Computer Science Classes and Their Place in High School Curricula

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Abstract

Computer Science is one of the fastest growing fields in science. Because of this, there is an increasing importance in Computer Science courses in high school. This paper attempts to highlight the most important aspects of a strong Computer Science class, the benefits such a course can have on students’ success after high school, and the importance of attracting more female computer scientists through these courses due to an increasing gender gap. This article cites several sources such as studies on success in college courses following high school, as well as lectures on the importance of Computer Science with young minds.

Keywords: high school, Computer Science, education

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## Introduction

Computers, smartphones, tablets, and now wearable technology are commonplace in American society. According to the 2013 census, computer ownership in American households was just under 84% including desktops, laptops, and handheld computers. With a majority of American households owning computers, computer literacy is immensely important. While many children and young adults are exposed to computers outside of the classroom, there is an increasing importance in the use of computer classes in secondary education. Computer science (CS) courses, while common in American high schools, often only address one or two aspects of the field. It is common for students to learn basic applications of computers such as how to use a word processor or how to create a spreadsheet, or basic programming in languages like C++, Java, and Python. Even schools that offer programming courses can miss the mark in teaching students about an immensely important branch of science. When high school CS courses skip over key topics, it diminishes what may be some students’ only exposure to the field, which may widen the gender gap that exists in college-level CS courses and beyond. Certain concepts and ideas pertaining to Computer Science are not only essential to students that may pursue a career in the field after high school, but students that end up in any field, scientific or otherwise.

# Computer Science’s Role in the High School Classroom

Although it is not uncommon for computer courses to be a part of high school curricula, the classes are largely unstandardized. Classes can range from typing classes to basic computer applications. Although computer applications are important in many ways, these classes do not focus on the *science* behind Computer Science. Some high schools offer programming classes, but “coding is only one side of the coin.” (Gal-Ezer, Beeri, Harel, Yehudai, "A high school program in Computer Science") The other side of the coin is the concepts and computational logic, as well as their implementation that defines Computer Science as an “autonomous scientific discipline.” In a TEDx lecture, Simon Jones argues that we do not teach students physics, biology, chemistry, and calculus because we expect them to be scientists, but because those subjects help people understand the world around them; Computer Science helps students understand the turbulent technological environment that they encounter on a daily basis.

## Preparing Students for the Future

Jones explains that “education should prepare young people for jobs that do not yet exist, using technologies that have not yet been invented, to solve problems of which we are not yet aware.” (Jones 2014) Although this sounds peculiar, it illustrates the idea that the concepts learned in high school Computer Science should transcend the ever-changing supply of new devices and services. Concepts like computational thinking, complexity in sorting algorithms, and logic are the groundwork for everything from programming languages to hardware. Jones argues that instead of equipping students to use the latest operating systems with the most advanced computers, curricula should be giving them the skills they will need to understand the technological world around them in the future. Furthermore, students should be taught “not only to consume technology, but to be imaginative creators of technological artifacts.” Although the link between students interested in Computer Science as a possible career and high school CS courses may be obvious, this is because the conceptual topics that are often omitted, are the aspects of CS that are most easily transferred to other fields of study.

# High School CS for Prospective Computer Scientists

“An early study done when computers were not as common in the high school showed that a prior high school course had no effect on success in college Computer Science.” (Taylor, Mounfield, "The effect of high school Computer Science, gender, and work on success in college Computer Science") This study was done before computers were common in a high school setting. Today, however, students are entering the CS curriculum having already been exposed to computers, and studies now suggest that CS classes in high school positively impact students’ performance in college level courses. In contrast with these findings, according to Taylor and Mounfield’s paper on the effect of high school Computer Science, some college CS professors consider exposure to Computer Science in secondary education to be detrimental to students’ success in college. Interestingly in this study, Computer Science majors that took an introductory college course, had among the lowest success rates when compared to students in other majors such as education, business, and electrical engineering. Furthermore, education majors had one of the highest success rates in the class, with 80% completing the course with a C or better. In another paper by Taylor and Mounfield, it is stated that the biggest indicator of success on a college level is the method by which students where taught Computer Science in high school.

## Programming Practices

The study shows that when students are taught structured programming “usually using BASIC rather than Pascal,” (Taylor, Mounfield, "An Analysis of Success Factors in College Computer Science") 77% of them were successful in an introductory college CS course. Importantly, although there is a correlation between high school *programming* courses and success in college CS, there is no statistically significant correlation between applications classes and success in the course. Applications experience consists of “word processing, database, spreadsheets, computer literacy classes or home computer ownership, but no programming experience.” (Taylor, Mounfield). Additionally, there was no significant difference between students that had taken a typing course in high school and those that had not. The study concludes that structured programming classes gave students skills and techniques that are universal to all languages, and emphasized the importance of style and form.

In a paper detailing the results of a survey administered to 836 high school students, Lori Carter explains that “High School students are severely lacking in experience with computing, particularly in the formal classroom experience.” (Carter, “Why students with an apparent aptitude for Computer Science don't choose to major in Computer Science”) This explains the need for more of the structured programming courses described above. Many computer classes offered in public high schools today are much more focused on how to use computers in other fields than they are on conceptual understandings of logic and algorithms. The latter is much more important to understanding Computer Science as an independent field of study.

## Ending the CS Gender Gap with High School Courses

Computer science is often regarded as a masculine field and statistics show that while a female presence in many professions and areas of study are increasing, the proportion of women in CS professions to men decreased by more than six percent from 2001-2005. (Anderson, "‘Because it’s boring, irrelevant and I don’t like computers’: Why high school girls avoid professionally-oriented ICT subjects") one possible explanation is not that Computer Science is “boring” as the title suggests, but that a perception of being comfortable with computers may stem from playing video games, which are most often marketed to males. Other reasons may include not wanting to be labeled a “nerd” or being intimidated by male classmates in a CS classroom setting. At the 2014 CSNYC Education Meetup, Computer Science educators met to discuss how to be more effective in recruiting females into the field of Computer Science. One method that was discussed is to approach CS education in a liberal arts context. This involves teaching Computer Science as a method through which young women can express themselves and that Computer Science is not about programming just as “History is not about citing primary sources and English is not about grammar.”(CSNYC Education Meetup 2014) If CS education is introduced without the use of typing and computers, but through the use of games and puzzles, young women are much more likely to be successful in the class. During the conference, Ashley Gavin, the Curriculum Consultant with a program called Girls Who Code, explains that one of the most effective ways to get girls into the CS classroom is to use project based learning with open ended guidelines. This allows the students to be creative in their approach to problem solving, and in the specific example of making apps, it lets them come up with their own ideas and design the final product. Some of Gavin’s other suggestions are to encourage young women to share their projects with friends and to base projects on socialization and popular culture, and to use field trips whenever it is possible. It is important to increase the number of females in the field of Computer Science for the same reason it is important to implement strong CS curricula in high schools: it is necessary and beneficial to young men and women of all backgrounds and interests.

# Conclusion

In conclusion, the use of Computer Science courses in high schools is an integral part of students’ success later in life and their understanding of the world around them. It is important to focus CS curricula on concepts and ideas that are the core of Computer Science, and use those concepts to introduce tools and understandings that will aid students after high school. It is equally important that the courses are taught using project based instruction that allows the students to be creative and social with their creations, and that the information learned is applicable to young men and young *women* whether they choose to pursue a career in Computer Science or not.

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