Creating Material Representations of Practice at the Boundary of Professional Development and Classroom Practice

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Large-scale observational studies in American science classrooms have documented there is a general focus on activity rather than sense-making discourse and that teachers seldom press for explanations (e.g. Banilower, Smith, Weiss, and Pasley, 2006). Reform efforts to impact teachers' activity in classroom have largely focused on standards and curricula designed to encourage and support enactment of sense-making pedagogies in the science classroom. Standards and curricula are tools that largely focus on the planning phase of the teaching process, without being designed to have intentional support for the individual reasoning of learners in local contexts. There has been little research focusing on the local creation or revision of tools of enactment teachers use to support their students' science explanation making. In this study we report on a yearlong professional development project with teams of middle and high school teachers who focused on the practice of *supporting students in generating evidence-based explanations*.

The teachers engaged in iterative design cycles as they modified tasks, tools, and classroom talk (Sohmer, Michaels, Connor and Resnick, 2009) with a goal of supporting their students in generating evidence-based explanations. Their work was done in the context of job-embedded professional development (PD) with studio-days. During Studio Days, multiple role-actors (classroom teachers, coaches, researchers, and university staff) collaborate to provide real-time feedback within current lessons. Our analysis focuses on the way two kinds of tools, formative enactment tools and face-to-face tools, act as reification and stabilization for the practices of supporting their students in generating evidence-based explanations.

Theoretical Framework

The analytical frame we use to examine the teachers' activity during studio days is professional vision. Goodwin (1994) described professional vision as "the discursive practices used by members of a profession to shape events in the phenomenal environment they focus their attention upon" (p. 606). In particular it consists of three practices: *highlighting* – marking as salient specific phenomenon in a complex context; *coding* – transforming materials being attended to into objects of knowledge; and *producing material representations* (inscriptions). These practices allow groups to structure and organize the social world around them into professionally meaningful patterns of practice.

Goodwin's (1994) notion of professional vision has been used as a way to conceptualize teacher learning (e.g Lobato, Rhodehamel, and Hohensee, 2012). Much of this literature, especially that of noticing has focused on highlighting and, to some extent, coding (van Es and Sherin, 2008). That is, the focus is on what teachers attend and respond to in the complex activity of a classroom. One practice in Goodwin's framework, the production and articulation of material representations, has received little attention in the literature on teacher learning. This study examines teachers collaboratively creating and revising particular material representations of practice (formative enactment tools and face-to-face tools) as a way of understanding their enacted professional pedagogical vision (PPV). Using the analytical lens of PPV, and specifically material representations of practice, can provide insight into how teachers make intentional changes to tools that support targeted learning experiences for students.

Formative and Face-to-Face Tools

The goal of each Studio Day is the co-creation of tools, tasks and talk that support students in creating evidence-based explanations of scientific phenomena (Windschitl, Thompson, Braaten and Stroupe, 2012). For teachers and others attending studio days this means engaging in multiple rounds of co-planning, co-teaching, and co-debriefing. This involves: 1) unpacking scientific content and developing a shared understanding of different levels of a scientific explanation students might supply, 2) debriefing how students are learning using formative tools such as a Rapid Survey of Student Thinking (RSST), and 3) developing/refining face-to-face tools that teachers provide to students support for their written explanations of scientific phenomena. As an initial step we used activity theory to analyze the function of formative and face-to-face tools in terms of their relationship to the object of work, subjects and roles, and rules governing actors/routines (Engestrom, 2004).

- Formative tools (e.g. RSST, see Figure 1)
    - *Object of work:* Understand and unpack students' ideas and support modification of face-to-face tool
    - *Subjects and Roles:* Group of teachers and coaches, video of productive conversation between students and student work samples

- *Rules that govern interactions among actors/routines:* Gathering students ideas (partial understandings, alternative understandings, everyday language and everyday experiences) without engaging in "repair talk," ways of fixing lessons

- Face-to-face tools (e.g. electrolysis model, see Figure 1)
  - *Object of work:* Mediating students' productive conversations and written explanations
  - *Subjects and Roles:* Students, teachers, explanation of a scientific phenomenon
  - *Rules that govern interactions among actors/routines:* Students' ideas are considered resources for explanation building, some parts of the scientific explanation (e.g. why level explanations) are more important that other

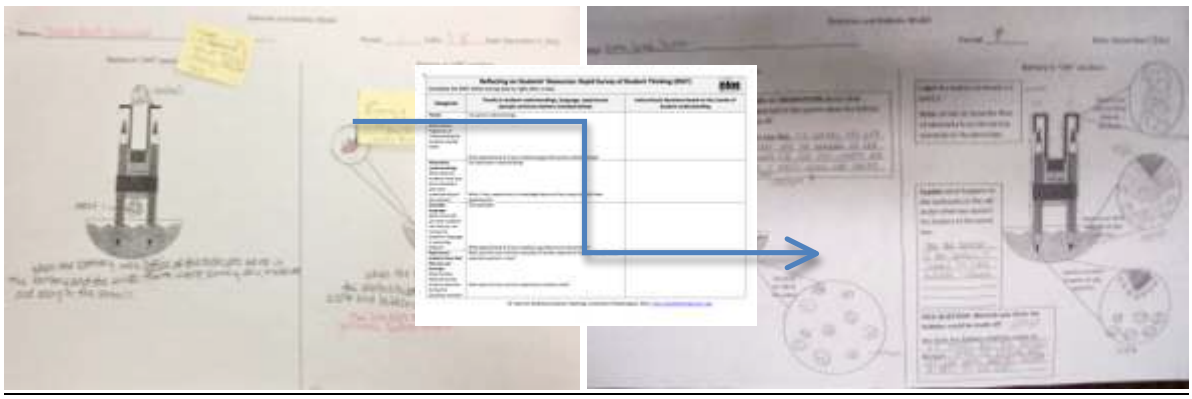

Figure 1. Iterative revision of face-to-face electrolysis model mediated by the RSST tool

Discussion

The role of tools in professional development and student learning has been under theorized and under examined in the context of large-scale pedagogical reform. We believe that framing teachers work with tools in terms of professional pedagogical vision, with particular focus on material representations of practice foregrounds the importance of tools as a way of improving practice, both within and across activity systems. This analytical frame allows for the investigation of how these tools are mutually reinforcing across professional development and classroom contexts. By foregrounding material representations of practice, we can better see how tools contribute to the reification and stabilization of practices. In particular, we can differentiate between meaningful iterative mutually reinforcing tool systems from less productive version, such as:

- *nominal appropriation* of tools and routines without adoption of the purpose of generating and revising scientific ideas
- *well intentioned tools* that don't fully support students in generating and revising scientific ideas
- adoption of tools *independent of* mutually reinforcing, iterative routines outside of a tool system

Educational reform efforts have invested massive amounts of resources into professional development and curricular materials. Reframing the activity of teachers as they engage with these curricular materials in professional development contexts to focus on how they develop and use tools and systems of tools allows us to differentiate productive uses from lethal mutations. Focus on PPV with particular attention to material representations of practice has the potential to expand practice-based theory of teacher and student learning across contexts.

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