Developing Interdisciplinary Competencies for Science Teaching and Learning: A Teacher-Researcher Professional Learning Community

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Abstract: We describe a research project examining teacher knowledge and practice over a multi-year professional development project centered on assessment literacy in the context of the U.S. *Next Generation Science Standards.* The project supports teacher learning through professional learning community workshops (LCW) and collaborative design team (DT) meetings. Five dimensions of knowledge are posited as essential to effective implementation of the NGSS, including assessment design for formative purposes and science literacies inherent in the practices of developing, carrying out and reporting science investigations. Learning along these dimensions is being documented through close analyses of teacher talk in the workshops, design team meetings, at their school sites, in the classroom, and in the assessments they design, implement and revise. In this poster we report on the initial year of work with these high school science teachers.

Keywords: Assessment, collaboration, secondary, science, teacher.

Introduction

What to teach as well as how to teach and assess it are persistent questions that confront educational systems. The digital age has catalyzed a resurgence of these questions over the past 10 years, with new and/or revised standards in traditional content areas (e.g., mathematics, science, the language arts, social studies) as well as expanded emphases important to life-long learning (e.g., affective, dispositional). A clear theme across these efforts is the call for learners to be actively involved in the ways of knowing — in the disciplinary habits of mind and knowledge-generating inquiry and representational practices that characterize particular fields of knowledge (e.g., Pellegrino & Hilton, 2012). For teachers to provide learners with opportunities to develop such competencies, teachers themselves need opportunities to develop competencies to teach and assess these competencies (Goldman et al 2016; Ford & Forman, 2006; Kelly, 2014).

We report on an effort by researchers and teachers to co-create professional learning contexts that enable high school science teachers to develop instructional and assessment competencies to effectively implement one U.S. example of redefined standards, the *Next Generation Science Standards* (National Research Council, 2014; NGSS Lead States, 2013). The three-dimensional emphasis of these standards — disciplinary core ideas, crosscutting concepts, and practices — demand different lenses on the work of science teaching and learning, including making explicit the science "reading" literacies inherent in all aspects of scientific investigations (Goldman et al, 2016). Teachers need to shift their understanding of what science is, change their modes of engaging students, and implement new ways of assessing students. Drawing on multiple domains of learning sciences research, we hypothesized 5 learning dimensions to enable teachers to shift instruction and assessment practices in NGSS-consistent directions: Participation within collaborative design teams and professional learning communities; Instructional practices aligned with NGSS; Assessment literacy and practices; Assessment design practices aligned with NGSS; and Views of student roles in assessment practices.

Collaborating for learning

Over the 3-year project duration, we are collaborating with teachers (approximately 20 representing four different urban high schools and the typical range of science domains) to design and enact learning opportunities intended to engender growth along the 5 learning dimensions. Consistent with design-based implementation research (DBIR; Penuel et al., 2011), the design process includes ongoing review and reflection on how teachers take up aspects of these dimensions in their teaching and assessment practices (Popham, 2009).

Our collaborative activities occur in two settings: learning community workshops (LCW) with all teachers and researchers and design team meetings (DT) with representatives from each high school and the

researchers. Both the LCWs and the DT meetings amplify teachers' agency with respect to their own learning and that of their students, their instructional practices with the NGSS-aligned assessments they design, and within school collaborations. A major mechanism for promoting agency and participation in learning communities is through iterative cycles of design, implementation, reflection and revision at the local school site and at the monthly LCWs (Lave & Wenger, 1991). During the LCWs, teachers' work within school teams, across science domains, and within science domains to consider how the instructional and assessment activities they design invite students into meaningful science learning. Between LCWs, teachers implement their designs and bring their experiences doing so to school site and subsequent LCW meetings. Collaborative co-design with researchers is most strongly enacted in the DT meetings where the content and focus of subsequent LCWs are discussed, debated, and outlined (Severance et al., 2016). DT meetings begin with each representative using "mirror material" (Engeström, 2011, p. 612) for relating discussions at their school, including what is being learned from classroom use of designed artifacts, and questions and concerns school teams are raising. The DT then turns to selected video footage from the prior LCW for reflective review relative to the goals and activities of that workshop. These documented DT discussions guide the scope and content of the subsequent LCWs.

Sources of evidence and initial findings

Discourse and artifacts from the LCWs and DTs constitute the primary data sources for tracing movement along the five learning dimensions. For example, we carry out analyses of the assessment and instructional materials teachers design, discuss, use, and revise. These, along with the discourse around them, suggest how teachers increase their understanding of three-dimensional assessments as well as of the reading and production demands of their current assessments. Analyses of video of DT meetings and LCWs provide indications of specific collaborative experiences and fruitful discussions about the tensions and challenges that underlie this approach to science instruction. Other artifacts we are analyzing capture initial "locations" and movement along the five learning dimensions include: (1) Year-long curricular maps aligned with the NGSS disciplinary core ideas; (2) Alignments of the curricular maps with science and engineering practices, providing the basis for teachers design of multi-dimensional instructional activities and assessments; and (3) A checklist for validity, reliability, and fairness of assessments. In creating these products teachers engaged in unpacking NGSS practices and are in the process of examining the NGSS crosscutting concepts and developing criteria for informative rubrics.

References

Engeström, Y. (2011). From design experiments to formative interventions. *Theory & Psychology, 21*, 598-628.

Ford, M. J., & Forman, E. A. (2006). Redefining disciplinary learning in classroom contexts. *Review of Research in Education*, *30*, 1–32.

Goldman, S. R., Britt, M. A., George, M. A., Lee, C. D., Brown, W., Cribb, G., Greenleaf, C., Shanahan, C. & Project READI (2016). Disciplinary literacies and learning to read for understanding: A conceptual framework of core processes and constructs. *Educational Psychologist, 51,* 219-246.

Kelly, G. J. (2014). The social bases of disciplinary knowledge and practice in productive disciplinary engagement. *International Journal of Educational Research*, *64*(Supplement C), 211–214.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

National Research Council (2014). *Developing Assessments for the Next Generation Science Standards*. Washington, DC: The National Academies Press.

NGSS Lead States (2013). *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press.

Pellegrino, J. W. & Hilton, M. (2012). *Education for life and work: Developing transferrable knowledge and skills in the 21st century*. Washington, DC: National Academy Press.

Penuel, W. R., Fishman, B. J., Cheng, B. H. & Sabelli, N. (2011). Organizing research and development at the intersection of learning, implementation, and design. *Educational Researcher, 40*, 331–337.

Popham, W. J. (2009). Assessment literacy for teachers: Faddish or fundamental? *Theory into Practice*, *48*, 4–11.

Severance, S., Penuel, W. R., Sumner, T. & Leary, H. (2016). Organizing for teacher agency in curricular co-design. *Journal of the Learning Sciences, 25*, 531–564.

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