Developing Assessment Tasks to Promote Student Sensemaking of Phenomena and Flexible Thinking

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Abstract: The knowledge-in-use perspective states that useable knowledge allows for problem solving, explaining real-world phenomena, and constructing new ideas. We developed assessment tasks that measure students' capacity to solicit and select from an array of the dimensions of scientific knowledge to make sense of an unfamiliar phenomenon. Evidence of knowledge-in-use includes *depth* of usable knowledge; *flexibility* in applying various ideas; and a robust *community perspective*. Our work shows that assessments can measure growth in knowledge-in-use.

Problem and objective

Knowledge-in-use (Pellegrino & Hilton, 2012) focuses on building and refining knowledge, solving problems, investigating the natural world and learning more when needed and results in deeper, more sophisticated knowledge. The knowledge-in-use perspective reflects an increased awareness by learning scientists, science educators and policymakers of the proficiencies learners will need as global citizens. (National Research Council, 2012; Finnish National Board of Education, 2015). They will need to use and apply knowledge in novel ways to solve the current and emerging challenges facing our world (OECD, 2016)

Designing assessments that can measure knowledge-in-use is a formidable task, and the field continues to struggle with how to construct assessments that challenge students to solve problems and makes sense of phenomena. Assessments that align with this perspective must engage learners in a complex phenomenon, similar to those learners experience in daily life, and assess students' capacity to apply multiple practices and ideas as affordances for sensemaking. In this research, we developed and used assessments that allow students to use multiple ideas and practices as tools to make sense of unfamiliar phenomena by promoting flexible thinking and developing alternative explanations for these phenomena. For flexible thinking, students need to access and evaluate all of the ideas that they may use to make sense of the phenomenon. Our research questions include: 1) *How can we design assessment tasks that measure students' flexible use of knowledge to solicit and select from an array of the dimensions of scientific knowledge to make sense of an unfamiliar phenomenon or solve problems*? 2) *How can we gather information to measure students' capacity to engage in socially-situated practice of considering and weighing possible alternatives for making sense of the phenomenon under study*?

This research presents one systematic method and related analysis for designing and evaluating assessments that will engage learners in making sense of unfamiliar and complex phenomena. The tasks engage students in the figuring out process of using multiple ideas and practices to make sense of phenomena as well as gauge their depth and flexibility of knowledge, and connections to science as a social endeavor developed by and for communities. We present related questions of teaching practices that develop knowledge-in-use.

Theoretical framework

Our approach stems from social constructivist theory that purports that sensemaking is an ongoing dialogue and as such, incorporating assessment elements that reflect the *context-rich* processes of learning allows for a more accurate portrayal of the figuring out process and of developing science competencies (Lave & Wenger, 1991). Thus building assessments that require a multiplicity of approaches to making sense of a phenomenon more authentically aligns with the language and activities of sensemaking. These assessments provide more access to underrepresented groups who draw from diverse intellectual resources (Ladson-Billings, 2006).

Methodology and analysis

Our work is situated in upper elementary project-based learning environments in the third year of the Multiple Literacies in Project-based Learning Project (ML-PBL; (Krajcik, Palincsar, & Miller, 2015). In this paper, we report on data from a third grade project focusing on adaptation, ecology, climate, and extinction. The work for this paper took place during SY2016-17 and SY2017-18. Our method for assessment development uses an iterative design-based research process. Our methods for designing tasks have three main objectives: 1) elaboration and synthesis of unit learning goals to develop enduring understandings and affordances, 2) creation of performance tasks and performances based on related phenomena and the enduring understanding, and 3)

testing and redesign of tasks to provide evidence of student learning. Evidence that students have developed knowledge-in-use includes *depth* of knowledge of affordances; *flexibility* in applying an array of key scientific ideas and practices; and a robust *community perspective* in which students make explicit connections to their local environment or social community.

The data for this study stem from pre- and post-unit assessments of the Grade 3 ML-PBL Unit: *Why do I see so many squirrels but I can't find any stegosauruses?* We used rubrics to score student responses. We analyzed the pre- and post-unit assessments of 80 students from four teachers and schools for depth, flexibility and application of community resources.

Major findings

Our analysis suggests that students can demonstrate knowledge-in-use as evidenced by full application and flexible use of science knowledge to make sense of complex phenomena. Learners' depth of knowledge, flexible use of affordances and robust community perspective increased over time in a majority of cases, but in some classes more than others, as well as across students with varying degrees of affordance. We found that students developed more sophisticated models and explanations in the post- than the pre-assessment, even for those students who did not show growth in flexible thinking. Students who grew in flexible thinking also developed sophistication of ideas.

Discussion and significance

Assessment and "what we can measure" informs instruction. We keep this in mind as we develop assessment tasks that are aligned to socially meaningful context-rich project-based learning environments. We integrate ideas from the practice world of scientists, and the knowledge-in-use perspective to inform teachers about what evidences of students learning we care about. Based on our findings, questions emerged such as why some classrooms fostered more growth than others in knowledge-in-use, and which instructional practices and contexts promote such development. We wonder about the relationship between richness of sensemaking discourse and the development of knowledge-in-use. Our hope is that we not only use unit assessments to gather understanding of what students know, but also an understanding that learning is inseparable from what students can perform *in the PBL socially-situated context* with a multiplicity of perspectives and community-grounded motivators for the science learning (Gee, 2010). Our work demonstrates that assessments can elicit depth of student knowledge, flexibility in thinking, and community perspective.

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