How Teachers Use Causal Reasoning About Classroom Experiences to Improve Teaching

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Abstract: While there is a growing consensus that teacher experience matters, the process by which individual teachers improve from their experiences has received little emphasis. This study investigates secondary mathematics teachers' in-the-moment sense-making about their classroom experiences used to change instructional practices through point-of-view observations. It finds that teachers often use causal reasoning when they propose future changes to their teaching practice, and that this reasoning is complex.

The idea that teachers can learn and improve through experience is pervasive throughout the design of teacher education (e.g. coaching, peer observation, student teaching, practice-based PD, data use). Case studies of math teacher improvement have shown that significant growth can happen through experience (Franke, Carpenter, Levi, & Fennema, 2001). Research on teacher collaboration has illuminated some of the processes by which teachers learn from sharing experiences (e.g., Horn, 2010). In contrast, the process by which teachers improve using their classroom experiences in less collaborative environments has received little emphasis (Little, 2012).

This study focuses on how teachers use their everyday classroom experiences to improve their teaching, one form of teacher learning through experience. It leverages the framework of teacher noticing to focus on teacher thinking by examining teachers' sense-making of everyday classroom experiences. In particular, it explores one component of sense-making: teachers' causal reasoning about students, or how teachers develop causal explanations for events that happen during their lessons.

Conceptual framework

This study draws on the teacher noticing framework (Sherin, Jacobs, & Philipp, 2011) to unpack how teachers use their everyday classroom experiences to improve. Based on this framework, the process of improvement through experience is conceptualized as consisting of (a) teachers attend to experiences in the classroom, (b) teachers make sense of those experiences, (c) teachers determine implications to future teaching based on their sense-making, and (d) make changes in future teaching based on implications. Therefore, the process links teacher noticing for instructional improvement (a & b) to improvement in teaching practice (c & d).

In particular, this study focuses on the sensemaking of teachers by examining teachers' *causal reasoning about students*, or teachers' identification of cause-effect relationships that are used to make sense of events involving students. *Causal reasoning about students* (causal reasoning for short) is defined as identifying explanatory factors (i.e. causes) that lead to particular outcomes (i.e. effects) in the classroom related to students. Previous research has examined teachers' framing or explanations of problems encountered in teaching (Jackson, Gibbons, & Dunlap, 2017), but does not model the detail and complexity of teachers' causal reasoning.

Methods

The primary data in this study is point-of-view observations collected with six secondary math teachers that had the goal of becoming more responsive to student thinking. Point-of-view (POV) observations are an innovative methodology for accessing teachers' in-the-moment thinking during teaching (Sherin, Russ, & Colestock, 2011). Teachers collect video from their point of view using small wearable cameras worn on their head. The camera allows wearers to record the *previous* one minute of action when they press a button. Prior to instruction teachers were asked to record "moments that will influence how you improve your teaching or moments you might want to reflect on or think about later" by pressing the button. Shortly after the lesson, the teachers were interviewed about their captured moments to uncover what they noticed, how they interpreted those moments, and how those experiences would influence what they plan to do in the future as a teacher. Two POV observation interviews from each teacher were randomly selected to be analyzed.

Qualitative analysis was used to identify when teachers were using causal reasoning and to look for themes in teachers' causal reasoning. First, causal reasoning was preliminarily indexed during the discussion about the moments saved. Then, each instance in which a teacher expressed causal reasoning was identified, and the causal reasoning in these instances was described in terms of the explanatory factors and outcomes. Finally, the expressions of causal reasoning were grouped into cause-effect models: a period of time when teachers

expressed causal reasoning that was logically consistent and provided a similar explanation. The expressions were coded for generality – (1) specific events, (2) general events, and (3) abstracted relationships), and function – (a) explanatory and (b) hypothesized. A subset of 15 percent of the discussion units was double coded by a second researcher. Cohen's kappa was calculated at .72 for generality and .84 for function.

Findings

The analysis found that teachers used causal reasoning in 91.5% of their discussions around saved moments in the 12 interviews analyzed. Across the discussions of teachers' saved clips, teachers expressed causal reasoning in many different forms. Within a single cause-effect model, teachers often expressed causal reasoning in multiple ways. On average, teachers used 8 different expressions of causal reasoning per cause-effect model. The number of expressions varied from as little as one expression up to 14 different expressions.

Variation was found in the different types of both generality and function in teachers' expressions that were part of the same general model. Teachers expressed causal relationships at all levels of generality (specific events, general occurrences, and abstracted relationships) and purposes (explanatory and hypothesized). For example, Mary explained what might have happened during a discussion if she had looked at a student's work before asking her to present, saying,

> [The student] said something like, "oh wait a second I think I did something wrong." She had seen it, instead of me seeing it for her, which probably wouldn't have happened if she would have come to me and said "is this right?" I'm sure I could have said something like "well take the derivative and find out"…but the fact that her whole process was independent of me was really awesome.

In the example, the teacher engaged in a thought experiment about two different times. First, the teacher suggests that the discussion would not have happened in the same way had the teacher looked at the work for her. Second, the teacher considers how giving the student a hint about taking the derivative could have also allowed the student to realize she did something wrong, but would not have created a process that was independent of the teacher.

Conclusions

The different purposes and expressions found in teachers' causal reasoning highlight how the teachers expressed their causal reasoning in complex ways. The high frequency and complexity of teachers' causal reasoning during moments teachers identified as relevant to their improvement suggests that it likely plays a useful role in how teachers use the classroom experiences to improve their teaching. As such, future research could investigate how this causal reasoning is tied to the changes teachers propose to make in their teaching, and how the substance of that causal reasoning influences the type of change teachers propose.

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