Science Teacher Pedagogical Design Capacity with Technology in an Integrated Teacher Preparation Program

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Abstract: This study unpacks a set of practices that impact preservice science teachers (PST) ability to incorporate technological resources into their planning in ways that support instructional episodes aligned with the goals and demands of an integrated teacher preparation program. Early results suggest that PSTs are able to develop the ability to plan high demand tasks using technology, pedagogical design capacity for technology, after instructional interventions in their teaching methods course.

Major Issues and Potential Significance

With more and more teachers turning to non-traditional curriculum materials, such as online simulations, blogs, electronic readings, math games, …etc., it is important for school administrators and teacher educators to understand how the technological resources teachers find and utilize are impacting the instructional episodes that teachers craft. This is especially true of new or beginning teachers. As others have detailed beginning or inexperienced teachers have a tendency to offload instruction from curriculum materials (Brown & Edelson, 2003; Forbes & Davis, 2010). However, if the materials they do offload to do not align with the instructional practices promoted by district administrators, the possibility for drift from the intended type of instruction are highly likely (Brown, 2009). This project first asks is it possible to train preservice science teachers (PST) to identify the affordances and constraints of technologies for instructional purposes? Second, if this is possible, what impact does this knowledge have on PST' instructional design choices? In other words, are PST' design choices resulting in instructional episodes that fit the mold of instruction being presented by their teacher preparation program?

Further, this work contributes to our knowledge of how we prepare PST to utilize technology in three ways. First, by developing an understanding of students' ability to evaluate teaching technologies' instructional constraints and affordances we can better develop opportunities for them to practice working with technology. Second, by developing an understanding of how PST design instructional episodes around technology and how those decisions relate to the constraints and affordances of the technology, we hope to lean how to better support this design process. Finally, this work allows for the development of a way for researchers to code and identify students pedagogical design capacity (Brown, 2009) related to technology, further illuminating how teachers' instructional planning unfolds.

Theory and Method

Traditionally, curriculum materials have been considered "instructional resources such as textbooks, lesson plans, and student artifact templates" developed by experts with the specific intent for how these materials should be used (Forbes & Davis, 2010, pg. 820). Sherin and Drake suggest that as teachers use curriculum materials they develop what is called "curriculum vision" (2009). This is the teachers' ability to evaluate and utilize curriculum materials to enact certain types of instruction, which meet the specific instructional goals they desire. Brown suggests that this ability to have teachers "perceiving affordances, making decisions, and following through on plans" is their Pedagogical Design Capacity (Brown, 2009, pg. 29). It is believed that teachers' Pedagogical Design Capacity (PDC) is developed over time with continuing enactment of curriculum, aka more practical experience, and through better-designed curriculum materials (Brown 2009). This study takes the framework of PDC and applies it to non-traditional curriculum materials, specifically, classroom technology in K-12 science classrooms.

Utilizing an exploratory qualitative based study, the context for this project is a Science Teaching Methods course at a large Midwestern University. The purpose of the course was ultimately to support preservice science teachers (PST) ability to plan and implement instructional episodes that incorporated high cognitive demand tasks in ways that encourage K-12 students to engage with difficult science content in productive ways. Others have shown that implementing high demand tasks in mathematics settings results in positive learning gains for students and incorporating this framework in science education has shown early signs of success (Stein, Grover, & Henningsen, 1996; Cartier, et al., 2013). In order to prepare PST to design such instructional episodes, the course utilized a framework that included cycles of representation, decomposition, and approximations of these technology practices (Grossman et al., 2009).

For this study, we first asked PST to design a lesson using a technology of their choosing (Pre Lesson Plan). This planning came before any instruction around the technology practices and was meant to establish a baseline of PST initial ability to plan with technology. PST then participated in an inquiry activity around

classroom technology, specifically simulators. The course instructor modeled appropriate inquire-based questioning and facilitating practices around the use of the simulator. In the second part of the same class PST participated in a discussion about technological affordances and constraints, planning highly demanding lessons with technology, and issues with carrying out instruction with educational technology, most of which was related back to the simulator activity. This entire lesson was video recorded and transcribed. At the completion of the lesson we asked the PST to revise the lesson plans they had previously turned in as they saw fit based on the discussions in class (Middle Lesson Plan). Finally, two weeks after the class period on technology practices, we then asked PST to implement a lesson with their K-12 students that involved "Students engaging with technology in a way that promotes learning that would not otherwise be possible without the use of the technology." After, we asked the PST to select technology that supported student engagement in a high cognitive demand task, and consider the constraints of their selected technology and setting during their planning. Finally, the PST created artifact packets (Borko et al., 2005), which included lesson plans, supporting documents, supervisor feedback, and reflection for this lesson (Post Lesson Materials).

We are currently coding data using emergent coding for PDC from the video transcripts and written lesson plans. The codes are based on the ideas from Brown and Forbes & Davis and have been based on examples of how PST demonstrate the different abilities to design instruction around the simulators or technology in their posted lesson. The coding indicates that 8 of 15 PST showed marginal development, 2 of 15 showed large growth, and 5 of 15-showed limited development of PDC for technology. Although most (13 of 15) of the PST were able to cite limitations of the technology they chose related to their classroom context, only 4 were able to identify affordances that would justify using the selected technology. The underlying reasons for this gap is still be explored in the second phase of coding

Early Results and Relevance

Early data analysis suggests that PST are able to make connections between the affordances and constraints of technology in relation to the instructional planning they complete after participating in structured course experiences. Early results also suggest that almost many of the students still struggle with integrating technology in ways that maintain the desired instructional practices forwarded by the teacher preparation program, specifically maintain high demand tasks that front scientific thinking. These results inform the design practices used in teacher preparation programs around technology and have the potential to shape the technology implementation practices of K-12 Preservice teachers. Unpacking the steps and processes that allow PST to carry out these practices is critical for producing well-started teachers who use technology in ways that align with the instructional goals of districts and teacher preparation programs.

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