Undergraduate Thesis Prospectus

Improving Computer Science Curricula for Higher Engagement

(technical research project in Computer Science)

Overcoming the Digital Divide among Youth

(sociotechnical research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

How can computer science and coding aid in the educational process?

. Within the context of K-12 education, the term computer science (CS) refers to the study of computers, computational thinking, and algorithms. Implementing these principles in the classroom requires complementary resources, such as accessible programming languages and user-friendly coding environments. This research problem invokes a study into the benefits of incorporating these concepts within a K-12 curriculum.

By determining the benefits, more information is available to assess the Digital Divide, the unequal exclusion of certain groups from access to technology. The consequences of these inequities stretch into many spheres of life, such as academic performance, work opportunities, and health care (Robinson, et al., 2015). Research shows that students with earlier onsets of IT use performed better academically, therefore furthering the divide between students who had access to technology earlier in life and those without (Jackson, et al., 2008). By studying how the integration of computer science in our education system benefits students, we can understand the strength of the digital divide on education in order to dismantle it.

Improving Computer Science Curricula for Higher Engagement

How can complex computer science topics be broken into digestible curriculums across multiple grades in K-12 schools?

This independent research project focuses on how topics in computer science are chosen and distributed across school grades to enhance students' learning. Through offering this contextual basis, I will propose a new curriculum with the purpose of teaching computer science at an early age and prioritizing student engagement through innovative teaching methods. This research project is guided by Professor Mark Sherriff in the Computer Science department at the University of Virginia.

As our information society continues to develop, the demand for computer scientists rises. However, the path towards a career in CS is reliant on a student's experiences with the subject. These early interactions are impeded by the presence of the digital divide, with numerous studies showing the racial and gender ties to the gap. Research shows that Black and Hispanic students show greater interest in learning computer science, yet they are the two demographics that suffer the most from lack of access to technology (Wang & Moghadam, 2017). In addition, Hispanic students are the least likely to know an adult who works in computer science, therefore reducing their chances of pursuing a career in CS. In my contribution, cost-efficient resources, early introduction to computer science, and student engagement are the primary goals to address the digital divide and promote positive attitudes towards CS. In addition, through my contribution to the academic community, I expect to receive criticism in order to improve my proposal before starting my path of teaching computer science in K-12 schools.

Although there has been improvement in accessibility and teaching methods for CS education, the formalization of computer science as a K-12 subject has only begun within the last ten years.

Learning Theory in Computer Science

The concept of constructivism is prominent within most computer science classrooms. This is a cognitive theory that assumes a student has a perceived mental model that may or may not map onto the true nature of a subject (Machanick, 2007). The theory is embodied through the student's mental process while coding: they hypothesize what the program should be doing, test it, then correct their mental model if they were incorrect. However, this method of learning focuses on the purely cognitive domain within computer science (2007). As a result, my proposed curriculum will consist of innovative teaching methods that integrate technical and social learning, such as apprenticeship and peer assessment.

Implementations of Computer Science Learning Across Ages

High schools are the primary source of formalized computer science courses, like the AP Computer Science Principles course. However, as this course takes a more rigid structure to prepare students for the AP exam, there is no room for teaching students through more engaging methods, such as group projects and gamification. Therefore, I plan to map computer science subtopics with corresponding activities that enable cognitive and social learning. For younger students, most computer science classes will be found in out-of-school programs, such as those offered by CodeVA. In their Eureka workshop, children are able to learn about CS through the combination of visual arts and coding through affordable, local classes. In my own contribution, I will incorporate methods of teaching such as this to engage younger children when considering how the curriculum's activities will change as students get older. In addition, I will research accessible, low-cost resources to include in my curriculum.

My final product will be a series of computer science curricula for primary, middle, and secondary schools that emphasize interdisciplinary technical and social skills while using cost-efficient resources. A successful curriculum will provide an accessible pathway towards computer science opportunities that will narrow the digital divide, instill important life skills into students, and foster a positive and inclusive atmosphere around computer science.

Overcoming the Digital Divide among Youth

How are organizations advocating for computer science education accessibility in high schools for all demographics of students?

This research project qualifies the effects of our information society on our education system. It is important to determine how students' lives and career opportunities are influenced by the digital divide. Disparities in online access cause a "homework gap" that disadvantages students in lower-income households that lack Internet access at home (Vogels, 2021). The COVID-19 pandemic made this disparity even clearer as education became more reliant on Internet and technology use. Within the past two decades, however, advocacy groups have led the fight towards easy access to computer science education and technological resources.

Organizations such as CollegeBoard and Code.org created formalized standards for computer science education in high schools. Their AP Computer Science principles course introduces computer science before college. State and local organizations promote education policies to improve access to computer science. However, as the COVID-19 pandemic proved, there are still fundamental inequalities including lack of resources for students, untrained teachers, and high-cost class materials. As computer science becomes recognized as a K-12 school subject, it is essential for advocacy groups to acknowledge the physical and monetary limitations students face.

The Expanding Computing Education Pathways Alliance (ECEP) advocates for state educational "policies, pathways, and practices that advance equity at scale." (ECEP, 2022). Based on their own publications, the organization develops a common framework for computer science and advocates for broad participation (Dunton et al, 2022). Code.org is a national non-profit organization that develops accessible CS resources for underserved schools. It helped develop the K-12 Computer Science Framework, “a high-level guide for states, districts, and organizations implementing computer science education” (Code.org, 2022). This organization also sponsors local advocacy groups around the country who hold the same values. CodeVA is an affiliate partner with Code.org that drafts state-level policy initiatives (CodeVA, 2022). It thereby contributed to a 2016 Virginia law that requires computer science literacy from kindergarten to eighth grade. Next, CSforALL is a national advocacy that provides CS educational resources and connections. It calls itself “a central resource for individuals and organizations interested in K-12 computer science (CS) education” (CSforALL, 2022). It also holds deep values in incorporating local efforts led by parents and teachers into their own mission statement. Lastly, the Association of Computing Machinery (ACM) facilitates academic discussion within various subject areas. Unlike the other participant groups, the ACM does not have a focus on computer science, but rather on the collection of computing teachers and professionals to share resources and discuss challenges within their respective fields (ACM, 2022). Computer science experts and advocacy groups can publish academic papers on the site in order to engage in discussions and formalize CS standards. In addition, publications with open access can provide new methods or perspectives for CS teachers looking to improve their own classes.

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