STEM Education and Interest in Computer Science

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Introduction

STEM (Science, Technology, Engineering, and Mathematics) education has been gaining popularity and momentum with the national concern about its declining state in the U.S. In 2006, the United States National Academies recommended several actions that could be taken to advance STEM education. "Their top three recommendations were: (1) to increase America's talent pool by improving K-12 science and mathematics education, (2) to strengthen the skills of teachers through additional training in science, mathematics and technology, and (3) to enlarge the pipeline of students prepared to enter college and graduate with STEM degrees" (Kocher, 2014). More recently, President Obama has made STEM education a priority because few students pursue careers in these fields. There is even data that shows that STEM jobs will see significant increases between the years 2010 and 2020 (Science, Technology, Engineering and Math: Education for Global Leadership, n.d.). Despite these prestigious proponents, the number of students actually pursuing STEM fields remains low (Munce, R., & Fraser, E., 2012). What can we do in K-12 education to foster interest in and emphasize the importance of STEM? Is what we are currently doing successful?

An underdeveloped field within STEM is the field of Technology education, specifically Computer Science. Science and Mathematics will always be self-perpetuating, core parts of our educational standards, and Engineering represents their direct application. However, Technology has historically been, and continues to be, poorly standardized and treated separately from core curricula. Whereas "Tech Ed" once gave students experience in hands-on construction, vocational skills, and design, the appropriate facilities and expertise have been set aside. Thus Technology education has been relegated to forgotten, ill-defined, and ill-supported electives. Computer Science represents a nascent, modern focal point for Technology education,

as it instead provides strategies that enable deeper exploration of the sciences and that leverage the power of everyday, ubiquitous devices. In years past, Computer Science was a course that could only be taken once a student reached high school. Now, there are different ways students may access this field and in younger grades, such as programming, algorithmic thinking, animation, robotics, and other sub-fields. Educators are gradually incorporating these experiences into their curricula, or schools are offering it within Technology education classes that all students will rotate through.

Generating Interest

One of the key components to generate interest in STEM fields among students is exposure. Presenting a variety of technology offerings should be started at a young age and continued through elementary and secondary schooling. In 2010, the National Science Board (as cited in DeJamette, 2012) reported that providing elementary students early exposure to STEM fields may motivate them to choose advanced math and science courses when they enter middle and high school. In recent years, there has been a shift to provide more STEM opportunities for students in younger grades so that when the time comes for students to self-select courses based on interest, these concepts are not foreign to them.

A study by Roth & Eijck (as cited in DeJamette, 2012) found benefits to lifelong learning when more emphasis and focus was placed on STEM initiatives. The benefits go beyond simply learning content; through STEM education, students are exposed to "problem solving, critical thinking, and open-ended inquiry" as found by Wood (as cited in DeJamette, 2012, p. 79).

Another issue with generating interest is not just student exposure, but also teacher preparedness in providing STEM experiences. Recent emphasis on state testing of reading, writing, and mathematics skills has caused much elementary class time to be spent on these few

topics (Banilower et al., 2013). Hopefully, with pushes for STEM education, elementary teachers might be able to more readily incorporate these STEM into their curriculum. Given an already packed school-day schedule, providing new specials or separate classes to address STEM education could prove difficult. Instead, teachers should work to integrate STEM concepts into what they already do. An identified problem is that many elementary teachers lack formal science education or the necessary training in order to teach STEM initiatives in an elementary setting, according to Harlen & Holroyd (as cited in DeJamette, 2012). As part of the Obama administration's goal to improve STEM education, there is a push to increase the number of teachers proficient in STEM fields (Science, Technology, Engineering and Math: Education for Global Leadership, n.d.). In a report by Epstein and Miller (2011), they also found that the teacher candidate selection process in the United States pales in comparison to the process in other countries. In the U.S., some colleges may have minimal entry requirements for teacher preparation programs, and some only require a basic skills test assessing the candidate's knowledge of elementary or middle school level math and nothing higher. In countries like South Korea, Finland, and Singapore, teachers come from the top 5 percent, 10 percent, and 30 percent respectively.

With studies showing benefits of early exposure to math and science, this clearly would also include Technology education. Studying Computer Science could provide a medium to bring together all STEM fields in order to provide useful experiences and lasting takeaways for children.

Attitudes Toward Technology

Another important piece to successfully support Technology education and Computer Science are the attitudes of the stakeholders. As stated earlier, there is a need for educating

teachers so that they can successfully incorporate STEM initiatives into their curriculum. A study by Jarvis and Rennie (as cited in Rohaan, E. J., Taconis, R., & Jochems, W. M., 2010) found that teachers were narrow-minded in their thinking about technology. Because of this, student understanding of technology and its uses could be inhibited. It would be interesting to see an updated study on this topic using more current Technology education initiatives.

With regard to students, about 1 in 4 high schoolers show interest in pursuing a STEM major or career, but about 60 percent of students who begin high school interested in these fields end up changing their mind by the time they graduate. While this does not sound promising, these numbers have actually been climbing for almost a decade (Morella, 2013). In a study by Wang (2013), it was found that among 6,300 students, 19.3 percent planned to major in a STEM field in college, but only 15.4 percent ended up actually declaring a major in one of those fields. Even with growing numbers of available jobs in STEM-related fields, not enough students choose to pursue these careers. Among students who do choose to major in a STEM field, some find it too challenging. According to a report by ACT, "only 26 percent of high school seniors who expressed an interest in STEM fields are academically ready for tough first-year STEM classes in college" (O'Shaughnessy, 2015). This may be because students lack the necessary scientific background in math and science before starting college. Computer Science, specifically, is the only STEM field that has experienced a decrease in student enrollment according to Time Magazine (as cited by Exploring Computer Science, n.d.). According to the College Board, it is clear that the numbers of students taking AP Computer Science exam are small in comparison to that of other APs. Based on data from the College Board, in 2011 in the state of California, only 3,101 students took the AP Computer Science exam as compared to

35,000 who took AP Government, 55,000 who took US History, and 58,500 who took English (as cited by Exploring Computer Science).

Parent involvement and support make a big difference in students pursuing STEM fields. Based on a report by Johnson, Rochkind, and Ott (2010), it was found that parents are in support of investing in STEM education, but many also say that "things are fine as is." Computer Science Education Week reports that 9 out of 10 parents would like their children to study Computer Science. It seems that parents are on board, but students are not. There is a discrepancy here that needs further clarification.

What's Out There

Some schools have already started to offer Technology education in the form of Computer Science. There are different ways of achieving this with the most common being offering specific elective Computer Science courses (usually at the high school level), integrating Computer Science into existing curricula, or by offering extracurricular programs, the latter two providing options for K-12. One program that makes computer programming accessible and can teach Computer Science concepts to young people is MIT Scratch. A study by Meerbaum-Salant, O., Armoni, M., & Ben-Ari, M. (2013) found that teachers were able to successfully teach Computer Science concepts through Scratch to students in a mathematics setting. While some teachers set aside days and lessons specifically to teach Computer Science concepts, other teachers end up using Scratch as a choice activity, reward, or a challenge.

Other options for Computer Science offerings beyond the school day include extracurricular programs such as Girls Who Code and FIRST Robotics Competition. With less than 20 percent of AP Computer Science exam-takers being female, Girls Who Code has recently become a popular after-school club that specifically targets young women (Stern, J.,

Reid, E., & Bancroft, K., 2015). The FIRST Robotics Competition provides four different levels of competition starting at age 6 and running through 12th grade. According to an Education Week article by Plotnick (2015), using robots, participating in Hour of Code, making use of computers in specific content areas, creating a new club or becoming involved with an existing one are all excellent ways to get students to become engaged and interested in Computer Science.

Conclusion

Few studies focused specifically on the Technology education portion of STEM and even fewer on just Computer Science. Many studies were dated and looked at Technology education as a way of incorporating technology in the classroom. More relevant studies are needed that assess whether or not what we are doing with Technology education and Computer Science is successful in having students pursue careers in these areas.

With computing comprising at least two-thirds of the projected new jobs in STEM, the fact cannot be ignored that Computer Science is important (Computer Science Education Week). We have also seen that computing is accessible whether it is offered as elective courses, integrated into existing curriculum, or provided as an extracurricular activity. This is not the case with all schools, however, as many schools do not provide Computer Science education (Exploring Computer Science).

Despite the variety of approaches to teaching Computer Science, a critically important question remains yet unanswered; when it comes to students self-selecting Computer Science courses, how are these courses presented? As Computer Science often does not command enough students to warrant its own department, it is usually included within other disciplines like Business, Mathematics, or Science. Does this play a role in how it is portrayed to students?

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