Models for Computer Science Teacher Preparation: Developing Teacher Knowledge

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ABSTRACT

Across the globe, Computer Science Education has grown tremendously over the past decade to teach primary and secondary students computing ideas and tools. From integrating computational thinking in disciplines to teaching computer science as a stand alone subject, models for teacher preparation range from one and done professional learning workshops to full certificate and licensure programs. The group will focus on providing a landscape of how CS teachers are prepared academically in various countries and make evidence-based recommendations for how teachers should be educated to develop knowledge and skill to teach computer science. The working group will also discuss how to develop these knowledge systems while promoting instruction that is equitable and centers students in the classroom. In addition, the working group will focus on new directions in computing education (such as, artificial intelligence and machine learning) and their implications for teacher preparation. We will bring together a group of international computer science education scholars who have been engaged in teacher preparation. In addition to what knowledge teachers need to teach CS, we will also focus on how the field is preparing teachers to think critically about AI/ML and the role of computer science in the design of technology tools to achieve goals while mitigating potential societal harms.

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CCS CONCEPTS

• **Social and professional topics** → **Computer science education**.

KEYWORDS

Computer Science Education, Teacher Education, Pre-service Teachers

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1 INTRODUCTION

In spite of the current efforts and enthusiasm around computer science education, we know little about what knowledge teachers need to bring high-quality CS learning experiences to their classroom. At the same time, CS teacher preparation differs across and within countries ranging from short-term professional development workshops to full degree programs. As a result, "it is possible that well-intentioned teachers engage in well-intentioned development yet still do not effectively integrate pedagogical knowledge with CS content knowledge. However, mere knowledge of either just the content or just the pedagogy is insufficient in transition to being a teacher, and it is important to possess both the knowledge of subject matter as well as the ways of teaching that subject matter (pedagogical content knowledge) [5]. This underscores the need to investigate how teachers acquire the requisite knowledge to

teach CS and what more can be done to help ensure that students experience high quality CS instruction

At the ITiCSE 2022, our working group "Models for Computer Science Teacher Preparation" will explore these questions and develop evidence-based recommendations for developing CS teachers' knowledge to teach CS. Specifically, the working group will be guided by the following research questions

(1) How are secondary computer science teachers prepared across United States, Germany, Ireland, Spain, Netherlands, and New Zealand?
(2) What knowledge do teacher preparation programs prioritize for preparing secondary CS teachers?
(3) How do teacher preparation programs prepare teachers to bring equitable and justice-oriented CS into their classrooms?
(4) How do teacher preparation programs prepare teachers to bring new computational ideas (such as, artificial intelligence and machine learning) into their classrooms

2 CS TEACHER PREPARATION AND KNOWLEDGE

Computer science teacher preparation varies widely from one country to another and even from one region to another within countries. A 2013 report by the Computer Science Teachers Association suggested that CS certification and licensure within the United States was deeply flawed and often required irrelevant information [1]. At the same time, CS teachers face a number of challenges unique to teaching CS, such as being the only CS teachers in a school, which has important implications for how to support them through ongoing professional learning rather than single time-bound activities [7].

A number of scholars have discussed the kinds of knowledge CS teachers need to be successful and become effective at CS instruction (e.g., [2][6]). Hubwieser and colleagues [3] categorized the knowledge teachers need to teach computer science into two overarching categories: Fields of Pedagogical Operation and the Aspects of Teaching and Learning. Fields of Pedagogical Operation includes the phases of the process of teaching and learning in the classroom encompassed by three types of knowledge: 1) planning and design of learning situations, 2) reacting on student's demands during teaching processes, and 3) evaluation of teaching processes. Aspects of Teaching and Learning included 14 other relevant pedagogical and content sub-categories, such as subject matter knowledge, curriculum, and lesson planning. In spite of these efforts to categorize and measure knowledge needed to teach CS, we know little about whether and how teacher preparation programs engage their students in developing this knowledge. While computer science across the globe has expanded over the last decade, the ways teachers are educated remains disparate. This working group brings together CS teacher educators United States, Europe, and New Zealand to shed light on models of teacher education and develop a model for how to develop CS teacher knowledge.

3 METHODOLOGY

3.1 Participants

As a part of the work, we will bring together CS teacher educators and CS education researchers from a number of countries including the United States, Ireland, Germany, the Netherlands, Spain, and New Zealand to get broader perspective on how CS teachers are prepared. Each of the participants is involved in teacher training within their home countries/states and have deep understanding of the CS education landscape.

3.2 Data Collection and Analysis

In order to address our overarching question of how CS teacher knowledge is developed, we plan to examine the various licensure requirements and CS course standards across participating members' home countries/states. We will collect the documents prior to the meeting for analysis during the ITiCSE working group meeting. In order to analyze the documents, we will code the data on how teacher knowledge is developed across the Fields of Pedagogical Operation and the Aspects of Teaching and Learning categories proposed by Hubwieser and colleagues [3]. Specifically, we will use Mayring's [4] step-by-step model of summarizing content analysis. The iterative process will involve defining knowledge sub-categories to come to a shared understanding of each type of knowledge relevant for teaching CS and then applying those sub-categories to documents collected from each country/state. We will continually add and revise the sub-categories to ensure that aspects of knowledge not captured by Hubwieser and colleagues is included in our analysis. We will conduct a inter-rater agreement to ensure that our analysis is reliable. This process will lead us to develop evidence-based recommendations for teacher preparation programs to develop teachers' knowledge to teach computer science

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