Science Teachers’ Initial Conceptions and Implementation of 21st Century Skills in Grade 3-8 Classrooms

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Overview
Science and engineering education are seen as promising vehicles to promote 21st century skills in the classroom because they are not only a body of accepted knowledge, but also involve processes that lead to knowledge (NRC, 2010). For instance, the Science Teaching Standards encourage teachers to teach science through inquiry (NRC, 2000). Doing so means engaging students in modeling and representation and learning through investigations and argumentation, which can foster critical thinking, problem solving strategies, collaboration, and communication (Michaels, Shouse, & Schweingruber, 2008).

In this paper, we describe teachers’ initial ideas about 21st century skills including their strategies for implementing and assessing these skills in their classrooms. Teachers’ conceptions about 21st century skills are compared to the skill sets defined in a framework developed by the Partnership for 21st Century Skills (see Table 1).

Participants
20 teachers (17 female and 3 male) from 11 schools in New Jersey are participating in the Partnership to Improve Students Achievement in Physical Science: Integrating STEM Approaches (PIPS) program. Twelve teachers are teaching grade 3-5 students and eight teachers are teaching grade 6-8 students. Sixteen teachers have at least six years of teaching experience.

Methods
In the first month of the program, we conducted individual, semi-structured phone interviews, lasting about 15 minutes. Our interview protocol included three questions: (1) Educators often consider both knowledge and skills that are important for their students to learn; focusing on skills, what skills do you think your students need to prepare them to become productive citizens of the 21st century? (2) How do you promote these skills in the classroom or in your lessons? (3) How can students demonstrate these skills in the classroom so that you can measure them? Interviews were audio-recorded, transcribed, and then analyzed.

Results

21st Century Skills Identified by Teachers
• Critical thinking and problem solving: 9 teachers defined critical thinking and problem solving as the student’s ability to apply prior knowledge, generate ideas or hypotheses, conduct and analyze experiments, and synthesize information based on experimental data or information provided.
• Communication skills: 9 teachers mentioned oral, written, and mathematical forms of communications as important skills.
• Information technology skills: 11 teachers mentioned Internet-based research, use of email, and proficiency with Microsoft Office applications as basic information technology skills.
• Comprehensive reading and listening: 9 teachers identified comprehensive reading and listening as important skills.
• 3 teachers mentioned social skills/cross cultural sense, 2 teachers cited collaboration, while creativity and leadership were each identified by only 1 teacher.

21st Century Skills Identified by Teachers in response to interview question 1

Table 1: Essential 21st Century Skills Defined by the Partnership for 21st Century Skills

Classroom Implementation of 21st Century Skills
Teacher responses on various ways they implement 21st century skills in the classroom were categorized into interactions:
• Student-Student Interactions: 13 teachers identified science lab work, group-generated problem solving, in-class discussions, role-playing, mail exchanges with children from a more diverse school district, and building model diagrams.
• Teacher-Student Interactions: 8 teachers mentioned teacher-led discussions/activities, reading newspaper articles, sharing of real life problems, etc.
• Student Technology Interactions: 9 teachers mentioned using information technology tools such as a Smart Board, Microsoft Office applications to produce projects and write laboratory reports, and Internet-based activities such as web-quests.

Assessing Students’ 21st Century Skills
• Written Tests: 8 teachers
• Teachers’ observation of students: 9 teachers
• Rubrics: 10 teachers
• In-class presentations/explanations: 9 teachers
• Several teachers identified other assessment instruments: oral tests, computerized tests, and self evaluation/reflections

Next Steps
Intersection of 21st Century Skills, Science Inquiry and Engineering Design

Conclusions
Our results suggest that the teachers’ conceptions of essential 21st century skills, during the first month of the program, showed a moderate degree of alignment with our theoretical framework, specifically with respect to (1) Learning and Innovation Skills, and (2) Information, Media and Technology Skills, which constitute our main focus for this research study. Also, our findings point to a low degree of alignment to Life and Career Skills.

Teachers promote 21st Century Skills in the classroom through a diverse range of activities grouped according to interactive approaches. However, aside from asking students to conduct experiments, teachers did not explicitly describe how scientific inquiry or the engineering design process can be used to cultivate students’ 21st century skills.

With regard to assessment, it is not clear if teachers were describing ways to specifically measure students’ skills, knowledge, or both.

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