results, we first looked at the POV video that allowed us to

determine a set of Area of Interests (AOIs). These AOIs are regions that are marked out on video frames and represent important areas that teachers looked at during a science lesson. Examples of designated AOIs within a classroom environment include the various areas where students were seated and the front of the classroom where the whiteboard and projection screens are normally situated. These AOIs are marked out by the analysts and are similarly assigned for both of the two teachers' POV videos. Once the AOIs are determined, the eye-tracking statistics were calculated based on the teacher's gaze point among the boundaries of the AOIs.

There are many measures that range from glances to fixations and saccades within a suite of eye-tracking statistics; we chose two measures that are necessary for answering the research question in this study. The first measure is the *probability of glance location*. This measure gives an indication of the location in a classroom that the teacher would most likely be looking at and with probing in the reflective dialogue, we can gather insights into the teacher's actions during classroom instruction. The second measure is called the *transition period*. In contrast with the first measure, this measure reports the proportion of recording time, measured in percentage, that a teacher is not fixated on any of the AOIs within a classroom environment. In terms of teacher noticing, the measure of *transition period* helps to identify the percentage of time that a teacher is dwelling on non-teaching or non-student related areas of the classroom environment.

In this paper, we report data from two female teachers, a novice teacher with two years of experience and an expert teacher of 15 years of teaching experience. Both teachers were teaching science in a secondary school. Although we recorded an hour's worth of data for the novice and half an hour for the expert due to their teaching assignment, we have proportionately recalculated the novice's data and based our findings on percentages to ensure a fair comparison. The nature of both lessons is pre-dominantly teacher-led instruction interspersed with some student interactions.

The initial results in Figure 1 showed that when compared to the expert, the novice teacher was spending a relatively longer time fixated at the whiteboard and projection screen. From the video, we also observed that the novice teacher's appearance and posture was wavering when teaching some parts of the syllabus. A review of the POV video showed instances where the novice flipped through the presentation slides and moved back and forth among the slides before speaking. These actions highlighted her uncertainty with the contents in the slides. This hypothesis was affirmed based on the observers' field notes, and the teacher's reflection that she was unfamiliar with part of the content taught during the lesson. Both the novice and experienced teachers also spent a majority of their time noticing events on the left side of the classroom, as some students were off task and required the teacher's immediate attention to avoid further disruptions to the lesson. Comparing the novice and expert teachers, shorter gaze time and thus lesser attention was required by the expert teacher in managing the students and although the issue was persistent throughout the lesson, the expert teacher was able to deal with the problem in a shorter amount of time than the novice teacher.

Concerning the transition periods for both teachers, the novice teacher spent 95.5% of her time noticing events and actions between the various AOIs. In contrast, a lower percentage of the expert teacher's time (84.8%) was spent in transition between AOIs, which means she had more time to focus on students and their actions during the lesson. This is corroborated with the findings shown in Figure 1, as the expert teacher was able to devote more time to notice other parts of the classroom, such as the right portion of the classroom, which the novice skipped due to the more pressing events occurring at the left portion of the classroom. This finding aligned with features of professional expertise (Chi, 2006) that suggested experts are able to notice and focus on features that novices tend to miss. A summary of the differences between the novice and expert teachers is shown in Table 1.

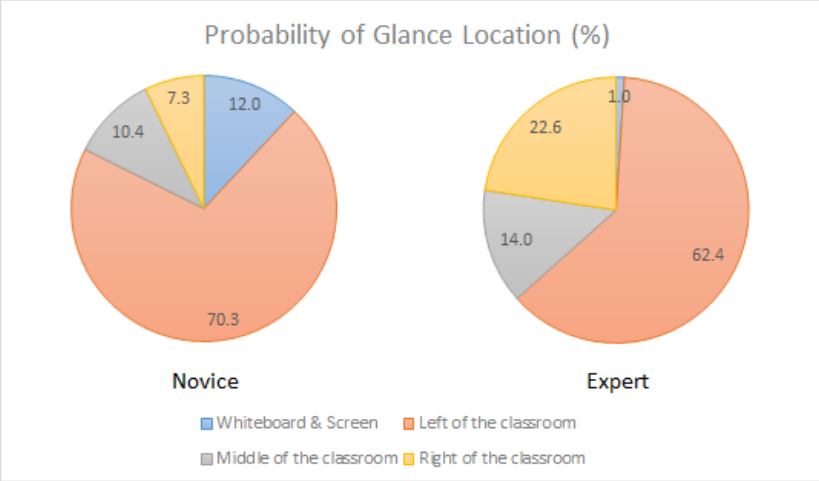

Figure 1. Comparison of glance location probability between novice and expert

Table 1

Summary of teacher noticing differences between novice and expert teacher in this study

Novice Teacher	Expert Teacher
Fixations predominantly occur on a certain section of the classroom	Fixations were more evenly spread out across the classroom
A large amount of time was spent in transition between AOIs, with little balance time for other features around the classroom	Relatively more time can be spared to notice other AOIs in the classroom
Likely skipped areas that might have cues and events due to inexperience	Able to systematically scan and devote more time to areas that require attention

4. Conclusions and Planned Work

We implemented a method to collect and analyze eye-tracking measures that provided insights into teachers' attention and areas of focus during lessons. From the eye-tracking measures and the POV video, the expert teacher interpreted and handled events differently from the novice teacher, whose attention was scattered and

confined to limited regions of the classroom with problematic scenes. The differences in noticing patterns between the two teachers are presented in a dichotomous manner in Table 1. In reality, these differences would likely occur in a continuum along a scale. The findings presented in this paper showed that there were more differences in noticing between expert and novice teachers, which could be discovered (1) with the implementation of reflective dialogue in the second phase of the larger and subsequent in-depth study and (2) by coupling the eye-tracking data with traditional in-depth video and discourse analysis. More in-depth analysis using (1) and (2) would also enable similarities between the noticing patterns of novice and experienced teachers to surface. By considering the initial results as a baseline for future empirical tests with the same pair of teachers, we proposed that teachers articulate and adopt a sense of educational purpose or goal, so that the teachers may use it to guide attention in the noticing, interpretation, and action on events within a classroom.

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