LEARNING FROM TEACHING: A NEW MODEL OF TEACHER LEARNING

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The development of a model that explains how teachers learn from teaching is critical for informing the design of quality professional development, which in turn can support teachers' effectiveness and student learning. This article reports the authors' effort to develop a model that brings together critical findings from existing research to unpack when and under what conditions teachers learn from teaching. Grounded in evidence drawn from research relating to teachers' learning and practice, the authors build a rationale for the Learning from Teaching (LFT) model, introduce each component of the model and propose two conditions that increase the likelihood of teachers' learning from their own teaching.

Keywords: Learning Theory, Mathematical Knowledge for Teaching, Teacher Education, Teacher Knowledge

Most people would agree that teachers continue to learn and improve their teaching throughout their career. Yet, when and under which conditions teachers learn from teaching are not clearly identified. Reviews of professional development programs pinpoint different attributes of professional learning opportunities that result in changes in teacher practices and improvements in student learning (cf. Blank, las Alas, & Smith, 2008; Borko, Jacobs, & Koellner, 2010; Darling-Hammond, Hyler, & Gardner, 2017; Desimone, 2009; Garet et al., 2011, 2016; Kennedy, 2016; Piasta, Logan, Pelatti, Capps, & Petrill, 2015; Santagata, Kersting, Givven, & Stigler, 2011). For instance, Darling-Hammond and colleagues (2017) identified in their review of professional development studies that the content focus was a characteristic of effective programs, whereas Kennedy (2016) found that programs with a content focus did not seem effective.

We suggest that this cycle of conflicting findings about what makes professional development effective can be interrupted by the development of a testable model of how teachers learn from teaching. Without such a foundational model that seeks to explain the key mechanisms underlying teachers' *learning from teaching*, researchers will continue to conduct assessments of teacher learning from various perspectives that yield conflicting findings. In alignment with our argument, Kennedy (2016) noted in her recent review that *"Education research is at a stage in which we have strong theories of student learning, but we do not have well-developed ideas about teacher learning"* (p. 973).

Thus, our intentions of the present article are (a) to contribute to the literature by bringing attention to the importance of developing a model of how teachers learn from teaching and (b) to share our theoretical Learning from Teaching (LFT) model that is informed by prior research and can be tested in future research. We conceptualize teachers' *learning from teaching* as adjusting, adding to, or changing instructional practices.

The Learning from Teaching (LFT) Model

Our model considers how teachers and students co-create the teaching context that shapes teachers' learning process (see Figure 1). Central to this model is that the *temporal links (i.e., time interval) between teaching actions and evidence of student learning* influences what can be learned from teaching. For instance, the model suggests that a teacher who does not attempt to capture students' learning (through formative or summative assessments) for a week will be unlikely to learn from his or her teaching because it will be challenging to pinpoint which teaching actions contributed to

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students' learning. We also identify teachers' problem-solving skills as the key mechanism for their learning. We argue that without problem-solving skills, teachers cannot learn from their teaching because they will not be able to identify what teaching action is causing students to learn or struggle.

Teachers and Students Co-Create the Teaching Context

As shown in the first part of the figure, our model highlights how characteristics of individual teachers and their students will co-create the teaching context. This teaching context will shape what teachers can learn from their teaching. What we suggest here is that each individual teacher has a somewhat different teaching context and encounters different teaching moments that influence the teacher's learning environment. Therefore, understanding how teachers, their students, and other contextual factors simultaneously create a potential learning environment that could be different for individual teachers is crucial.

This dynamic and yet individualized teaching context includes instances of teaching actions and evidence of students' learning. While many scholars focus on either teaching actions (e.g., improving the cognitive demand of tasks) or students' thinking (identifying instances of students' mathematical thinking as key to productive classroom discussions; Leatham, Peterson, Stockero, & Van Zoest, 2015), both are included in the LFT model.

Temporal Links Between Teaching Actions and Evidence of Student Learning

In the next part of the LFT model, we consider how the temporal links between teaching actions and evidence of student learning play a key role in whether teacher learning occurs. If the time interval between the teaching actions and evidence of student learning is too great, it becomes a difficult task for teachers to identify which of their actions is leading to student learning. Our argument is both supported by research suggesting that formative assessment, which includes teachers' informal assessment of students' learning throughout a lesson, can lead to student learning (Black & William, 1998) and data driven research (e.g., Farrell & Marsh, 2016a; 2016b). To illustrate our point, consider a dramatized example of two teachers who have identical teaching contexts (identical students, the same levels of knowledge and skills, identical beliefs, and the same teaching materials). Teacher A is not collecting any information on his students' understanding through questions or observations and is not frequently inviting students to share their ideas to reveal their thinking. In contrast, Teacher B is frequently "collecting data" from her students through observations, student participations, or questions to see whether her students are on track. Thus, we propose that because the time distance between the teaching actions and student input is longer for Teacher A, it becomes challenging for him to pinpoint what his students do or do not learn and identify what part of his instruction could potentially have contributed to this outcome. As illustrated in Figure 1, when the time distance between the teacher's actions and student learning narrows, the number of potential links decreases, which in turn helps the teacher identify how his or her teaching interacts with the students' learning.

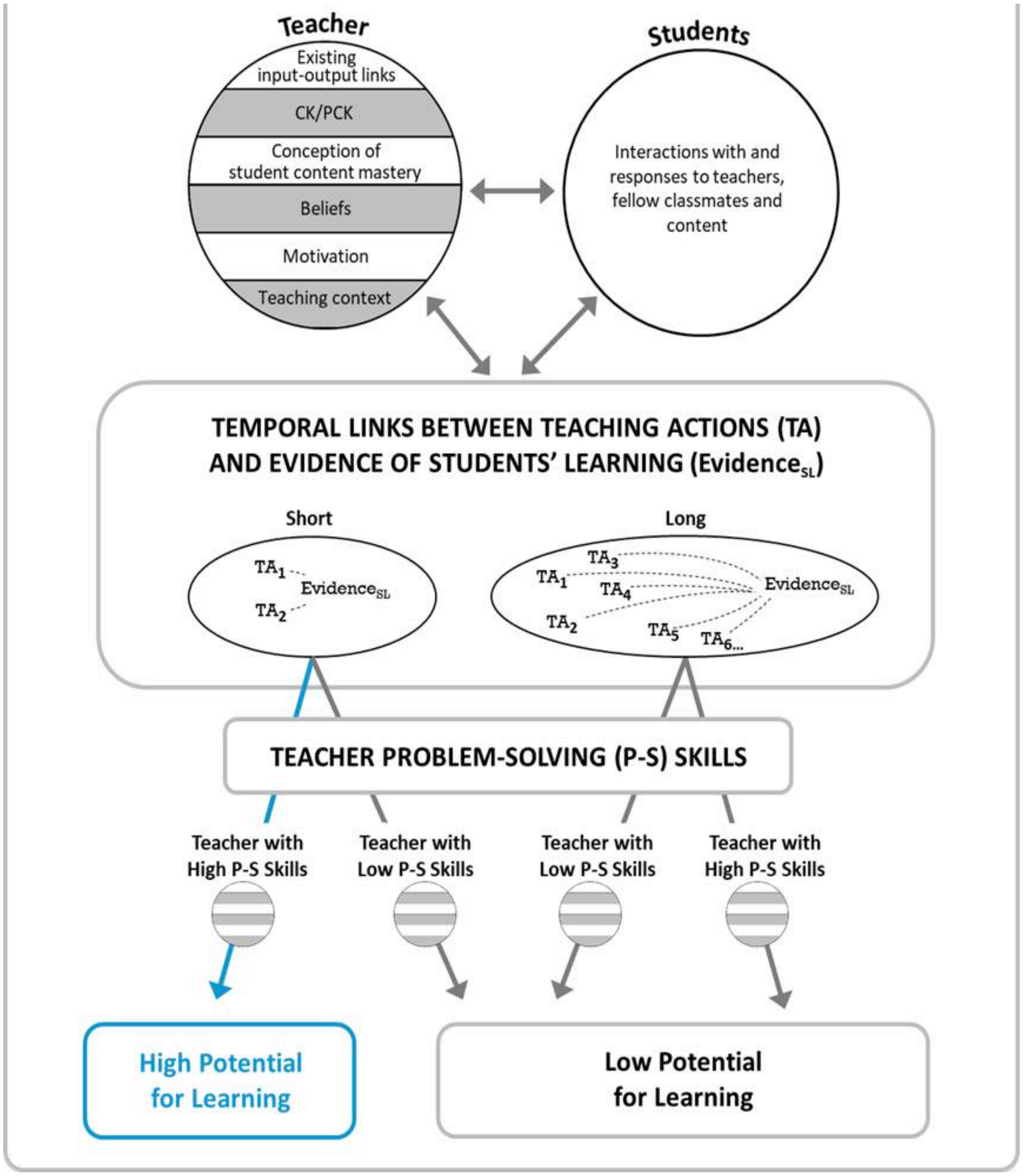

Figure 1. The Learning from Teaching (LFT) model.

Teachers' Problem-Solving Skills

We argue that problem-solving skills are key to teacher learning, and those who have developed problem-solving skills can learn on their own from teaching (Franke, Carpenter, Levi, & Fennema, 2001). As for any sorts of problems, dealing with them effectively requires developing a systematic approach to problem solving. That is why we have turned to one of the most successful strategies developed by Polya (2004) to help students develop problem-solving skills. According to Polya, problem solving involves four phases: (1) understanding the problem (why students learned or did not learn, what contributed to this outcome, what data we must have to find a solution, what other factors we need to take into consideration); (2) devise a plan (of all the potential strategies, knowing which one is more likely to lead to a correct solution); (3) execute the plan; and (4) look back (identifying whether the strategy was the right one and what can be generalized from this experience to other similar situations).

Understanding the problem is one of the first and most vital steps in solving any problem. It requires teachers to identify "the unknown, the data, the condition" (p. 28, Polya, 2004). Consider a teacher who wants to know whether his or her students have achieved the learning goal. What is *unknown* is what contributed to students' learning or confusion. The *data* are the temporal links created during teaching or additional data, such as exit tickets, gathered on student learning. The *condition* is whether other factors in the teaching context and the available data are sufficient to determine what students learned or did not learn.

Devising a plan is the long journey that takes place after understanding the problem; it involves many unsuccessful trials. Indeed, this is why we created different learning paths, depending on teachers' problem-solving skills. Teachers with strong problem-solving skills may think of a similar situation with similar unknowns and analyze how the current problem is related to similar problems solved before.

The third phase, *carrying out the plan*, is testing what is determined to be the reason for student learning. Executing the plan requires paying attention to the steps involved in the plan. For instance, if the plan is to use a specific manipulative (e.g., base-10 blocks) to help students understand the concept they are struggling with (e.g., the place-value system), then attending to the fact that mathematical ideas and representations (base-10 models) are clearly linked is the step required for correct execution of the plan.

The final step is *looking back*, which allows teachers to reexamine both the strategy and the result (e.g., whether modeling with base-10 blocks helped students understand what each digit means in the base-10 system). Checking whether the solution is supported by all the data collected helps teachers learn to analyze their teaching systematically to determine what works. Finally, good problem solvers generalize what is learned from a particular problem to solve similar problems by looking back at the same problem. Thus, we propose that only teachers with good problem-solving skills may change or adapt their existing conceptions because they collect data, devise a strategy, and evaluate their strategy by using evidence and reasoning.

Summary of the LFT Model

The LFT model suggests that teacher learning from teaching is situated in the teacher's dynamic teaching environment and is jointly created by teachers and their students. Learning from teaching depends on the time distance between teaching actions and student learning evidence as well as on teachers' problem-solving skills. In particular, two conditions increase the likelihood of teachers' learning from teaching: (1) shortening the temporal links between teaching actions and evidence of student learning, because this limits the amount of potential actions the teacher can select to explain a certain outcome and (2) problem-solving abilities, because these allow teachers to use the information on hand systematically to find an answer to how particular teaching actions are linked to student learning. Teachers with problem-solving skills can work on the problem of teaching systematically and eventually find a correct answer to what is helping students learn or causing them to struggle.

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