Chapter 3
Assessment of Learning and Technology:
Computer Science Education

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ABSTRACT

The education of a nation is a critical component of economic growth. Education is itself shaped by economic, political, historical, technological, and other cultural factors. Society today is increasingly dependent on computers and technology. However, computer science (CS) continues to be viewed as an optional specialization rather than a core subject in U.S. education. The result is that our leaders will continue to lack the necessary understanding of technology that is critical for good policy and decision making. It is time to realize the importance of including CS as part of the core curriculum and utilizing current technology to assist this mission. This chapter discusses the current state of CS education in the US and focuses on how the integration of learning theories in digital educational environments along with rigorous assessment of such environments in the academic community can provide effective learning tools for increasing the availability and effectiveness of CS education.

INTRODUCTION

Human reliance on technology is increasing rapidly with time. The ability to utilize technology for learning, innovation, and creation stands to replace reading/writing literacy as the barrier to success in modern society. Modern life depends on computing. Our financial system and related economic activities have become nearly entirely computerized. One can bank, buy, and sell goods and services completely over the Internet. Our personal data is passed back and forth across networks as a part of everyday routine interactions which include accessing medical, financial, and identification information. Many countries rely entirely on computers for their utility and transportation systems as well as for other key government services.

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Cybercrime has increased dramatically along with our increased dependence on computing. The FBI's Internet Crime Complaint Center had 262,813 complaints in 2013. PCWorld reported that there was an average of 82,000 new malware threats per day in 2013. Decisions are being made concerning net neutrality that will affect who owns the Internet. This will not only impact the quality and availability of Internet services, but will also affect the power distribution between corporations and consumers as well as between governments and people. Issues of copyright infringement in the digital realm are being defined in the courts. We not only need to train technicians and scientists that will continue to maintain and create technological advances to move society forward and correct problems that technology itself has caused, but also leaders who have a fundamental understanding of computing to better enable them to make sound decisions concerning technology to benefit society.

While participation in computer science education is increasing in the rest of the world, it has been declining in the U.S. Other countries are incorporating computer science into primary schools, while the U.S. still lacks course offerings in high schools. In Vietnam, students begin learning basic computer skills in the second grade and begin programming in the fourth grade. Estonia's ProgeTiiger Project has students coding as young as seven years old. The Indian company Directi created the online programming interface Codechef to help prepare Indian students for the International Olympiad of Informatics. The UK's new curriculum requires students to learn basic computer programs and algorithms beginning at age five. According to Exploring Computer Science, there are over 42,000 high schools in the United States, but only 2,100 were certified to teach the AP computer science course in 2011 and only ~22,000 students took the exam. Of these, about 63% received a score of three or higher. Many schools only accept a 4 or 5 for credit; slightly less than half the students that took the exam received a 4 or 5. Computer science is all but absent in elementary and middle schools. The U.S. is in danger of falling behind.

The U.S. Education System is at a crossroads. Early American Education was primarily private or religious. Curriculum varied widely across both classical studies and utilitarian subjects. By 1913 all states had enacted compulsory education laws. Secondary education separated students into tracks: college preparatory, business, vocational, and modified (Goldin, 1999). This tracking system was found to be discriminatory and No Child Left Behind (NCLB) legislation was passed in 2002 with the goal of ensuring that every student achieves college readiness in the foundation subjects: Language Arts, Mathematics, Science, and Social Studies. Some schools offer elective options from other fields such as the fine arts, physical education, vocational, and technical fields. If computer science is offered, it is generally as an elective course. However, with the new focus on academic subjects, funding has been drastically cut for providing elective subjects.

As of 2014 many schools are still struggling to reach the target standardized test scores mandated in NCLB legislation. Because of this, schools have begun to teach to the standardized evaluation tests which emphasize facts over critical thinking and problem solving skills. This is alarming given that science, technology, and math (STEM) subjects, including computer science, require problem solving and critical thinking skills for success. In addition, computer science success requires abstract, algorithmic thinking that is both difficult to teach and lacking from the curriculum (Sleeman, 1986). Many colleges and universities report attrition rates of 30%-40% for computer science. Deficits in problem solving and math skills are considered a major factor (Beaubouef & Mason, 2005).

Computer science courses in the US are available in very few high schools and even fewer middle and elementary schools. According to the U.S. Department of Education's most recent