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A Framework of Factors that Influence Academic Achievement in Computer Science within Capacity, Access, Participation and Experience

Isabella Gransbury
North Carolina State University
Raleigh, NC, USA
igransb@ncsu.edu

Monica M. McGill
CSEdResearch.org
Peoria, IL, USA
monica@csedresearch.org

Angelica Thompson
CSEdResearch.org
Atlanta, GA, USA
angelica@csedresearch.org

Sarah Heckman
North Carolina State University
Raleigh, NC, USA
sarah_heckman@ncsu.edu

Jennifer Rosato
College of St. Scholastica
Duluth, MN, USA
jrosato@css.edu

Leigh Ann DeLyser
CSforALL
New York City, NY, USA
leighann@csforall.org

ABSTRACT

Motivation. There are countless factors that contribute to academic achievement [3, 6–8]. For K-12 computer science (CS) education, these building blocks of student success are broadly captured in the four components of the CAPE framework, which considers the capacity for, access to, participation in, and experiences of students learning CS through a lens of diversity, equity, and inclusion [4]. However, there is currently little published research that identifies factors within each component that influence the education ecosystem that students rely on to participate and have positive learning experiences in CS [10].

Research question. Our research question for this study was: *What are factors impacting academic achievement among K-12 CS students that comprise each component of CAPE?*

Methodology. We conducted a systematic mapping review [1] of relevant literature using a deductive coding technique. We first created an *a priori* codebook based on previous research findings that identified factors that contribute to academic achievement [3, 7–9] including the CS Teachers Association K-12 CS Standards [2]. We grouped these factors into capacity (69 factors), access (12 factors), participation (4 factors), or experience (84 factors). We then conducted the systematic mapping review of K-12 CS education research articles (2019-2021) (n = 196) from publicly available data from the K-12 CS Education Research Resource Center [9]. Adapting the Framework Method for coding [5], two researchers carefully read and examined each article, identifying all the factors studied in each. The researchers noted discrepancies, which were then reported to the larger team to review and resolve. Through this mapping, we found additional factors (n=129) that have been studied by researchers, some of which are specific to CS education, and added these to our codebook.

Results. As a result of this analysis, we created a comprehensive codebook containing over 300 factors that contribute to the educational ecosystem for CS. Given the large number of factors, we used similar method groupings by Hattie and Yates to group factors within each CAPE component into subcomponents, subcomponents into categories, and categories into subcategories [6]. These groupings provide researchers with an easy way to understand and search for the various factors within a component. Figure 1 shows the subcomponents and categories for the Capacity component. Each of these factors can, in a small or large way, impact academic achievement among students.

Implications. The expanded CAPE framework is now publicly available and can be used to inform researchers and practitioners what each CAPE component comprises. This codebook is accompanied by descriptions of each factor and, in some cases, examples. Not only does it surface the many factors to be considered when designing and delivering CS education to K-12 students, it also provides a solid framework for studying various factors and how they can be correlated. In future planned research, we intend to provide the ability to quickly find articles providing direct or indirect impact evidence, which can be used to inform decision making and practice through meta-synthesis and meta-analysis.

CCS CONCEPTS

• **Social and professional topics** → **K-12 education**; **Computing education**; **Computer science education**.

KEYWORDS

Equity, K-12, primary, secondary, education research, CAPE, CAPE Framework, capacity, access, participation, experience

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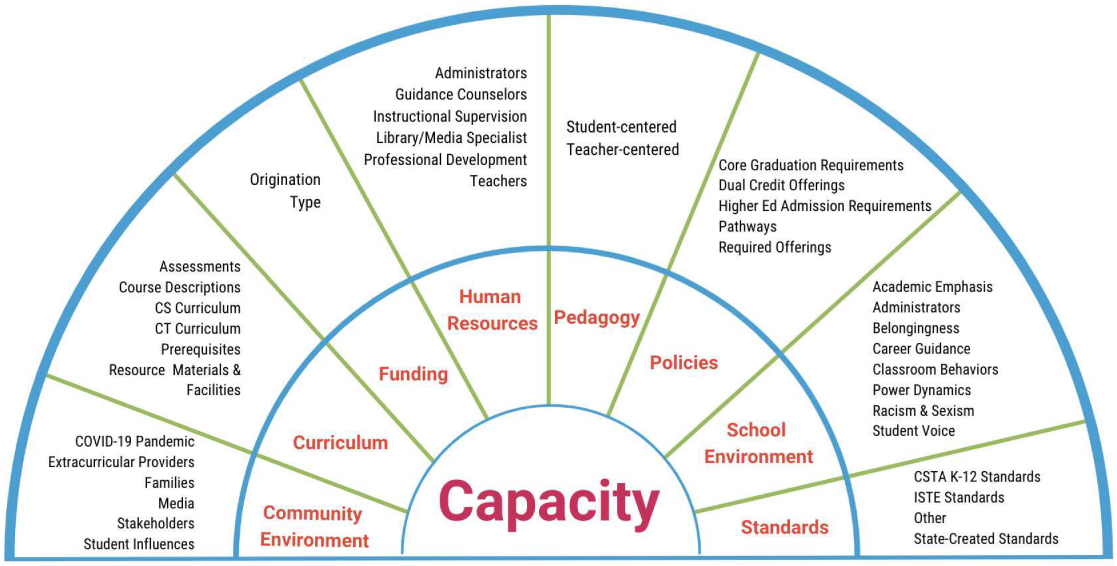

Figure 1: Subcomponents and categories for the Capacity component (as an example). Subcategories can be found at the K-12 CS Education Research Resource Center (https://csedresearch.org).

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