Exploring Equity and Self-Directed Learning in Computing Undergraduates: A Capability Analysis from the Global South (An extended abstract)

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1. Motivation Problem

Imagine three children and one problem. You must decide who (Anne, Bill, or Carla) should get a mini keyboard built essentially from Arduino components. Anne claims the mini keyboard because she is the only one capable of playing it (and the others do not deny this fact). In her vision, denying the mini keyboard to the only person who really knows how to play it would be unfair. If this were all you knew, you would have a solid reason to give Anne the mini keyboard.

Now, imagine a second scenario. Bill claims the mini keyboard because he is the only one so poor that he has no toys. The mini keyboard allows him to play (and the others admit they are more prosperous than him and dispose of a good variety of toys). If you listened only to Bill, you have a solid reason to give the mini keyboard to him.

Imagine, at last, the third scenario. Carla says that she built the mini keyboard with her own hands. She worked hard for many months for this. And only when Carla finished making it, the other children claimed the mini keyboard. If you listened only to Carla, it would be plausible to agree that she should be able to use something she made.

These analogies are an adaptation of Amartya Sen's example [Sen 2009], identifying the difficulties of choosing the fairer option. Depending on your philosophical basis (e.g., utilitarianism, libertarianism, economic egalitarianism), the decision may differ in each case but is still "obvious" from each viewpoint. We can transpose this problem to Computer Science Education (CSE). How could (CSE) stakeholders (e.g., professors, educational managers) appropriately consider the various equity issues that emerge from a diverse class? How could they balance race, gender, and socioeconomic issues, for instance? How can this be done in the active learning context, where student engagement is highly expected?

It is important to highlight two essential contexts that benefited from this deepened discussion about equity. First, the Brazilian community of computing education research gained strength from 2019 with the collective articulation of *Grupo de Interesse em Educação em Computação* (GIEC)[1], leading to the emergence of *Comissão Especial*

[1]GIEC stands for "Interest Group in Computing Education" in English.

de Educação em Computação (CEduComp)[2] of the Brazilian Computer Society (SBC) in 2023. Investigating equity and active learning in computing contributes to the formation of more humanized computing research in Brazil, also favoring the promotion of a critical mass of computing researchers in Computing Education (CEd).

Second, there is a worldwide ongoing movement that is delegitimizing efforts towards the Diversity, Equity, and Inclusion (DEI) agenda. This movement signals reforming the aims of education and, consequently, CEd [Matti Tedre and Malmi 2018]. Deepening this discussion about equity not only contributes to computing research but to a better understanding of this agenda as a whole, which is of high importance in this context of political polarization and the uncertainty about the future of DEI policies and affirmative actions around the world [Malcom 2024].

2. Overview

CSE concerns the reflection of equitable variables. Various works in this area approach equity issues like gender [Kim et al. 2011], race/ethnicity [Nakajima et al. 2024], socioeconomic status [Parker et al. 2018], and culture [Arawjo and Mogos 2021]. Equity and diversity also used to be two sides to a story in CEd, allowing us to see the same problem from these two perspectives [Lewis et al. 2019]. However, addressing how to balance different sources of inequities is still an open challenge.

A framework to address this problem is CAPE [Fletcher and Warner 2021]. This stands for 'Capacity for', 'Access to', 'Participation in', and 'Experience of' (CAPE). This framework proposes a lens for assessing equity not only in CSE but in CEd as a whole. Although CAPE can map most of the main variables to an equity analysis, the concept of capacity is strongly related to resources, ignoring some essential aspects relative to the real opportunities for a computing student.

Another framework that can address this problem is the Capabilities Approach (CA) proposed originally by Amartya Sen [Sen 1992] and improved by Melanie Walker [Walker 2006] for education purposes. This approach allows us to identify not only the resources that are supposed to be absent in inequity scenarios but also map the capabilities that cannot possibly be developed by a student. Other education fields use the capabilities approach (e.g., Geography [Walkington et al. 2018], but CEd has explored its potentialities only marginally.

The CA is a theoretical framework based upon two normative claims: (i) the freedom to achieve well-being is of primary moral importance, and (ii) the understanding of well-being is directly related to people's capabilities and functionings. The freedom of being educated is one of the aims of this perspective, understanding it as a part of the broad problem of liberating people for a fulfilling life.

In this direction, active learning can potentialize the freedom of CSE students, promoting more autonomy and crucial soft skills in our complex society. Pedagogical frameworks and methodologies like andragogy [Ellis 2002], problem-based learning [Santos et al. 2021], and peer instruction [Bispo Jr. et al. 2021] somehow develop the idea of active learning in this area. These approaches strongly dialog with the constructivism theory (which asserts the students "construct knowledge rather than merely receive

[2]CEduComp stands for "Special Comission of Computing Education" in English.

and store knowledge transmitted by the teacher" [Ben-Ari 2001, p. 45] and, by consequence, with self-directed learning [McCartney et al. 2016].

In the Science, Technology, Engineering, and Mathematics (STEM) context, active learning pedagogies have been effective in promoting the increase of learning outcomes [Prince 2004]. However, collaborative pedagogies in the CSE context have led to marginalization [Lewis and Shah 2015] like over-dominance concerning student participation. Self-Directed Learning (SDL) is a potential equitable practice [Anderson and Beach 2022], but there are open challenges to consider regarding when and how to use it [Brookfield 1993]. Understanding better how SDL effectively occurs in CSE students can also contribute to comprehending the potentiality of active learning in terms of capabilities.

In developing countries, other challenges emerge. Beyond the potential inequity sources that emerged from natural diversity in the classroom (e.g., gender, race), structural barriers deepen the situation (e.g., socioeconomic status, poverty). In African countries, for instance, CAPE framework is used to analyze equity issues in CEd [Tshukudu et al. 2023]. Although the authors highlight the strengths of its use, they also point out some limitations:

> "The CAPE framework helps map the progression from 'Capacity for' to 'Experience of' computer science education as a route to equity, but in order to support development in low and middle income countries, it may be helpful to have the capacity level finely grained" [Tshukudu et al. 2023, p. 1].

Maybe the capability approach can help to fill some gaps during equity analysis using only the CAPE framework.

In this way, the proposed research helps to establish a process to identify the crucial CSE capabilities in the context of self-directed learning in developing countries. The fundamental presupposition is to ensure fair and equitable CSE, mainly in the Global South. However, how do we propose the actions and policies needed to mitigate and, if possible, eliminate the sources of unfairness from an interrelated and multifactorial perspective of equity issues (e.g., race, gender, socioeconomic status)? One way is to assess the educational scenario from the capabilities approach.

The Main Research Question (MRQ) of this Ph.D. thesis is

(MRQ) "How do CSE students conduct their SDL in developing countries from the CA lens?".

Three research goals (RG) help to address this question:

(RG1) understanding how CSE students build their SDL trajectories in developing countries;

(RG2) mapping the main elements of SDL capabilities observed in CSE students in developing countries; and

(RG3) recommending guidelines to (CSE) educational stakeholders concerning how to consider effectively equity issues and active learning from the CA lens.

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