Undergraduate Thesis Prospectus

A Tool to Support Remote Collaboration Among Computer Science Students

(technical research project in Computer Science)

STEM Teachers and Classroom Technology

(sociotechnical research project)

by

Charles Fang

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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.
Charles Fang

Technical advisor:	Aaron Bloomfield, Department of Computer Science
STS advisor:	Peter Norton, Department of Engineering and Society

General Research Problem

What role does technology play in education?

Educational technology (edtech) use must be balanced with "developmental psychology, the psychology of addiction and educational psychology" (Arnold-Schwartz, 2019). There are concerns that "certain ways of using technology could curtail their thinking processes and obscure underlying ideas" (Wexler, 2019). Teachers in half of the departments interviewed by Hennessy et al. (2005) felt pressured to introduce edtech into contrived learning exercises. Although Bishop (2020) mentions its benefits "for interactive learning, for socializing and for social-emotional health and wellbeing" especially during COVID-19's remote learning period, Veletsianos and Moe (2017) warn that edtech "envisions technology as a solution in and of itself" and should be evaluated with empirical evidence.

A Tool to Support Remote Collaboration Among Computer Science Students

How can the use of technology mitigate the effects of COVID-19 on CS education?

As a CS major, I will complete my capstone project in the Spring semester. My preliminary capstone project advisor is Aaron Bloomfield (CS). I plan on individually proposing a new software tool to assist with adjusting to remote office hours and code reviews. This tool is a shared coding environment with additional features such as a virtual whiteboard and a connected mobile scanner app.

During the COVID-19 pandemic, the vast majority of in-person education transitioned to entirely remote. The U.S. Census Bureau (2020) found that "nearly 93% of people in households with school-age children reported their children engaged in some form of 'distance learning' from home".

A significant drawback of remote education is the difficulty of providing and effectively using office hours. In most Computer Science courses at UVA, there is a significant dependence on getting help from teaching assistants (TAs) and professors during office hours. In addition to trying to get a better understanding of recently-taught concepts, students often need help with debugging their programs.

In the past, TAs could simply draw on whiteboards to explain concepts and examine the program on the student's laptop directly. Nowadays, without access to a tablet, communicating a visual explanation is extremely tricky. The process of drawing on paper, taking a photo, and uploading is both tedious and time-consuming. Remote office hour debugging has consisted of sharing the screen and scrolling when asked to. Naturally, this method is not particularly effective when you have hundreds of lines of code to parse. Google Documents allows for real-time shared access and editing but cannot compile and run code.

If successfully implemented, this tool will allow users to upload, simultaneously edit, share, and run source code. A secondary tab would provide access to a whiteboard element featuring textbox notes, drawings, and an invitation code. Through the invitation code, the mobile app can quickly scan paper drawings and automatically upload it to the connected whiteboard as a post-it note. The special commenting syntax would allow the user to embed images directly within the code editor's view. The creation of a unified application would streamline the process of getting help during office hours and increase the level of effective communication.

Given that this project consists of both web and mobile applications, ReactJS and React Native are possible framework choices. To better understand the needs of the users, students and instructors at UVA can be surveyed about the type of features that would be most beneficial.

Due to the scope of this project, I will not attempt to develop a working prototype. However, I will use wireframes to convey what this tool should look like. As part of my capstone project, I will explore the tool architecture, perform a risk assessment, and describe the use case. With a successful capstone project, I hope that I have laid the groundwork for the future implementation of this tool. COVID-19's effects on the shift towards digital education will be long-lasting and this tool can mitigate a portion of its negative impact.

STEM Teachers and Classroom Technology

In U.S. secondary education since the early 2010s, how have STEM teachers resisted, applied, or adapted to digital technology in the classroom?

Snyder (2018) observes that engineering education is a way to "integrate disciplines, such as math and science, using hands-on learning activities to solve problems," bridging "foundational knowledge and technological development through thoughtful planning and design." It "can help make science and mathematics come to life through application" (p. 46).

STEM instructors in U.S. secondary education disagree about how and for what purposes educational technology is useful, and under what circumstances is it a detriment. Some STEM instructors caution that educational technology can introduce problems of security and equity.

During the early 1970s, "the scientific calculator generated a worldwide and intensive debate on whether these calculators should be allowed in mathematics classrooms and, if yes, in which grades they might provide opportunities or cause problems" (Drijvers & Weigand, 2010). History tends to repeat itself. Recent debates about new educational technologies are analogous.

Seven decades ago, Coch and French (1948) asked: "Why do people resist change so strongly?" (p. 523). The question bears questionable assumptions, however, which Dent and Goldberg (1999) have examined.

In a review of research trends, Billings et al. (2012) found growing attention to technology integration and distance learning. Kelly (2015) cautions that "issues of access, time, professional development, support, consistent policies, and sustainability of programs need to be addressed prior to the implementation of any technology."

School administrators develop technology policies that often supersede the personal policies of instructors. School systems are bound by software contracts and bear a legal obligation to secure students' information, limiting instructors' and students' technology choices (Waseem, 2020).

Some educational technologies have been subject to cyberattacks. For example, Kahoot is a game-based educational quiz tool. Students can connect to the web application by phone through an invite code and participate in classroom activities. In one incident, students flooded their own Kahoot session with disruptive bots (Barcelona, 2020).

Educational technology can also exacerbate the digital divide. Some school districts can afford to supply technology to students who need it (FCPS, n.d.), but many cannot. According to the president of Integrated Education Strategies: "I've seen huge disparities, where I've gone into classrooms in urban districts and the paint is peeling and there's not a computer in sight, to very high-end districts where every kid has an iPad they can bring home" (Pandolfo, 2020).

Mupinga (2017) concludes that as education tools, mobile devices can be adapted to help students prepare for the workplace. According to Wash (2014), Socrative, an application, "engages students in the classroom using their own devices, regardless of platform, with the

interactive, real-time, web-based student response system tool" (p. 99). Most secondary school students own a mobile phone and a laptop (fig. 1).

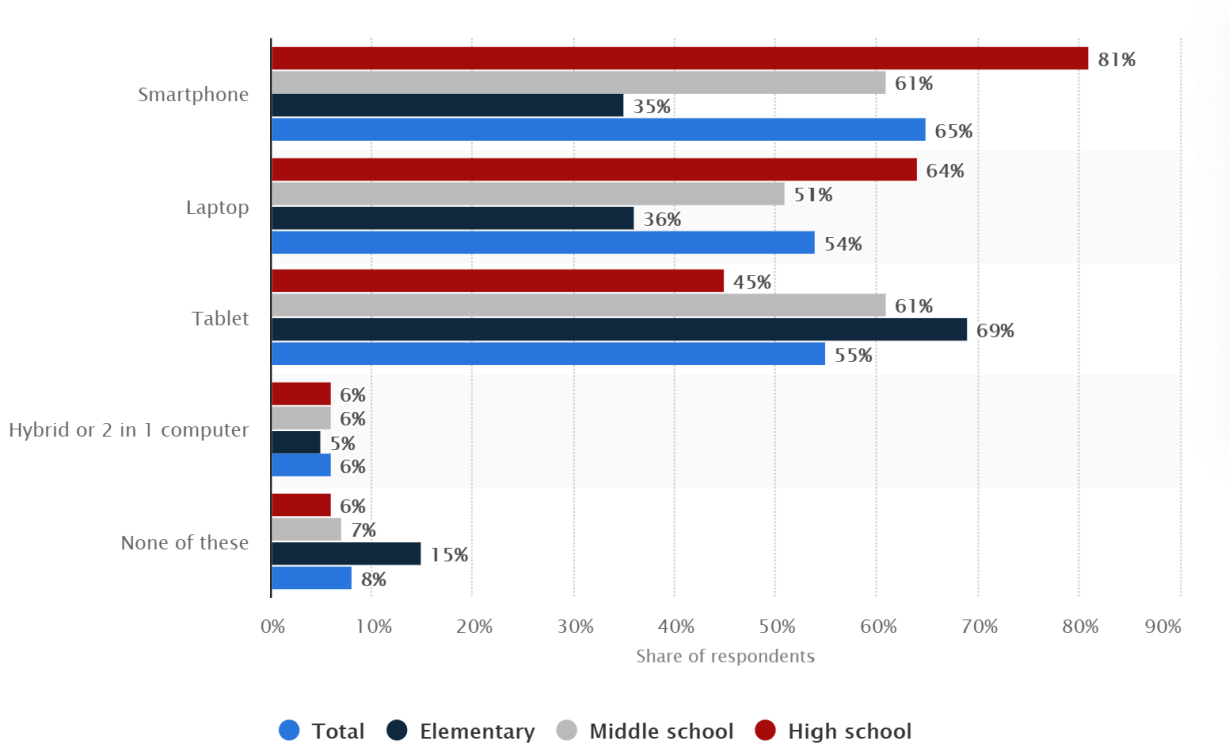

Figure 1. Mobile device ownership by U.S. students, 2015 (Statista, 2016)

Portable devices can be useful for note-taking. Reins (2007) found "positive perceptions" of technology; Osugi et al. (2019) concludes that "writing with a digital pen may improve learning relative to the use of an ink pen" (p. 275).

With videos that they can pause and replay on their own devices, students can typically learn more than they learn from noninteractive video presentations (Schwan & Riempp, 2004, p. 294). Shabiralyani (2015) reports that "using visuals aids as a teaching method stimulates thinking and improves [the] learning environment in a classroom."

Intelligent Personal Assistants promote "the development of Self-Regulated learning, which increases academic performance and student satisfaction towards personal learning"

(Sáiz-Manzanares et al., 2020, p. 5618). Such software may be integrated into a Learning Management System (LMS), which combines "resources such as virtual laboratories, computer graphics, flipped learning, and flipped classroom experiences, virtual workshops, and messaging" (Sáiz-Manzanares et al., 2020, p. 5618).

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