Investigating Third Grade Students' Collaboration in Project-Based Learning to Inform Curriculum Design

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Abstract: This case study examines the extent to which the Multiple Literacies in Project-based Learning Curriculum supported students to (a) understand scientific concepts (b) engage in scientific inquiry and (c) collaborate successfully. It examines two dyads collaborating over several months to construct, test, and re-design a toy rocket. Although the collaborative process was not without limitations, students were generally positively engaged, used executive thinking to support scientific inquiry, and showed conceptual growth on pre/post assessments.

Keywords: Collaboration, Project-based Learning, 21st Century Skills, Science and Engineering

Introduction

Collaboration is regarded as an essential "21st century" skill (Griffen, Care, & McGaw, 2010). Collaborative learning refers to learning in which students both (a) engage in cooperation and b) engage with the same problem, building on one another's ideas (Webb and Palincsar, 1996). In addition to the benefits offered by cooperation (Gillies, 2016), collaboration additionally supports students to engage in distributed cognition by providing a "joint problem space" where students can reason together (Roschelle & Teasley, 1995). By focusing on the same work and building on each other's ideas, collaborating students can, hypothetically, accomplish more together than any individual could have accomplished alone. Nevertheless, although collaboration has significant potential, it can also play out in ways that are neither enjoyable to students nor conducive to their learning (Salomon & Globerson, 1989). Hence, it is essential to examine how students' experiences with collaboration unfold "on the ground" as they engage in sustained inquiry over time. This study contributes to that examination, guided by the following research questions:

(1) How do the children in a 3rd-grade classroom environment engage in and interpret a goal-oriented collaborative endeavor involving both science and engineering?

(2) What is the evidence regarding how these experiences and opportunities influenced student learning?

Methods and theory

The theoretical framework for this study draws from socioconstructivist theory (Palincsar 1998), which views learning as highly influenced by social interactions. The study was conducted in a third-grade classroom at a school in rural Michigan, which was engaged in a year long, project-based learning curriculum integrating science, literacy, and mathematics. Participants were four focal students, who worked in partnerships to build rockets, model their rockets' motion, test and improve their rockets, and prepare a design portfolio. Data sources include: (a) video recordings of collaboration, (b) student and teacher interviews, (c) pre/post tests, (d) student artifacts, and (e) student attitude surveys. Transcripts were coded by interaction type and conceptual content. A second, trained, rater coded a randomly selected 20% of the data (94% agreement for levels of conceptual talk; 84% for interaction type; 83% for whether questions received response). Analytical memos examined student engagement in inquiry.

Results and interesting points for discussion

This study found mixed results regarding student collaboration. Collaboration provided a venue for students to (a) engage in self-direction and executive-thinking, (b) engage in disciplinary practices such as describing and modeling the rockets movement (literacy), discussing force, pressure, and friction (science) and comparing distances that the rocket traveled (mathematics), and (c) practice and improve collaboration skills. During interviews and on the attitude survey, all focal students reported enjoying the collaborative process. Together with the relatively low levels of conflict (5% of talk turns) and off-task behavior (11% of talk turns), this suggests that students were typically engaged, respectful, and enjoying themselves. Furthermore, the pre- and post- assessments showed learning gains across all four focal students. Nevertheless, the students' collaboration was marked by unbalanced participation and a scarcity of conceptual talk (7% of total talk). Participation was most symmetric when students worked hands on with the rocket, or when students worked in distinct partnerships, rather than

joining together to work as a group of four. Conceptual talk, when it occurred, was often supported by discussions surrounding how to answer questions in the science notebook (see Figure 1, below).
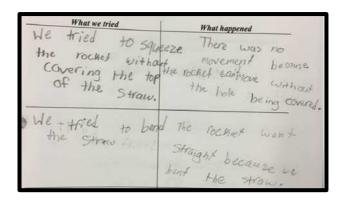

Figure 1. Example of one student's science notebook

Implications

There may be a benefit to teachers and curriculum designers balancing small-group collaborative learning opportunities with whole-class, teacher-guided learning opportunities. During the collaborative activities, the teacher must, by necessity, yield some control to the students. When students have control, they may not be as conceptually-oriented as the teacher would be. On the other hand, if the teacher always has control, the students will not have the opportunity to build collaborative and executive thinking skills or to independently discuss concepts. This suggests benefits to a balance of whole-class and collaborative time. Furthermore, it may be beneficial for curriculum designers to include scaffolds to support students' conceptual talk, during collaboration. In this study, the science notebook was particularly important in prompting conceptual talk. Additionally, the hands-on learning opportunities supported more balanced participation. In curriculum design and planning, guiding questions may be key to supporting student conceptual talk, while diverse learning opportunities may be key to supporting student engagement and participation. Future research might focus on identifying additional scaffolds to support conceptual talk or considering ways that students might use additional mediums (such as blogs, film, etcetera) to respond to guiding questions.

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