SCHOOL SCIENCE AND MATHEMATICS

Research to Practice Article

Instructional Implications of a Motivation Study: Motivating Opportunities in an Informal Science and Engineering Program

Based on the published SSM Journal Research Manuscript:
Elements of design-based science activities that affect students' motivation

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Overview

The type of design thinking that is emphasized in technology and engineering education will be needed at all levels of K-12 education to prepare for a global community that requires problems to be solved by teams of collaborators (Friedman, 2005). It will also be necessary to replace the projected 1.3 million scientists and engineers exiting the workforce in the next decade (Bureau of Labor Statistics, 2013). Given these needs and based on the premise that middle-school age is a critical time for children to become interested in pursuing STEM (science, technology, engineering, and mathematics) education and careers, Jones et al. (2015) designed and implemented a study to investigate various factors that affected students' motivation in an after-school program called *Studio STEM*. Students learned science content and application skills in Studio STEM as they solved problems set in real-world contexts. The design-based curriculum was consistent with the National Research Council's vision for K-12 engineering education (Katehi, Pearson, & Feder, 2009) and the Next Generation Science Standards (NRC, 2013). The Jones et al. (2015) study examined a 12-week implementation of Studio STEM that included 14 upper-elementary and middle school students in a rural community in Virginia. The purpose of the present article is to review the Jones et al. study and highlight the implications of it for practicing educators.

Research Topic

Jones et al. (2015) surveyed, interviewed, and observed students during the 12 weeks of Studio STEM to assess how the program affected students' motivation to engage in science and engineering activities. They used the MUSIC^{SM} Model of Motivation (Jones, 2009) as their conceptual framework because it was developed with the purpose of helping instructors to implement effective instructional strategies and based on motivation research and theory. MUSIC is an acronym for the five key components and principles of the MUSIC model, which are that the instructor needs to ensure that students: (1) feel *eMpowered* by having the ability to make decisions about some aspects of their learning, (2) understand why what they are learning is *Useful* for their short- or long-term goals, (3) believe that they can *Succeed* if they put forth the effort, (4) are *Interested* in the content and instructional activities, and (5) believe that others in the learning environment, such as the instructor and other students, *Care* about their learning and about them as a person (Jones, 2009; www.theMUSICmodel.com). The MUSIC model is a multidimensional model that is not limited to any one theoretical perspective and can be used in designing instruction and diagnosing strengths and weaknesses of instruction in any subject area. The Jones et al. (2015) study provides an exemplar for how teachers can apply the MUSIC model to the practice of design-based science instruction and could be valuable for any elementary or middle school science teacher who wants to improve instruction and student engagement in STEM activities.

Discussion of Findings

The results of the Jones et al. (2015) study indicated that students were motivated and engaged much of the time, but not always. Observations and students' responses showed that the instructors: showed *caring* through supportiveness, fostered *success* beliefs, and *empowered* students by providing guidance without infringing on the their autonomy. The relevance of activities to real-world contexts was helpful to generate *interest* and show the *usefulness* of these design-based science projects. Thus, all five of the MUSIC model components were helpful in engaging students in the activities.

What may be most useful to educators from the Jones et al. (2015) article is examining the "motivating opportunities" that they identified as a result of their research, because these opportunities can be used by teachers in other learning environments. For example, choices within activities can be used to empower students. The topics and activities that teachers select can be used to affect students' perceptions of the usefulness of the instruction. Perceptions of success and caring can be affected by students' interactions within their groups and the support that instructors provide. And finally, in implementing presentations that involve direct instruction, instructors can consider how the presentation will affect students' interest, in order to avoid student boredom.

Implications for Practice

Teachers who are busy with all of their regular teaching tasks may find it difficult to plan and implement investigations regarding student engagement and assess the efficacy of their instruction. The MUSIC model provides a template with explicit instructions that can be easily and efficiently implemented by a teacher (in any type of instruction, not just design-based instruction), and can be used to help diagnose areas for instructional improvements that can then be incorporated immediately in the classroom.

Because the time to implement a project such as Studio STEM might not be available to teachers during the regular school day, informal after-school settings can provide an alternative means to provide these types of opportunities due to the extended time available. Given the findings of the Jones et al. (2015) study, we speculate that after-school STEM clubs could benefit both the students and the overall goals of a school system. However, careful planning would be needed to ensure that the after-school clubs did not place excessive burdens on the teachers. Perhaps the PTA (Parent Teacher Association) could work with teachers to help supervise and provide expertise (coaches and mentors) through a network of parents. With this model, educators could create the instructional plan and provide periodic instruction (through lectures or tutoring on specific content) to help maintain the learning objectives of the activities.

Other Resources

Research related to the MUSIC Model of Motivation is ongoing (see www.theMUSICmodel.com) and there are plenty of practical motivation strategies that researchers have identified related to the MUSIC model components over the past several decades. An example of motivating opportunities using a problem-based approach in a college engineering course might also be of interest to readers because these principles are also relevant in other settings (see Jones, Epler, Mokri, Bryant, & Paretti, 2013). In addition, a discussion of useful methods to foster meaningful communication between students in collaborative environments and meaningful assignments to help develop technical writing and speaking skills is provided in Paretti's (2008) paper.

Because students in the Jones et al. (2015) study often did not feel supported or cared for by their teammates, it may be worthwhile to introduce some teambuilding and collaboration activities to help students develop trust and interdependence with each other. Suggestions for best practices for designing group projects include: creating interdependence among team members, devoting time specifically to developing teamwork skills, and building individual accountability (Team Based Learning Collaborative, n. d.). These Team Based Learning concepts can help support students' perceptions related to empowerment, usefulness, success, interest, and caring.

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