Growing Knowledge about Using Culturally Responsive Pedagogy and Universal Design for Learning in Computer Science Education

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***Abstract*—Practitioners are introducing culturally responsive pedagogy (CRP) and Universal Design for Learning (UDL) into computer science (CS) education in increasing amounts. Researchers, however, may be missing a vital opportunity to accumulate knowledge about these important equity-focused practices. CRP and UDL are complex, and researchers are likely measuring them in incompatible ways. Our research-practice partnership (RPP), through a project called "Time4CSforALL," is tackling this challenge by using a component-based research approach with clearly specified language to study and communicate about CRP and UDL in elementary computer science education. This session will focus on effectively communicating and growing knowledge about CRP and UDL, particularly in today's cultural climate.**

Keywords—Culturally Responsive Pedagogy, Universal Design for Learning, Measurement, Component-based Research

I. Introduction

Improvement efforts to bring equity to education in general, and computer science education in particular, have been insufficient. In our lifetimes, many have documented injustices leading to what some might describe as "disproportionate" experiences [1]. Over the past two decades, the field has benefitted from the identification and growth of two particular approaches to bringing equity to education: culturally responsive pedagogy (CRP) and Universal Design for Learning (UDL). Generally speaking, CRP aims to generate learning experiences that resonate with learners' culture, knowledge, and lived experience. UDL aims to reduce barriers to learning for all students, including those with learning differences or those who are neuro-diverse. These approaches are present in work focused on broadening participation of groups historically excluded from STEM.

As CRP and UDL become increasingly present in education innovations, including those in CS education, it is essential that the field reflects on and does not repeat historical missteps including: (a) insufficient intervention specification and (b) minimal actionable knowledge accumulation. These go hand-in-hand; one cannot accumulate knowledge on poorly specified innovations. Misunderstandings occur not only when the innovations are complex, but even when considering individual pedagogical approaches. For example, educators have spoken of "inquiry" for decades with no shared understanding of what it means. Some might actually mean student taking responsibility for learning, manipulating materials [2] or any other dimension of inquiry but default to using the over-arching "inquiry" label. Other examples are "problem-based learning," "critical thinking," "scaling," "interdisciplinary," and even very common terms such as "STEM schools" or simply, "STEM."

CS education research (and research in other domains) may be on the verge of repeating this pattern when it comes to CRP and UDL. Below, we provide brief descriptions of these concepts and share an approach to measuring each that can better position researchers to learn and grow knowledge together.

II. What is UDL?

A growing body of literature suggests that UDL can increase access and participation in K-12 CS education for students with disabilities. The concept of UDL originated from the Universal Design (UD) movement, which promotes designing accessible and inclusive environments and products [3]. UDL adopts this perspective in instructional contexts by removing barriers to learning through implementing flexible goals, materials, methods, and assessments [4, 5]. However, UDL is an evolving paradigm that has been broadly defined and theorized in the literature. There are several related models that prioritize instructional inclusion and differentiation including Burgstahler's Universal Design of Instruction model [6], which is based on the seven original principles of UD: flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for approach and use. Alternatively, the Center for Applied Special Technology's UDL framework [7] features only three guiding principles that align with key brain networks identified in cognitive neuroscience research: multiple means of representation, engagement, and action/expression. Although emerging research in the field commonly references CAST's framework [8], a consensus is lacking regarding how UDL should be integrated into and measured in the curriculum.

III. What is CRP?

There is some emerging convergence in the field regarding the promise of bringing CRP to school and classroom level innovations. In contrast, however, are the divergent ways that researchers and practitioners define CRP. For example, CRP has been described as "cultural caring" [9], as "sharing" the features of student-centered practice, [10] and as "connecting lessons to real world examples" [11]. Gay defines CRP as using cultural awareness, students' previous experiences, and their core ideas within a content area [12]. Other researchers have embraced Gay's definition, and it is not difficult to envision the wide range of ways it may manifest in their studies. Hammond's description of CRP is also often cited and includes building meaningful relationships, giving instructive feedback, building trust, and leveraging patterns of learning that children bring to the classroom from their cultural contexts [13]. While there may be a broad sense of alignment in these descriptions, measurement, clear communication and knowledge accumulation nonetheless remain out of reach.

IV. The RPP and Time4CS4All project

A. Overview

Time4CS4All is a National Science Foundation funded project (NSF#2031424) that is a research-practice partnership (RPP) between the Broward County Public Schools in Florida (BCPS), the University of Chicago and the University of Florida. The team aims to establish time in the elementary school day for CS using an interdisciplinary problem-based module that includes science, English Language Arts, and CS. A preceding project established the feasibility of module implementation and yielded some promising research results [14]. A distinguishing feature of the module in this project, however, is that the developers have taken on the challenge of infusing CRP and UDL into the lessons so that they cannot be skipped or overlooked. The challenge and importance of this work is acute in BCPS which is the 6th largest district in the country and resides in a volatile cultural climate that challenges terms like “CRP” and “equity.”

The research questions associated with developing and implementing this module seek to examine relationships between implementation of module features, in particular CRP and UDL, and student outcomes. At the outset of this work, the team sought out existing measures of CRP and UDL and uncovered the many dimensions of these overarching practices and differences in the ways they were defined and measured. It was clear that what some meant by CRP or UDL was not what others meant. To complicate matters further, in some cases, CRP and UDL had overlapping characteristics like “relevance to the learner” and “student choice.” It was clear that rigorous research that would support communication and contribute to actionable findings called for more precision.

B. Component-Based Research Approach

The research design of the Time4CS4All project uses a component-based research (CBR) approach. CBR disassembles study elements into precisely described parts and calls for disaggregating whole innovations into components that can be examined alone or in groups. CBR also calls for specific and systematic descriptions of the *conditions* surrounding an innovation as well as precise descriptions of *beneficiary* characteristics (e.g. sociodemographic characteristics, life experiences). Finally, CBR requires clear descriptions of outcomes. With this precision, CBR enables equity-driven examinations of associations between innovation components, contexts, beneficiaries and outcomes to generate knowledge about what *parts* of an innovation work, *how, for whom,* and *under what conditions* [15].

C. Measuring CRP and UDL

With this as context, the team looked at CRP and UDL, which might otherwise have been considered “components” themselves at a smaller component grain size. In a collaborative process, the RPP members distinguished between the specific dimensions of the larger constructs of CRP and UDL that were intentionally written into the module and those that were not. This enabled the researchers to create component-specific measures, meaning, they focused on measurable dimensions of the larger CRP and UDL constructs. For example, while CRP has many dimensions as described earlier, the study’s measures focused on two of these in a student questionnaire, namely “relevance” (e.g. “In class I learn things that are important for my life outside of school.”) and “connection” (e.g. “In class, I get to share experiences from my background and culture.”).

Similarly, the UDL measures honed in on specific dimensions of UDL. For example, items focused on “choice and multiple options” (e.g., “My teacher lets me choose how I show I understand.”) and “guidance and goals” (e.g., My teacher explains assignments so that I can understand them.”). All items used a 6-point Likert scale. The team used a similar approach on the teacher questionnaire.

Without using this approach, a study might report on CRP or UDL as a whole, leaving a black box of interpretation for others to sort out and no ability to accumulate knowledge in a meaningful (i.e., actionable) way. In this study, precise findings on “relevance,” or “choice and multiple options” for example, open the door for clear communication about and accumulation of actionable knowledge. This sets a stage for innovations outside this study to build on this knowledge, should they share components with this study’s innovation, even though as a whole, they might appear to be very different.

V. Implications

Computer science education researchers are at a flexion point. As researchers and their practitioner partners work to further equity through increasing use of CRP and UDL, there is an opportunity to put opaque ways of discussing research behind us and bring clarity to our collective understandings about promising ways to advance equity in CS education.

A. Getting clarity in the field

Some researchers might bristle at the suggestion of agreeing to use “common language” to describe specific pedagogical approaches. Some may be comfortable with the language they have used in the past. Others may feel ownership over definitions they have generated. These dispositions haven’t served the field well. It is time to compromise to make space for bringing clarity to the field. The fact is that it doesn’t matter what we call a practice, as long as everyone understands what the label means.

B. Accumulating Knowledge

Critically examining our past practices can result in personal, professional and organizational risk. This is not, however, without the possibility of high reward, particularly when looking at equity-focused strategies such as CRP and UDL. Had researchers 20 or 30 years ago taken on the challenge of finding ways to more clearly accumulate actionable knowledge, imagine how much better positioned researchers and their practitioner partners would be today to bring equity to education. We can provide that advantage for the researchers who will proceed us in the coming decades.

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