Summary: Stakeholders' Interpretations of Data for Equitable Computing Education

Benjamin Xie
Ph.D. in Information Science

Purpose: Computing education faces inequities that include exclusionary online learning experiences, biased assessments, and inadequate student feedback mechanisms. Many minoritized groups disproportionately experience these inequities, including students who are Black, Hispanic/Latinx, Native-American/ Indigenous, Pacific Islander, women, non-binary, transfers, international, first-generation, and students with disabilities.

To ensure students of minoritized groups can realize their potential to participate in and challenge computing communities, we must enable stakeholders (e.g. students, teachers, curriculum designers) to take informed, timely, and equitable actions. Data on students' prior performance, assessment responses, and feedback may be able to support such actions. Research communities such as learning analytics and computing education have typically used data to identify disparities and model learning experiences to make predictions. But they have struggled to "close the loop" by making data-driven insights actionable, often inadvertently perpetuating or exacerbating existing inequities. One explanation for this shortcoming is that researchers lack domain expertise, framing data as static, isolated, and easily quantified. In contrast, equity requires consideration of learners situated in dynamic, interwoven, and not easily quantifiable contexts.

Significance: Data may reveal the existence of bias and inequities, but not how to respond to them. To address inequities, we must rely on stakeholders and their domain expertise. This dissertation contributes a framework and design explorations that support equity-oriented goals in computing education by positioning situated stakeholders as direct interpreters of data. By doing so, we can bridge gaps between data which reveal nuanced patterns of inequities and stakeholders with domain expertise who are positioned to take equitable action. My dissertation demonstrated the following thesis statement: *Interactions with data that consider prior knowledge (existing frameworks of knowledge), perceptions of power relationships (critical consideration of how dominant systems oppress minoritized groups), and cultural competency (behaviors, attitudes, and policies that enable effective cross-cultural work) can enable computing education stakeholders to connect their interpretations of data with their domain expertise in service of equity-oriented goals.*

Results: In this dissertation, I conducted three design explorations to understand how stakeholders interpreted data in support of equity-oriented goals.

To support more equitable self-directed online learning for novice programmers of varying levels of self-efficacy (learners' belief in their own ability to take action), I designed for learner agency. I designed *Codeitz*,

an online tool that provided adaptive recommendations while also affording learners agency over their own learning experiences. I found that agency did not have an effect on learning. This could have been because most participants were undergraduates who were not used to or expecting to have agency to guide their own learning experiences. So prior experiences and perceptions of power relationships made exercising agency unexpected and unfamiliar. By considering how agency can support learners of varying levels of self-efficacy, these findings inform the design of self-directed online learning tools which millions of learners rely on every year. Over 500 people have used Codeitz, including 40+ high school students from minoritized groups as part of a virtual STEM summer camp run by a UW student organization during the COVID-19 pandemic.

To support equitable assessments, I explored how curriculum designers interpreted empirical evidence of test question bias by gender and race. I identified empirical evidence of test questions that were biased against non-binary, reported female, and Black, Hispanic/Latinx, Indigenous, and Pacific-Islander learners. I then partnered with curriculum designers from nonprofit Code.org to interpret data on test bias and identify potential changes to instructional and test design. Curriculum designers drew upon prior knowledge of the design and use of instruction, focused their attention on what they felt they could control (perceptions of power relationships), and some drew upon cultural competence to connect these biases to broader systemic inequities. Code.org incorporated these changes to support the inclusion of the most used middle school CS curriculum in the world (500,000+ students/year). This study demonstrated how data on test bias typically reserved for exclusive interpretation by statisticians could be instead interpreted by domain experts.

To support more equitable learning experiences in large courses, I explored how contextualized student feedback could inform teaching teams of which challenges disproportionately affected students of minoritized groups. I built *StudentAmp*, an online student feedback tool that collected data on challenges students faced, demographic data, and perceptions of their peers' challenges. StudentAmp enabled contextualizing student feedback with intersectional demographic data so teaching teams could consider the perspectives of unique students sharing the feedback (rather than assume all students fit a dominant stereotype). Students found sharing demographic data an asset and seeing peers' challenges as reassuring. Teaching teams drew upon their prior knowledge from taking and teaching the course, focused their conversations on changes to what they could control (perceptions of power relationships), and used their cultural competence to consider nuanced student identities within broader contexts. To date, over 1,500 students from across 40 courses have used StudentAmp. This study contributed design guidelines around the tension of supporting equity while also ensuring learners' privacy and wellbeing, a tension that only grows as the volume, velocity, and veracity of student data grows.