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Give the Students Science: Creation and Implementation of a Fourth Grade STEM Unit

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GIVE THE STUDENTS SCIENCE:

Creation and Implementation of a Fourth Grade STEM Unit

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ABSTRACT

In America, students often are not taught science curricula until sixth grade or later, giving them roughly six years to become scientifically literate. Science has historically been taught separately from other interconnected disciplines, including technology, engineering, and math. As a result, the number of students entering science careers remains low. In response, educators have recently implemented STEM integration—a pedagogy geared toward combining major tenets of these disciplines. Theoretically, connecting STEM integration with scientific literacy should encourage student interest and improve preparedness to enter into STEM careers. As part of an EDCI605 Teaching Science class, the instructor and Purdue students created and implemented a STEM unit for fourth grade students combining STEM integration with the nature of science instruction. The students were motivated and engaged throughout the lesson, and the instructor was interested in furthering this initiative in the future.

INTRODUCTION

National science reform documents have been published in America about twice every decade for the past two decades (American Association for the Advancement of Science, 1990, 1993; Common Core Standards Initiative, 2012; NGSS Lead States, 2013; National Research Council, 1996). However, the number of high school students choosing to major in and successfully completing a degree in a field of science remains low (National Science Board, 2004, 2006). One explanation is that science courses often are not introduced into a students' curriculum until around the sixth grade. Many students already have developed other career interests by that time. Another reason may involve standardized testing, which is strongly tied to language and literacy and places less importance on science knowledge.

According to the Next Generation Science Standards (2013; the newest K–12 science education reform document in America), emphasis should be placed on the development of scientifically literate citizens. This includes an understanding of core science concepts, how science progresses, as well as critical-thinking and problem-solving skills. However, literature has repeatedly shown this is not the case (Lederman, 1992).

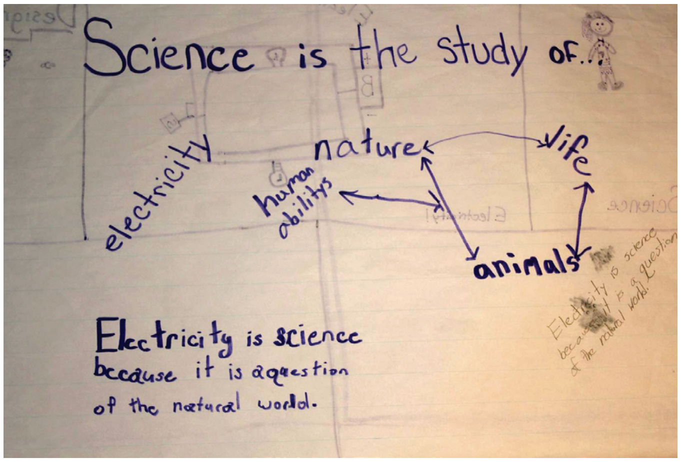

Figure 1. Students define "science" at the beginning of the STEM unit to gather baseline nature of science understanding.

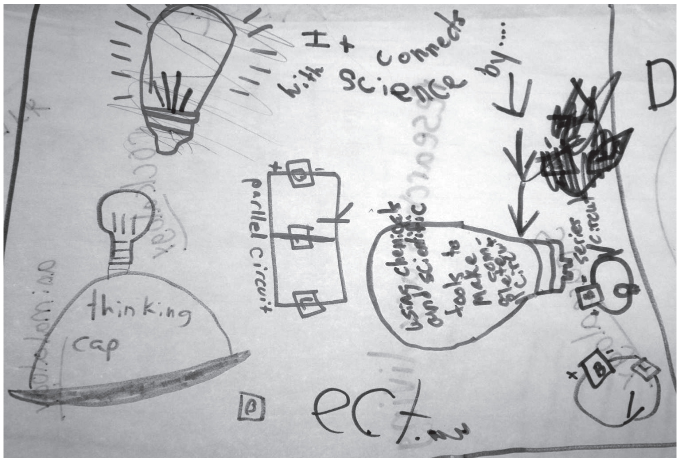

Figure 2. Students drew and presented their lighting designs, the cost of materials, and their rationale for choosing their designs.

Hurd (1998) suggests that to increase the number of scientifically literate students, we must help them develop deeper understanding (and better conceptions) of the nature of science (NOS). NOS refers to key tenets of scientific knowledge and its progression, including evidence-based knowledge (as opposed to faith- or culture-based), a way of knowing (performed via a clearly defined process), and human endeavor.

Science, technology, engineering, and mathematics (STEM) integration in the K–12 classroom, in combination with NOS instruction, is a relatively unexplored avenue by which to increase numbers of students entering careers in science, as well as to enhance scientific literacy. STEM integration engages students in inquiry, critical thinking, collaboration, and investigation by integrating content and skills associated with science, technology, engineering, and mathematics. In science and engineering, these skills make up scientific inquiry and engineering design, the processes by which scientists and engineers perform investigations and solve problems. Using scientific inquiry or engineering design in the context of real-world problems authenticates classroom experiences. These are experiences modeling actual scientific investigations or engineering design projects. Learning and implementing STEM skills in real-world contexts assists in providing students with a smooth transition into STEM careers. It teaches students how to think and work like scientists, technologists, engineers, or mathematicians.

As part of my EDCI605 Teaching Science class, I worked closely with Dr. Siddika Guzey and a classmate to create and implement a STEM unit for fourth grade students, with the intention of bridging the gap between STEM and the NOS. We used scientific inquiry and engineering design as a pedagogical framework, which models the processes used by scientists and engineers in performing investigations and creating and revising experiments or prototypes. Through scientific inquiry and engineering design, students incorporate STEM skills, including observing and creating questions, designing experiments, gathering and interpreting results, and communicating those results to the public.

Within this framework, students engaged in an investigation of electricity using an engineering design project. Specifically, the students defined science, investigated electricity via hands-on activities, and used the knowledge they gained through their investigation to design a lighting system for the athletic fieldhouse being built by their school. They then presented their designs to the rest of the class and had the opportunity to revise. This activity simulated the peer-review process that scientists and engineers go through when disseminating their work. To the students' surprise (as well as ours), the project manager of the fieldhouse actually came into the class and talked with the students. The project manager taught the students about the real lighting system design process, the complications of getting lighting to each room of the building (via a large, snaking complex of wires traveling throughout the walls), and the costs associated with the lighting system and building itself ($7 million). Not only were the students engaged with the hands-on activities, but they also were able to connect the experience directly with their community through the fieldhouse context and the visit from the project manager.

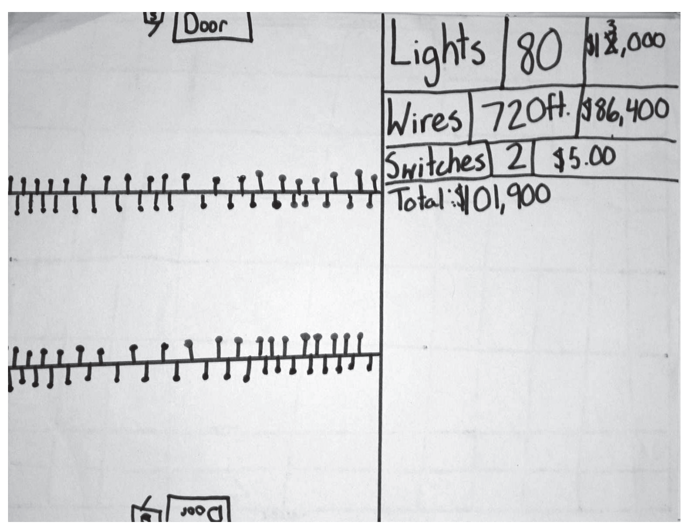

Figure 3. Students are formatively assessed throughout the unit through story-boarding. This shows students connecting science with investigating electricity.

The students only have one 50-minute class period per week allotted for science. Although this is a very short amount of time, it is more time than many fourth grade students receive in other elementary schools nationwide. How are students supposed to gain a deep understanding of science and its progression if they only receive one science lesson per week?

We also learned it was the first time they had experienced investigating science and engineering concepts using STEM skills. Throughout our three days there, the students were actively engaged with science materials and their design projects. They practiced critical thinking, problem solving, and collaboration—all skills that are used daily by scientists and engineers. They were focused and eager to participate as we guided them through a variety of different science concepts. Likewise, when we asked the students questions about electricity and engineering design, they eagerly raised their hands to be the first to answer. We could clearly see the benefits of STEM integration in action.

Our service project helped us directly tie together the STEM and NOS research we had read about (in class) with a real-world teaching experience. Not only did the students engage in inquiry in a real-world setting, but so did we, which raised self-awareness and promoted reflection. Although it was only a three-day project, seeing how excited the students were throughout the unit emphasized the effectiveness of STEM integration, as well as the need for STEM instruction to reach our youth. Our experiences reinforced to us that institutions should provide access to science instruction earlier than the sixth grade.

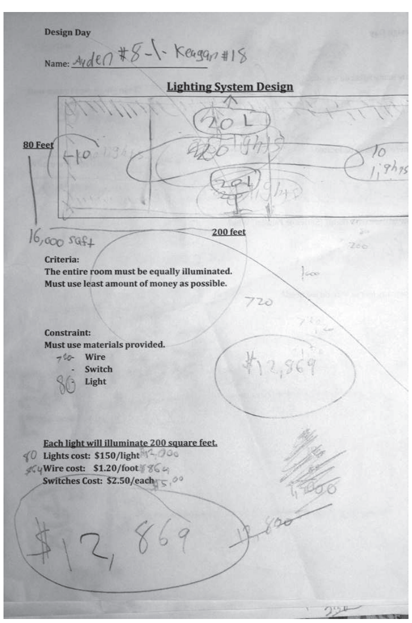

Figure 4. As a part of investigating and creating their lighting designs, the students brainstormed ideas and used math to come up with their total cost of materials.

Likewise, educators need more accessibility to STEM units such as ours. As a result of this experience, we are now working on publishing our lesson plans. The teacher whose class we had the opportunity to teach in expressed interest in having us back to implement more lessons. While we have both worked as teaching assistants at the college level, neither my partner nor I had ever instructed fourth grade students or created and implemented a STEM unit. These were impactful experiences. Hopefully our lesson will be remembered by students, as well as adapted by the teacher whose class we taught. No matter how much scientific reform is published in America, our experience tells us that students not only need more STEM-related experiences, but also the opportunity to receive this instruction at lower grade levels.

ACKNOWLEDGMENTS

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