Chapter 8
Assessing K-9 Teachers' Computational Thinking Skills

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ABSTRACT

Many national curricula have incorporated computational thinking (CT) into compulsory education. Teacher ability to deliver the revised curriculum determines whether these new skills can be successfully integrated into teaching. Therefore, it is crucial to examine teacher readiness. This study measured Swedish K-9 teacher CT skills through a CT test validated by an expert review panel and a principal component analysis. Additionally, we engaged statistical analyses to examine the relationship between the teachers' background and their CT test scores, as well as their self-reported ability to teach CT. The result demonstrated the teachers' proficiency in different types of CT skills. Another finding revealed that the type of programming language mastered by teachers was associated with both their CT test score and self-reported ability to teach CT. This CT test can support teachers to identify specific areas for professional development and may facilitate the school management to plan teachers' competence training strategically.

INTRODUCTION

The idea of computational thinking (CT) has been present since the 1950s as "algorithmic thinking" and was defined as an ordered and precise sequence of steps to solve problems using a computer to automate that process (Denning, 2017). During the 1980s, Papert (1980) coined the term computational thinking in his seminal work "Mindstorms." Two decades late, the concept of CT was popularized by Wing (2006, p. 33) as "solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science." Furthermore, Wing stated, "To reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability." Hence, CT has been

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identified as one of the critical 21st-century skills that all students should develop (Nouri, Zhang, Mannila & Norén, 2019). Today, various operational definitions of CT have emerged in the research community.

Consequently, many national curricula have been revised to accommodate CT skills for compulsory education. For instance, since September 2014, England has been implementing a new curriculum, Computing, into the education of age 5-16, and with a strong focus on computational thinking (Yadav, Gretter, Good & McLean, 2017). In the US, the College Board with support from NSF, designed a new Advanced Placement (AP) course that covers the fundamental concepts of computing and CT, available for high school students from Fall 2016 (Wing, 2017). In Sweden, teachers were obliged to integrate programming primarily in Math and Technology education from July 2018 (Regeringen, 2017). Similar changes are observed in other parts of the globe, including Australia, Estonia, Finland, New Zealand, Norway, South Korea, Poland (Heintz, Mannila & Färnqvist, 2016). The same interest sparkled the development of different tools for teaching CT including visual programming languages (e.g., Scratch, Alice), online courses (e.g., Code.org), and hardware (e.g., BeetBot, Micro:bits).

While the education systems embrace CT, the implementation of the new curriculum is rife with challenges. The most important in the process is preparing in-service and future teachers (Rees, García-Peñalvo, Jormanainen, Tuul, & Reimann, 2016). Emphasized by Gal-Ezer and Stephenson (2010), preparing teachers to teach the curriculum is equally critical as having a curriculum. Currently, in-service teachers experience difficulties in delivering the new curriculum. Revealed by Webb's et al. (2017) investigation, CT posed a significant challenge for teachers' professional development in the UK, New Zeeland, Australia, Israel, and Poland. One major cause is teachers have not had any education nor training regarding this subject. For CT to permeate through more subjects at the K-12 level, it is essential to provide all teachers with adequate knowledge of CT (Yadav, Mayfield, Zhou, Hambrusch, & Korb, 2014). Unfortunately, as CT became obligatory in the curriculum only in recent years, most in-service K-9 teachers were not equipped with adequate subject knowledge. This can be attributed to two reasons. To begin with, K-6 teachers are usually generalists, and they typically do not have a strong computer science background (Gadanidis, Cendros, Floyd, & Namukasa, 2017). Also, CT is not a part of formal teacher education (Bower et al., 2017) and the development of teacher education to incorporate CT lags behind (Yadav, Gretter, Hambrusch, & Sands, 2016). A recent study (Sentance & Csizmadia, 2017) surveyed over 300 teachers who were currently teaching CT. It reported that the most commonly-mentioned challenge teachers experienced was their knowledge of CT and their CT skills.

The importance of measuring teachers' CT skills is threefold. First of all, previous studies have shown evidence that teachers' subject knowledge affects their instructional practice and their students' achievement gains (Kleickmann et al., 2013). Elementary teachers' subject knowledge was substantially associated with student gains (e.g., Hill et al., 2005). Therefore, to ensure the quality of students' learning, it is necessary to measure the teachers' understanding of CT. Secondly, K-9 teachers need goals and guidance for their learning of CT. Assessment tools are needed to capture important learning goals and processes of a subject (Gibbs & Simpson, 2005). Without proper tools to assess teachers' cognitive understanding of CT, it is difficult to map teachers' CT skills or to distinguish the areas in need of improvement from the CT skills that teachers already possess. An appropriate CT assessment tool can lead to the effective planning of teacher training and the use of resources. Some studies were carried out to shed light on the teachers' perceptions, attitudes, and self-efficacies, etc. (e.g., Yadav et al., 2014; Grgurina et al., 2014). However, since the perceptions and attitudes do not assess cognitive processes, none of the previous research objectively measured teachers' proficiency of the actual CT skills. One reason is that there are few standardized CT assessment tools in the current literature (Kong & Lao, 2019; Román-González,