FLVS Computer Science is STEMulating

Bill Jordan and Amie Ross
Florida Virtual School

ABSTRACT

Does computer science come to mind when you think of STEM? To date, the "T" in STEM has focused primarily on enabling students to develop proficiency in the use of commercial software rather than learning to apply algorithmic thinking to actually create software. Computer science has received short shrift in the rush to implement STEM programs despite its unique ability to connect the dots among science, technology, engineering and math. This oversight is troubling given that no other discipline offers as many 21st century opportunities, regardless of a student's occupational goals. This presentation will demonstrate why computer science is STEMulating.
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INTRODUCTION

Computer science has been the innovation engine driving economic growth, personal empowerment, and social change for several decades. It is impossible to imagine a future without computers, especially in the workplace which is increasingly dependent on science, technology, engineering, and math (STEM), yet the unfortunate omission of explicit references to computer science at the beginning of STEM education reform marginalized its role in the search for solutions. The inconvenient fact is that every STEM discipline essentially rests on a foundation of computer science; the future of STEM is digital. The STEM pipeline is leaking; many capable students are ambivalent about math and science. Of the four STEM disciplines, Technology holds the most potential for engaging students' interest if for no other reason than digital technology is already a meaningful focal point of their personal lives, but we fail to capitalize on their interest.

Clearly STEM is a hot topic among educators, politicians, and business leaders in recognition that America's economic success, technological leadership, and even national security depend on a well educated work force and an informed citizenry. Science and math garner the headlines and the funding of the STEM education movement, but the "T" in STEM is seldom explicitly addressed. "Many observers assume that computer science is the "T" in STEM, but this is, by and large, not the case. Computer science education focuses on teaching fundamentals of computing and computational thinking just as core mathematics, physics, chemistry, and biology courses teach fundamental concepts. K-12 technology education focuses primarily on the use of computing as a tool to solve problems in other fields, specifically the use of computer applications in pursuit of that goal" (Wilson, 2010). Florida Virtual School (FLVS) has demonstrated this approach and offers two computer science courses which are the epitome of STEM: Computer Programming 1 (CP1) and AP Computer Science (APCS).

ONLINE COMPUTER SCIENCE AT FLVS

CP1 is a two semester course intended to prepare students for an accelerated transition into AP Computer Science. The first semester of CP1 teaches Python based on a curriculum developed by the Institute for Personal Robotics (IPRE) (Blank, 2006). All students are loaned a hobbyist-level robot as they learn Python. By kinesthetically interacting with a

programmable manipulative, students are better able to visualize algorithmic design in relation to the outcome of the programming process. Fundamental concepts such as user input and output, variables and calculations, loops, conditions, and data structures are covered in Python. STEM connections to math and science are integrated into every lesson. Assignments include writing programs to make the robot perform complex driving maneuvers (e.g., parallel parking, figure eights, etc.), drawing complex geometric shapes, detection of obstacles, seeking a bright light, playing music and a simple game. Examples of these will be demonstrated during the presentation.

The second semester of CP1 is based on the media computing curriculum developed at Georgia Tech (Guzdial, 2003). Media computing involves manipulation of digital objects such as graphics, images, audio and video which are naturally appealing to students. Having first learned Python, students easily transition to Java's more complicated structure and syntax because fundamental programming concepts have already been mastered (e.g., input and output, variables and calculations, loops, conditions and data structures). Assignments include writing programs to draw simple pictures, create fractals, construct Escher prints and kaleidoscopic images, plot data retrieved with a web crawler, and play MIDI music. Connections to STEM concepts will be demonstrated during the presentation.

The AP Computer Science A course is equivalent to a first semester college level computer science course. The course involves developing programming skills in Java. APCS also emphasizes the design issues that make programs understandable, adaptable, and when appropriate, reusable. At the same time, the development of useful computer programs and classes is used as a context for introducing other important concepts in computer science, including the development and analysis of algorithms, the development and use of fundamental data structures, and the study of standard algorithms and typical applications. In addition, understanding the basic hardware and software components of computer systems and the responsible use of these systems are integral parts of the course. Approximately 75% of the FLVS APCS assignments are STEM-related including estimating the value of pi using the Monte Carlo method, modeling students' carbon footprint, determining body mass index, decoding a secret message, and estimating the distance a cantaloupe can be catapulted. This presentation will describe these lessons.

RAISE THE BAR FOR THE "T" IN STEM

Computer science has struggled for 40 years to gain a foothold in the K-12 curriculum. Left largely to the whim of administrators, high stakes testing imposed by politicians, and the tug-of-war between academic and vocational interests computer science courses are fading from the curriculum just when they are needed the most. "Increasingly, students are turned off to computing long before they graduate from high school, often because they have come to think of computing as little more than word processing and spreadsheets, offering few opportunities for the excitement that has always attracted people to computing. At the same time, students are increasingly disenchanted with the perception they have to work in a field, which they see as isolating, disconnected, unchallenging, and overwhelming" (McGettrick, et al., 2008). At a time when the Bureau of Labor Statistics predicts there will be greater gap between the number of STEM-related computer jobs and graduates than for engineering, math, physical science, or the life sciences, isn't it time to raise the bar for the "T" in STEM? The failure to teach computer science in the K-12 curriculum squanders the opportunity to better prepare students for employment in science, technology, engineering and math as well as to be well informed 21st century citizens.

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AUTHORS INFORMATION

Bill Jordan has taught Computer Science courses for 30 years. He joined Florida Virtual School in 2000 where he has developed and taught the AP Computer Science and Computer Programming 1 courses. He earned a BA in Biological Science from Florida State University, a MS in Marine Science from the University of South Florida, and an Ed.S. in Computer Education from Barry University. He is also a 1st degree black belt in Kenpo Karate. bjordan@flvs.net

Amie Ross has taught AP Computer Science and Computer Programming I courses at Florida Virtual School since 2003. Her teaching career began 16 years ago with middle school and high school Computer Science courses. She earned her Computer Science BS from the University of Central Florida. Outside the classroom she and her husband can be found supporting her son and daughter in their interests. aross@flvs.net