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From Micro to Meso: Scaling of a Teacher Noticing Study

Alwyn Vwen Yen LEE* **& Seng Chee TAN**
National Institute of Education, Nanyang Technological University, Singapore
*alwyn.lee@nie.edu.sg

Abstract: Teacher noticing is specialized to its purpose of noticing events and students that are central to the teachers' professional goals. This study extended prior work of teacher noticing beyond case studies of individual classrooms into implementation across several schools, leveraging eye-tracking and video technologies to collect and analyze teacher-noticing patterns that complement video-based reflective dialogues for additional insights. Practices at the micro level (single school) were reconsidered and implemented at a higher meso level (across multiple schools) in this study. The findings show that differences between teachers' noticing patterns across schools may be attributed to school cultures, teaching strategies, and teacher beliefs, backed by eye-tracking data analyses and reflective dialogues.

Keywords: Teacher noticing, eye tracking, learning analytics, micro to meso, scaling

1. Introduction

Learning analytics, the use of analytics in the understanding of teaching and learning, has leveraged new methodologies and technologies to make sense of data and provide insights for the school stakeholders, including educators, learners, and researchers (Knight & Shum, 2017). It has an impact on teachers who co-design the analytics with researchers, monitor the implementation in the classroom, and readily seek out the value and benefits of applied analytics that may affect future lessons.

One specific area of impact is on improving teaching practices. Various mechanisms and concepts in teacher research have helped to improve teaching practices, such as professional learning networks (e.g., Ledford, 2016) and use of interactive online tools (e.g., Kuosa et al., 2016). However, in order to make learning activities more visible and accessible to the teacher, significant inroads into traditional eye movement research, which was previously limited to medical and psychological fields, have been introduced into educational science (Jarodzka, Gruber, & Holmqvist, 2017).

Noticing is a natural phenomenon of human sense-making to interpret one's goals during lessons; teacher noticing is specialized to its purpose of noticing events and students that are central to professional goals (Sherin, Jacob, & Phillip, 2011). Teacher noticing literature (Jacobs, Lamb, & Philipp, 2010; Schack, Fisher, & Wilhelm, 2017) has generally described noticing to encompass three processes, namely 1) attending to events in an instructional setting, 2) interpreting and making sense of noticed events, and 3) deciding if interventions are necessary based on the analysis. This set of procedures is similar to the theoretically grounded Learning Analytics Cycle (Clow, 2012) that conceptualizes learning analytics work as a cyclic loop to generate, analyze and inform learners. The latter step of informing the teachers, however, is lacking in some of the previous teacher noticing research procedures. This gap was addressed by researchers (e.g., Lee, Tan, & Tan, 2019) using a multilayered approach that aided teachers to adapt their practices in order to cater to dynamic student needs.

Although prior work was found to be effective at a micro level in a single school, the conceptualization and analysis of evidence for improvement in teaching and learning practices can also be conducted on a larger scale, as shown in this study, where the adopted practices were reconsidered and implemented at a higher meso level. This study aims to extend teacher-noticing research beyond case studies of individual classrooms to implementation across several schools, by leveraging on eye-tracking and video devices to gather and consolidate teacher-noticing patterns that are complemented with video-based reflective dialogues for additional insights. The research question guiding this study

is: “what are the differences between teachers’ noticing patterns across schools and what attributed to these differences, as shown by eye-tracking data analyses and reflective dialogues, in unfamiliar and novel situations?”

2. Methods

2.1 Participants

Three secondary schools across the country participated in this study, of which six teachers, two from each school, were involved. All six teachers underwent formal pedagogic training at a teacher preparation institution before they entered the teaching service. Each pair of teachers comprises an expert and novice teacher, differentiated by experience in teaching practice, and co-teach science lessons to a class in the same school. A novice teacher in the local context has less than three years of teaching experience at the point of this study, while an expert teacher often has more than 10 years of teaching experience and is usually appointed as a mentor for in-service novice teachers and student-teachers undergoing school practicum.

2.2 Data Collection, Processing, and Analysis

Each teacher taught a series of three lessons, during which the teacher was equipped with an eye-tracking device that consists of a forward-facing camera to capture what the teachers saw during the lesson and two inward-facing cameras to track the position of the teacher’s eye pupils. This enabled us to capture two kinds of data, namely, visual data showing what the teachers saw during the lesson and stored in the form of a Point-of-View (POV) video, and eye movement data that allowed us to calculate the teacher’s gaze in real-time and superimpose it onto the POV video. This is shown in Figure 1, where the teacher was reading off the text from a presentation slide during the lesson.

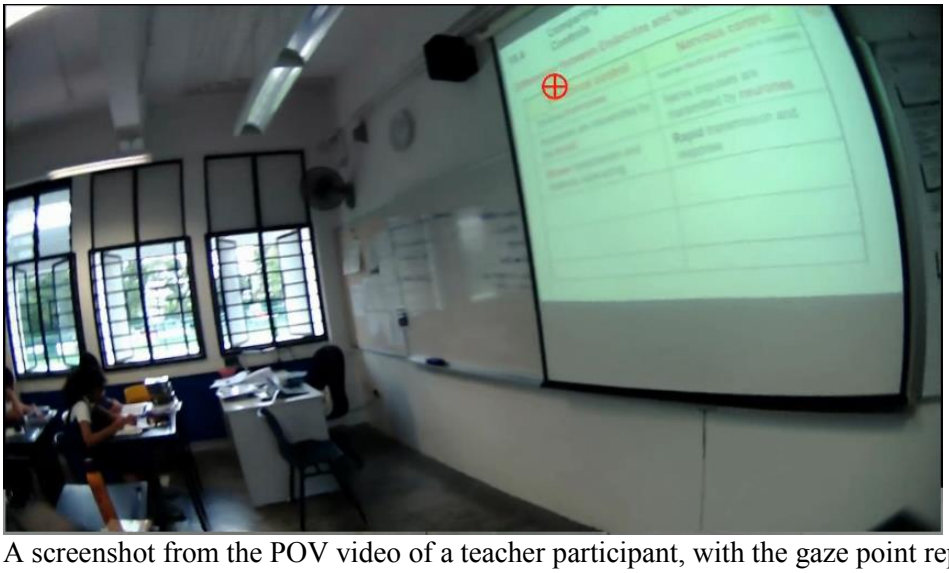

Figure 1. A screenshot from the POV video of a teacher participant, with the gaze point represented by an encircled red cross.

From our previous work (Lee, Tan, & Tan, 2019), we were able to distil insights from a single case study on a micro level. In this study, we scaled up the deployment for two more schools, using similar interrelated and cyclical processes in the multi-layer analysis to firstly scrutinize student activity in the classroom, followed by using a combination of video and discourse data to interpret teacher-student interactions, and finally including eye-tracking data into a concluding analysis for the entire

lesson. A summary of potential insights obtained from the respective layers of analysis is shown in Table 1.

Table 1. *Summary of insights obtained from the respective layers of a multi-layer analysis (Lee, Tan, & Tan, 2019)*

Layer of analysis	Potential insights from dataset	Example of insight
Basic layer – Elementary understanding using video analysis	The video analysis in the basic layer can provide an intrinsic understanding of happenings and actions in the classroom without specific attention to detail. This can be used to provide a narrative view of a whole lesson.	The teacher was seen to be communicating with a student as the student walked into the classroom.
Intermediate layer – A more thorough examination of interactions through video and discourse analyses	The discourse analysis helps to provide additional details regarding the interactions between the teacher and students. The transcript may also provide clearer indications that signal the intent of actions that the teacher may or may not subsequently take in the lesson.	The teacher was questioning the student on being late for the lesson, with a tone of frustration and a harsher choice of words, as shown in the transcript.
Final layer – Triangulated findings using a combination of video, discourse, and eye-tracking analyses	Eye-tracking data can provide clearer statistical and visual indications, such as the number of glances and conspicuous noticing patterns, of why certain actions took place and if any preceding factors (such as subjects or objects) were considered before eventual actions were taken by the teacher.	The teacher's gaze was in fact alternating between the late student and another group of rowdy students in the classroom, with intention to manage the rowdy students after the reprimand.

After each pair of teachers finished co-teaching a lesson, we conducted a review of the recorded lesson and selected segments of the video that showed teachers' engagement and interactions with the students for a prolonged period of time. For example, a teacher might be fixated at a portion of the class in silence for a significantly long time and this moment in the lesson could be selected to be used as a concrete talking point during the reflective dialogue with the teachers. This dialogue would also allow researchers to further understand the non-visible processes that were demonstrated in the classroom, such as the interpretation and sense-making of noticed actions and class happenings.

During the reflective dialogue, we relied on Video-Stimulated Recall (VSR; Sturtz & Hessberg, 2012) as a method that replays certain segments of the recorded classroom instruction to provide additional stimulus to the teachers in recalling details from recorded lessons. After the teachers' reflection, we then shared some of our analyses on noticing patterns with the teachers and identified several practices that could be improved to enhance instructional effectiveness in classrooms. With the observations from the eye-tracking data analyses and insights from the reflective dialogues with teachers, we can then identify factors and reasons that attributed to the differences in teacher noticing during novel situations, and potentially further understand the underlying skills and abilities that teachers may exhibit in unfamiliar circumstances.

3. Findings and Discussion

To answer the first part of the research question on what are the differences between teachers' noticing patterns across schools, we analyzed data from the entire dataset that comprises 18 lessons, with each

lesson lasting an average of 35 to 40 minutes, which is the typical duration of one period of a lesson in all three schools.

The findings from the lessons were compared across the three schools, which we anonymously name in this study as School D, School K, and School S. In alignment with prior work, we also split the analysis to display expert-novice differences within and between schools as listed in Table 2. This allows us to be able to spot potential trends of noticing exhibited by teachers of various experiences from the same or different schools.

Table 2. *Differences in noticing patterns of teachers across schools*

Schools	**Novice Teachers**	**Expert Teachers**
School D	Gaze repeatedly returns to several fixed regions of the classroom, as if expecting to catch happenings in the classroom	Uses prior knowledge to predict several potential students who would require attention and alternate gaze between them
School K	Scanning of students from left to right of the classroom and vice versa, but not in order	Constantly scans certain portions of the classroom where students who would likely require attention are seated
School S	Gaze is random and unorganized, and reacts towards noticed happenings that occur in the classroom	Gaze settles quickly on potential trouble hotspots, then weighs and form connections between pieces of visual information into problem units or conclusions

From Table 1, it was apparent that expert teachers tend to utilize prior experience to guide their noticing around the classroom and quickly focused on problems or potential hotspots. The novice teachers' noticing was more dispersed and unorganized. These findings coincide with recent studies on expert-novice differences (e.g., Auerbach, Higgins, Brickman, & Andrews, 2018; Wolff, Jarodzka, Bogert, & Boshuizen, 2016) and are likely to be generalizable as we scale the number of observed teachers and schools at the meso level.

The second part of the research question pertains to what attributed to the above-described differences in unfamiliar and novel situations. This can be answered via the reflective dialogues that we conducted with the teachers, which provided us with insights on how teachers perceived and processed visual classroom information, and whether this is affected by factors such as classroom culture, teaching strategies, and teachers' beliefs, as shown in Table 3.

Table 3. *Possible factors attributing to teachers' noticing patterns*

Schools	**Classroom culture**	**Teaching Strategy**	**Teachers' beliefs**
School D	Mostly collaborative culture working as communities of inquiry	Cooperative learning and Q&A style	Adaptive responses to teaching materials and continues working using current resources
School K	Partially collaborative inquiry and individualistic culture	Direct instruction coupled with scaffolding as a form of teaching strategy	External assistance, such as props and online tools are quite essential for engaging students
School S	Diverse, anti-authoritarian and potentially disruptive culture	Reactive towards noticed happenings that occurred in the classroom	Proactive and predictive practice required to handle students' behaviors

Through the reflective dialogues, we found that in School D, as students of mixed abilities were often encouraged to work together in small groups during whole-class activities, the teachers opted to use a cooperative style of learning and often designate a member of the group to answer questions on behalf of the group, as a measure to ensure that all group members actively express ideas and share their answers. In School K, the culture was partially collaborative due to the focus on pair work or groups of three. As the majority of the class was of high ability, teachers identified several students who were unable to catch up to the main cohort and assisted their learning with scaffolds. However, individualistic culture also surfaced in the form of competitive answering and argument between students during questioning. As for School S, the students were situated in a diverse culture, with some students leaning towards being anti-authoritarianism and disruptive, while there were several students who were keen to learn from the teachers. Therefore, the teachers were understandably on edge whenever engaging this particular class of students and were mostly reactive towards happenings within the classroom,

When we combined and compared the findings from Tables 2 and 3, we are able to obtain a better sense and understanding of how certain factors can lead to specific teacher noticing behaviors. The culture of students belonging to the different schools in this study was fortunately unique in their own respect and largely follow what was observed in other schools and literature (e.g, Squire et al., 2003), which allows us to observe the different teaching strategies that teachers adopt in comparison with their beliefs and how these affect the way they notice during lessons.

We are thus able to identify three types of noticing behaviors that are likely to have resulted from various observed cultures, teaching strategies, and teacher beliefs. First, repeated returns of gazes to same objects is a noticing sequence that most expert teachers tend to exhibit, and occasionally even by novice teachers when they feel insecure in unfamiliar situations and revisit to provide more certainty of a classroom situation. Reactive strategies are then often implemented, including ad-hoc actions and decisions to handle the students, but may also lead to increased chances of mishandling and heightening tensions in the classroom. Second, a systematic and methodical manner of scanning the classroom was also observed in schools that encourage collaborative efforts. Teachers' teaching strategies and thoughts are organized closely with sensorial perceptions, an observation also seen in Wolff et al's study (2016), leading to a more considerate and deliberate manner of noticing. Third, faster fixations by the expert teachers were observed as they ignored insignificant visual cues and focused on consequential actions and happenings with a focused and purposive mindset. A proactive stance in an encouraging school environment also helps to cultivate and nurture a more predictive mindset to handle most classroom situations.

Table 4. *Relating teachers' noticing patterns with classroom culture, teaching strategy, and beliefs*

Noticing patterns	**Likely due to**	**Observed in**
Revisiting of same areas or objects	Reactive teaching strategy with some prior knowledge and history with the noticed object as a stable configuration	Most expert teachers and some novice teachers to a certain extent
Systematic and methodical method of scanning the classroom	Collaborative culture and working with communities of inquiry	Both expert and novice teachers, more so during classroom management situations
Targeted (shorter saccades) and longer fixations at objects	Teacher's beliefs in proactive practices and predictive thinking to imagine and anticipate actions that that can handle likely events	Experienced teachers with expert knowledge

4. Conclusion

The use of teacher noticing in prior work was assessed to be effective at a micro level for a single school and through this study, teacher-noticing research was extended beyond case studies of the single

classroom into implementation across several schools. Eye-tracking and video devices were used to collect and analyze teacher-noticing patterns that complement video-based reflective dialogues for additional insights. We found differences between teachers' noticing patterns across schools and explored underlying school cultures, teaching strategies, and teacher beliefs that may have attributed to these differences, backed by eye-tracking data analyses and reflective dialogues. Moving forward, due to the copious amount of data that were gathered through this study and prior work, we seek to narrow our scope of analysis on a more specific set of data, such as looking at the moments of silence in classrooms as part of event-oriented inquiry (Tan, Lee, & Tan, 2020). We will also continue to utilize gaze data from a prior study (Lee et al., 2019) and this study to inform novice teachers and aid their practice, as well as continue to involve more teachers as part of ongoing research, so that we can obtain a larger sample size for possible generalization in future work.

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