Surveying Middle School Computer Science Education and Teacher Self-Efficacy

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1 Introduction

Personal privacy, security, health, and financial stability are all influenced by an individuals understanding of computers and software. Preparing students to have a successful future now requires equipping them with a higher degree of technological literacy. However, as technology becomes an integral part of our everyday lives, we find that our ability to effectively educate students about that technology lags behind.

We not only concern ourselves with improving the breadth and diversity of computer science education (CSE) for the sake of providing students more opportunities and improving their lively-hood, but because the students we educate now will decide how future technological systems are designed and whether or not they will be designed in un-biased and equitable ways [11]. Efforts have been made to establish standards and build resources for high school computer science education, but less attention has been paid to beginning students technology education at the middle school level.

A sharper view of the current state of middle school computer science (CS) is needed as we move toward implementing more extensive training and standards of practice for middle school CSE. When we refer to the state of middle school CSE, we mean where it is being taught, to what extent, and by whom. The purpose of this study is to not only provide that view, but also identify the challenges faced by educators currently implementing CSE or those who are interested in teaching CS in the future. We will identify these challenges by collecting the perspectives of educators through interviews and surveys. Our goal is for the results of this study to better inform those interested about the gaps that exist in current CSE practices and how to better support training for future computer science teachers. The primary result of this study will be descriptive and qualitative data collected from teachers about how CS is being taught at their school. This project is a work in progress and data is currently being collected.

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2 Related Work

Over the last couple decades, pushes have been made, both by non-profit organizations and policy makers, to implement computer science curriculum in schools across the country. However, changes in policy do not immediately lead to changes within actual classrooms and that change looks quite different amongst classrooms throughout the U.S.

In 2018, the Computer Science Teachers Association (CSTA) performed a study with the help of the Code.org Advocacy Coalition. They found that across 24 states, only 35 percent of high schools taught computer science. In addition, schools with a greater percentage of under-represented minority (URM) students were far less likely to provide access to CS. Forty-one percent of schools with 0-25 percent URM students teach computer science and only 27 percent of schools with 75-100 percent URM students made CS accessible [4].

The proposed study is novel because computer science education has not been documented at the middle school level as it has for high schools. It also goes beyond previous studies by focusing on the perspective of teachers and attempting to measure their beliefs about their own self-efficacy. We have chosen the lens of the teacher perspective because their involvement in the improvement of CSE is critical and often paid inadequate attention. Understanding teacher's experience of change and building teacher capacity for change is essential to effective educational reform [6]. Going further, a 2007 study by Fullan found,"teachers that are more self-actualized and have a greater sense of efficacy ... take action and persist in the effort required to bring about successful implementation, [6]. The challenges faced by teachers that may arise in our data collection can have sociological or psychological context. To better understand the context of those challenges, we have developed the following contextual framework.

3 Conceptual Framework

3.1 Self-Efficacy

From our previous experiences working with Middle School teachers, we can hypothesize some of the struggles that may arise for teachers new to CS. The hesitation amongst teachers with the potential to teach CS is often rooted in a lack of self-efficacy. Self-efficacy is a teachers individual beliefs about their own abilities to perform specific teaching and learning related tasks within the context of their own classrooms [5].

A 2021 study by Ofen et al. found a strong positive correlation between both past experience and teacher identity, and self-efficacy [10]. Most current teachers did not receive any instruction in computer science during their preparation to become a teacher, nor are they likely to have been taught computer science in their own middle, high school, or college courses. Without that foundation of previous experience, we cannot expect teachers to have developed any sense of efficacy or an identity as a computer science teacher.

The development of self-efficacy in computer science varies amongst individuals, however several common factors have been identified as hurdles. These hurdles include negative experiences such as computer anxiety, stereotype threat, and impostor syndrome [8]. Inadequate structural support and school resources can also have a large impact on a teacher's confidence development in CS. Factors like stereotype threat and impostor syndrome arise most often for individuals from non-dominant groups in STEM or CSE. Improving the overall diversity in CS, which starts with middle and high school education, can help to lessen the impacts of both impostor syndrome and stereotype threat.

3.2 Diversity in CS

One important outcome of broadening CSE is to improve upon the lack of diversity amongst students and teachers receiving computer science training. Mediating this short-coming should be a priority not only to provide more opportunities to non-dominant groups, but also to the shape the future of technological systems. When considering the future of CSE, it is important to recognize the intersection of CS and sociopolitical systems such as systemic racism, law enforcement, and the U.S. immigration system.

In a 2019 publication from the Association for Computing Machinery, Jennifer Higgins and Sepehr Vakil point out several ways that computing affects sociopolitical systems as well as the lived experiences of individuals from non-dominant groups. These include the way in which machine learning is changing law enforcement practices in communities of color and the ways in which commercial search engines reinforce racial and gender bias. If the field continues to be dominated by those not directly affected by the repercussions of bias and discrimination in modern computing systems, these sociopolitical systems will continue to negatively affect minority groups [7].

4 Methods

4.1 Overview

This study will implement mixed method strategies. Narrative inquiry will be applied as a means to honor the experiences of the participating teachers [1][2]. The data gathered through surveys and interviews will be coded using qualitative methods. As an interpretive framework, we will use thematic analysis based on our goal to identify the challenges facing teachers.

The population for this study is not only teachers currently teaching computer science, but also those who have the potential to teach CS, but have not yet taken on that role. The survey will be designed to accommodate each type of participant and a convenience sample will be gathered from around the U.S. The following figure illustrates our process.

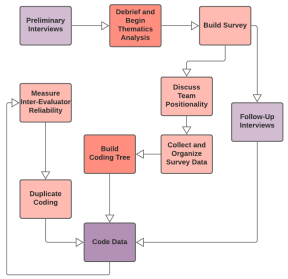

Figure 1: A visualization of our data collection and analysis process.

4.2 Data Collection

The first step of our data collection will be to perform interviews with department of education officials in areas of or related to computer science as well as current computer science teachers. The purpose of these interviews is to better inform our interview guide and survey questions. The initial draft of the interview guide will consist of a series of open-ended questions pertaining to teacher's and administrator's professional experiences and views on CSE.

Through introductory interviews, we will determine more specific follow up questions and identify challenges and promising strategies for improving

teachers experiences in CSE training. By identifying those challenges and strategies, we can address them directly in future interviews. That said, care will be taken to ensure that interviewees have the opportunity to bring up challenges and strategies that they have found personally important before previously mentioned topics are addressed by the interviewer. This is to prevent swaying interviewees opinions to align with our previous findings.

Once we have an interview guide that we feel confident will thoroughly address all of our research questions and objectives, we will translate those questions to a survey format. This format was chosen because we found it important to ask both open and closed-ended questions to adequately answer our research questions [3]. The survey will collect descriptive data such as how long the participant has been a teacher, what subjects they have previously taught, and where they currently teach. Open ended questions asking for their views on the challenges of teaching computer science, their experiences with computer anxiety, and if they do not already teach CS, the challenges they believe they face in taking on that role will also be asked.

4.3 Data Analysis

An exploratory pass will be taken through the qualitative data to identify important themes. These themes will then be discussed in a group debriefing session with participating team members. Each team member will also be asked to consider their own positionality based on their personal and professional experiences before participating in the coding process. Next, a coding tree will be developed for use by team members. Data will be organized and categorized by code, and emerging themes and subthemes will be identified. All data will be coded by at least two team members. After themes are developed, textual and structural descriptions will be used to further analyze each theme [3]. Textual descriptions will include direct quotations from interviews about teacher experiences and structural descriptions will describe how and why the teacher may have had that experience [9]. To ensure inter-evaluator reliability, analysis will be duplicated and reliability will be measured.

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