The Quantum for All Project: Student Outcomes and Connection to Teacher Professional Development

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Abstract. The Quantum for All project is designed to expand Quantum Information Science education in precollege education. The professional development model includes an opportunity for teachers to learn QIS and then teach a summer camp. In this presentation, we will examine growth in student knowledge and confidence in the QIS, as well as attitudes the students have around the topics and careers in QIS. We will also correlate these findings with teacher content knowledge and confidence for the various topics, since some topics were initially unfamiliar to the teachers.

Introduction

Quantum information science (QIS) is the foundation for data encryption, security, semiconductors, cryptography, and electronic devices and students who understand quantum effects will be better prepared for and knowledgeable about future careers. Even among non-STEM careers QIS will play an increasingly important role and in the future workplace [1], and individuals will be more and more dependent on QIS to keep personal data secure. To develop a pipeline of future workers who are capable of operating in an increasingly QIS-dominated environment, precollege students must be introduced to the importance of being quantum-smart, which by default means educators must learn how to teach quantum mechanics and QIS applications. However, most precollege educators are not prepared to teach principles and applications of quantum information and technology as they are not taught these concepts unless they are a physics major [2].

It is important to prepare secondary students (specifically high school students who will enter the workforce in the next 2-3 years) for the current and future careers, which require understanding of technology (ICT). The Quantum for All (QfA) Project, funded by US National Science Foundation (NSF# 2048691), targets secondary STEM (Science Technology Engineering and Math) educators and students, specifically high school students in grades 9-12, to increase STEM and ICT (information and communication technology) career awareness. The aim of the project is to allow QIS to be incorporated into standard instruction in physics, chemistry, and computer science and technology, facilitating the use of the materials in classrooms.

The Student Summer Camp and Data Collected

The QfA couples a 4-day QISE focused professional development (PD) for teachers followed by a 4-day student camp. The student camp, taught by the participant teachers, is designed to help students understand how QIS is the foundation for ICT. By learning and then teaching the student camps, teachers gain practical practice which simulates a classroom environment. This learn-practice environment helps them gain confidence and allows them to see student engagement and interest in QIS and ICT, thereby increasing the chance of implementing the lessons in their own classrooms.

Content assessments were developed to measure the level of content knowledge for both teachers and students. Each assessment question was coupled with a query as to how confident the respondent felt that their answer was correct, and these responses were used to gauge individual levels of confidence for their answers. For the teachers, assessments were given at 3 different times: before the start of a specific content during the PD, after the teacher PD, and after the teachers taught the content to the students in the camp. Students also had assessment questions, but they were only given before the instruction and after the instruction.

Findings and Conclusions

Preliminary results indicate both teachers and students had statistically significant gains in content for most topics which leads us to conclude that the materials, teaching methods, and environment were effective in increasing both teacher and student knowledge. However, for teachers, most of the gain was after they learned the content, not after they taught it at the camp, which was not the anticipated result. In addition to content, the level of confidence also generally increased, but it was not always statistically significant.

As expected, there were some topics where teachers knew more content initially and this was reflected by higher pre scores. However, because most of the students were entering grades 9 and 10, they did not have the background knowledge and they had lower initial scores. A closer analysis of the specific topic pre and post scores may provide useful information as to which topics need a larger focus on fundamental understandings before the content topic is addressed. Data are also being analyzed to focus on comparisons between the content and confidence exhibited by the students as compared to the teachers. For example, if the teachers had a lower content understanding for a specific topic, was that reflected in the student understanding and/or confidence?

References (Vancouver numeration and APA Style)

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