

Equitable Computing Education

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Abstract

The field of computing continues to struggle to increase participation that better reflects the domestic composition of the US society at large. Society could benefit from diversifying its workforce as broader participation would invariably produce better tools and services for all. However, the benefits of broader participation also could address socio-economic disparities in existence given the lucrative jobs available in computing.

Unfortunately, conversations about equity are often associated with racial dynamics, academic rigor, and political correctness. One challenge faced is the lack of a clear definition and measures of equity that would enable objective conversations. While there are some common themes in the general understanding of equity, there is also a lot of confusion about the difference between equity and equality and a fair amount of disagreement whether equity is a goal to pursue or just a desired outcome if we can afford it.

The goal of this paper is to present a literature review about equity in computing education and to propose a definition of equity so we can engage the community in a collective, professional, and productive dialogue about equity. We hope that such dialogue would enable us to move forward on assessing equity and thus broadening participation in computing. The definition presented is adapted from equity in health and mirrors prior definitions of equity highlighting the difference between equity and equality. We close with some concrete suggestions on how to use the definition to define actions that CS programs could implement as part of an equity assessment.

1 Introduction

Over the last two decades, the field of computing has been concerned with diversifying the discipline to better reflect the domestic composition of the US society at large [1]. Given the lucrative jobs in computing, this could be a tool to address the socio-economic disparities in existence and help improve the social mobility of people from marginalized groups. But the computing discipline also benefits from diversifying its workforce. The common news of yet another system implementing discriminatory practices (e.g., loans, sentencing, facial recognition) has shown that participation from a broader section of the population is a requirement for us to produce better tools and services.

Unfortunately, conversations about equity are often associated with racial dynamics, academic rigor, and political correctness, making it difficult to have open conversations about equity and its implications in our field. Even within the confines of our own research [2, 3], we found that participants' comments in a survey gravitated towards *individual responsibility* and how equity

can be *destructive to the individual, the group, and society*. Equity was even called a language used by a *political tribe*. As we expected, it is difficult to have an open conversation about equity in computing education (or society) without having to deal with some extreme and often incendiary opinions.

In this paper, we present a summary of the literature discussing various definitions of equity, the need for equity in STEM as well as computing education. We briefly mention various areas where equity has an effect in our educational enterprise and provide more details on how grading practices can impact equity. In a later section, we describe the challenges the CS discipline faces when we try to discuss equity in computing education. We proposed a definition of equity adapted from previous literature and highlighted various aspects of that definition as it relates to computing education. We close with some concrete suggestions on how our definition of equity could be used to assess how equitable CS programs are toward improving participation in computing.

2 Literature review

One initial challenge in this work is reaching agreement on the meaning of equity. While there are some common themes in the general understanding of equity, there is also a lot of confusion in the difference between equity and equality [4, 5, 6] and a fair amount of disagreement as to whether equity is a goal to pursue or a political message [2] meant to advantage/disadvantage some groups.

2.1 Definitions of equity in health

In order to understand equity, we start this section with a dictionary definition and follow it with various definitions of equity and equality in health.

The Merriam Webster dictionary (online edition) defines *equality* as “the quality or state of being equal”¹. The definition for *equity* is “justice according to natural law or right; specifically : freedom from bias or favoritism.”

An online report for equity in health [5] provides links to various reports with definitions of equity. In their definition, *equity* “refers to eliminating barriers and providing various levels of support and assistance depending on specific needs or abilities to reach full potential” [5].

The U.S. Centers for Disease Control and Prevention [7] defines health equity as a situation where “everyone has the opportunity to be as healthy as possible.”

The World Health Organization [8] defines it as “the absence of unfair, avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically or by other dimensions of inequality (e.g. sex, gender, ethnicity, disability, or sexual orientation). Health is a fundamental human right. Health equity is achieved when everyone can attain their full potential for health and well-being.”

¹<https://www.merriam-webster.com/dictionary/equality>, accessed 2023-08-14

Finally, Braveman and Gruskin [9] have proposed a definition of equity in health that is highly appropriate for our discussion. They define equity in health (highlight is ours) as:

... equity in health can be defined as the absence of systematic disparities in health ... between social groups who have different levels of underlying social advantage/disadvantage — that is, different positions in a social hierarchy. Inequities in health systematically put groups of people who are already socially disadvantaged (for example, by virtue of being poor, female, and/or members of a disenfranchised racial, ethnic, or religious group) at further disadvantage with respect to their health [9, p. 255].

We will adapt this definition for use in computing education in a later section of this paper (see section 4).

2.2 Other definitions of equity

In the online book *Critically Conscious Computing*, Ko et al. [10] define *equality* as “A social state in which everyone is treated equally (in terms of resources, laws, rights, policies, opportunities, and other social processes.)” *Equity* on the other hand is defined as “a social state in which everyone is given the resources and support they need to thrive at equal levels, implying that some people may get more to address disparities.” They use a very good example of a website with information for Covid tests that is available in English only and how that is equal for all (i.e., everybody sees the same information), but inequitable for the part of the population that can’t read English. The main distinction in their definitions is where “equal” is used. For equality, equal means everybody receives the same resources. For equity, however, equal is used to relate to the outcomes with the acknowledgement that the resources needed might be different in each case.

A National Academies report [11] defines “equity” as the “outcome from fair conditions (policies, practices, structures, cultures, and norms) in which all individuals and groups have the opportunities and resources they need for general well-being or success in specific metrics” [11, p. 4]. In this definition they connect “fair conditions” with “individuals and groups” and the success in whatever endeavor being evaluated (e.g., “specific metrics”), but clearly at the outcome of the endeavor.

A report calling for technology design to be more inclusive provides another take on the challenges we face trying to understand equity and equality. In [12], *equality* is defined as everyone having “the same opportunity” even if it affords some in the group “an existing (and often unconscious) unfair advantage.” In contrast, *equity* means everyone getting an opportunity that levels the “playing field with their peers” thus increasing the “fairness to compete.”

In summary, these definitions draw attention to the importance of the difference between equity and equality. Equality is often defined in terms of giving everybody the same resources needed to accomplish a task. Equity, however, is acknowledging the differences that already exist in society and assigning resources as needed to ensure that all have the same opportunity to accomplish the desired task.

2.3 Equity in STEM

Gilda Barabino, President of the Franklin W. Olin College of Engineering, recently [13] exhorted us all to create a more “just and fair scientific enterprise”. Equity has always been a central pillar in science, according to Dr. Barabino. Institutions must change their policies so the efforts to reach equity and parity are intentional. Scientists must go beyond the pure scientific facts and also consider if new science should be done and who is impacted by the development of new science.

In one of the early reports (1976) presenting the challenges that women from minority groups face in science [14], Malcom et al. present the status of women in science, with a particular focus on the experiences of ‘minority women.’ This report is, sadly, still relevant today. A recent systematic review of the literature on broadening participation in computing [15] shows that many of the challenges highlighted in [14] still exist today in terms of representation, inclusion, and promotion of women in computing.

More than a decade ago, Scientific American [16] dedicated a special issue to “How Diversity Empowers Science and Innovation.” Several authors highlight why diversity is necessary for the scientific enterprise and enhances creativity [17]. Another author presents empirical grounding of diversity [18] which they argue that it is often lost in the ideological discussion of diversity.

A statement signed by 52 Black scientists [19] highlights the challenges and struggles they face to be part of the larger scientific enterprise. They encourage us to re-imagine diversity, equity, and inclusion: “Diversity is only transformative when the underlying institutions are inclusive and equitable” [19, p. 2514].

All the recent (as of this writing) attacks on DEI initiatives would make most think that we don’t need these initiatives anymore. A statement published in June 2023 issue of Cell journal (experimental biology) [20] highlighted the importance of DEI initiatives and why we still need them. The article mentions how we still need to highlight the successes of scientists from marginalized communities as a way to reshape the image of academia. It also argued for the importance of being able to study topics connected to their person and identity within their discipline.

There is so much literature on this topic, that it is impossible to do justice in a limited-page format such as this publication. From the Double Bind report [14], to numerous National Academy reports [21, 22, 23, 24, 25, 26, 27, 11], and even conferences dedicated to this topic (e.g., RESPECT). Overall, it is clear there is still work to be done and that some of the issues raised in the double bind [14] report still exist today in science.

2.4 Equity in computing education

Members of the computing education community have made recent requests for a more critical CS education [28], for CS teachers to learn about race [29], and to address the power inequality that exists within our discipline [30].

Narrowly looking at computing, computer science educators should strive to make our discipline one that espouses values of equity. However, the challenges of diversifying the discipline have

shown us that we still have much work to make computing an equitable discipline. Equity is deeply connected to broadening participation, equal access to computing (e.g., CS4All), culturally relevant pedagogy, fairness in AI, disinformation, social justice addressing the inequities of society, and ethics/professionalism topics. In most of these topics, equity in computing is still forming and not widely seen as an integral part of the discipline.

N. Washington [31] discusses the glaring omission of non-technical issues from the CS curriculum that would allow CS students, and future professionals, to understand, analyze, and offer solutions about the inequity and lack of representation that exists in computing. Dr. Washington argues that there is a need for all CS students to have a level of cultural competence so that students can begin to understand, critically analyze and look for solutions that will improve equity in our field. Another CS Educator, Casey Fiesler [32], states that the topic of ethics should be introduced in the first course in the major, as to eliminate the perception that technical work and ethical work are two distinct activities.

Santo et al. [33] discuss how the nature of CS Education depends on who decides how computing is taught (e.g., culturally relevant pedagogy) and what content is considered part of computing (e.g., is ethics part of computing?). Often the discussion about what is included or not goes back to history, and conventions, without realizing that this history was narrowly defined by only a portion of the population. In a similar vein, Tara Yosso makes this argument [34] by asking “whose culture has capital?” Her work encourages us to look at “cultural wealth” as the value given (or not) to aspects of cultures from communities that have been marginalized.

One example of cultural wealth is “linguistic capital” [34], that is the knowledge acquired by groups that communicate in more than one language. Instead of considering these groups as “oddities”, we ought to engage them in discussions in the creation of new technology. A recent article [35] makes the argument that the assumption that “mono-lingualism is the norm” has led to the creation of interfaces that work in *one language at a time* going against how bilingual individuals communicate. Considering the linguistic capital of bilinguals would produce a more equitable technological environment where multilingual individuals are not constrained to use one language at a time. This becomes a form of racio-linguistic discrimination [36] enforced by our technological designs.

Rankin, Thomas, and Erete [30] exhort us to address power relations within computing as a required first step to truly create an equitable environment. They say: “if we are truly committed to transforming CS education into an inclusive, diverse, and equitable community for all, then we must take steps to dismantle systemic oppression and its many manifestations in the field of Computing.” [30, p. 807]. This is an echo of Barabino’s call for changes in institutional policies [13]. This has led agencies like the National Science Foundation (NSF) to commit significant funds to promote initiatives that broaden participation in computing (BPC) and enable research on BPC efforts. Aspary provides a historical account of many of these efforts [37, 38] and a recent publication [15] provides a summary of the research in this field.

In [3], we report on faculty adoption of various educational practices tied to different aspects of a course that impact equity in computing education. The various aspects of a course offering discussed there include: course design and organization, use of educational technology, course content and materials, course assessments and grading; in-class engagement, and out-of-class

engagement. To explore equity in more depth, in this paper, we include a discussion of equity in grading.

2.5 Equity in grading

One area where equity is receiving attention and gaining traction is in grading student work. Grading practices have become a source of inequity in classrooms with traditional practices reducing achievement, and discouraging students [39, 40]. Most CS classrooms use traditional grading practices where points are allocated to assignments, mistakes result in point deductions, and assignment scores are combined using some form of weighted averaging to determine grades. “Traditional grading practices have been used for over one hundred years, and to date, there have been no meaningful research reports to support it” [40].

Some common elements of traditional grading practices are so negative that they have even been termed toxic [41] including: using zeros for missing work; averaging scores throughout the academic term; and the use of heavily weighted high-stakes tests or project assignments where one assignment’s score can make the difference between achieving an average grade or needing to repeat a course.

According to Feldman [42], traditional grading includes a component that evaluates student’s behaviors, often including timeliness, effort, and other behavioral measures. Often these expected behaviors make an assumption of life outside of the classroom which indirectly and disproportionately affects students with part-time jobs, students with family responsibilities, and other non-traditional students.

In an online interview with Cornelius Minor², he states: “One of the first aspects of truly inclusive grading is understanding that the assignment doesn’t matter, the learning outcome does.” This places the emphasis of grading on the outcomes or results of the process. Equity in assignments is giving all an opportunity to meet the learning outcomes. Some students might not require extra attempts in an assignment to do so, others might require additional attempts, while others might require one-on-one office hours or tutoring. Equity is all about providing an opportunity to reach the goal. However, the effort/resources utilized by the individual may vary, which will be reflected in how they achieve the goal. This parallels the definitions of equity discussed in refsec:OtherDefinitions.

Equitable assignments must consider structural barriers that students must overcome before they can succeed. This often requires reconsidering assignments, content, etc. to meet students where they are. Professor Michel Estefan [43] writes that “Equitable teaching [...] requires instructors to change their assignments and class activities to reckon with those structural barriers.” This might translate into allowing students to miss some assignments without carrying a 0 that would dis-proportionally impact the average or having a late submission policy that still allows students to demonstrate mastery.

²<https://www.ascd.org/el/articles/turn-and-talk-antiracist-grading-starts-with-you>

3 Challenges

Utilizing the literature summarized above and some of the findings from prior studies [2, 3], we discuss here some of the challenges the computing education community faces in understanding equity. We hope this discussion will help in clarifying the need for equitable education and help in addressing such misconceptions.

3.1 Understanding the definition of equity

From the sources mentioned above, it is evident that we (computing) are not the only discipline struggling to reach a consensus on the meaning of equity. Whether it is confusion between equity and equality (see section 3.3), or unclear on how to address inequities or concerns about others seeing equity considerations as some kind of “woke” agenda, we are still struggling to come to grips with this topic. Curiously, in our previous work [2, 3], the participants readily accepted the notion that there are social groups with different backgrounds that have a disparate impact on the educational outcomes of students. Yet, agreeing on how to address it appears to be a concern for many.

It is worth considering that if we have students with different backgrounds in our academic programs, achieving equitable outcomes might require changing the entry point into our programs recognizing and addressing these disparities. For example, we probably should define pathways for those students who come to computing from underfunded high schools without any background in programming. Pretending this doesn’t impact performance simply makes us an accomplice of pre-existing inequities in society and allows our academic offerings to be inequitable themselves.

3.2 Equity as a trade-off

Addressing equity is, unfortunately often seen as a trade-off. Sometimes the trade-off is with quality and professors worrying about “diluting the content of the course” as reported by a participant in our previous study [2]. Sometimes the equity trade-off is with student preparation. While acknowledging that students have different backgrounds, addressing the differences is considered as a “freebie” to the students, instead of being considered as an equitable treatment. Another form of trade-off is in effort. More equitable accommodations require more work from professors, TAs, and graders. For example, while some grading practices might be more equitable, some instructors/professors wonder if they can afford to implement them [2].

Considering equity as a trade-off shows that we still consider equity an option, something that we can ignore under certain conditions (e.g., too many students). To change our practices to be more equitable, we must consider equity as a requirement of our mission, and we must consider equitable outcomes for various groups as an educational goal. We cannot evaluate the feasibility of equity and consider it too expensive to pursue. We must consider the lack of equity in our outcomes as a failure of our educational mission. We must provide the appropriate resources needed so all students have the same opportunity to succeed.

3.3 Equity vs equality

Equity and equality are often, and wrongly, used interchangeably [9]. In our previous work [2] we discussed how participants in a study confused equality with equity and often considered lower quality standards as a way to reach equity. One participant even went as far as saying that policies that are used to reach equality of outcomes are racist [2].

The Race Matters Institute, in a blog post from 2014 [4], highlights the importance of the distinction between equity and equality when it comes to making decisions on resource allocation in a school district. Racial equity will be achieved, in their words, “when you cannot predict advantage or disadvantage by race” [4]. They acknowledge the challenges of distributing limited resources to different schools and how the dichotomy of equality (e.g., divide the resources evenly among all schools, independent of their needs) vs equity (e.g., provide more resources to underfunded schools to raise the bar for all) makes it difficult to properly set policies. In their blog, they close by saying “This is why we advocate the dual aspirations of raising the bar and closing the gaps” [4].

In the CS Education community, we need more resources to help teach the students the difference between equity and equality. A lesson plan [6] by Just Health Action helps participants understand the difference between equity and equality. This is based on work done by Equity Matters³, a Seattle, Washington-based women of color consulting team. We encourage the community to create more lesson plans like this one, where we can further explore the distinction between equity and equality in ways that are specific to our field. Others in CS are doing excellent work in preparing opportunities for us to teach equity [31] and ethics [32] in our classrooms. We need more voices and more space to discuss and disseminate this work without concerns of push-back.

3.4 Group vs individual

Several participants in our study [2] wrongly considered systemic differences between social groups as differences between individuals. Equity is not measured based on individual performance but is about differences between groups. One student not passing a course is not a sign of inequity. However, a group of students from the same social group (e.g. transfer students) with an underlying social disadvantage (e.g. lack of pre-requisite knowledge in a computing course) under-performing in a course is a sign of the existence of inequity. To be clear, making computing equitable is about giving the appropriate resources and/or support to eliminate the equity gap in the outcomes. The goal is to provide resources so that all members of that group have the same opportunity to succeed as their peers. However, this does not mean that we give a higher grade to every individual in that social group and call it success. Equity is not about *giving a free pass* to individuals who are members of particular groups. Equity is ensuring that all have the opportunity to succeed, knowing that some individuals might require a different set of resources.

A quote [5] commonly attributed to Paula Dressel states: “The route to achieving equity will not be accomplished through treating everyone equally. It will be achieved by treating everyone justly

³<https://www.equitymattersnw.com>

according to their circumstances.” This quote highlights the tension between treating everybody the same without ignoring the particular circumstances of each individual. This, in our opinion, highlights the importance of understanding the difference between individual needs and social classifications. For example, it would be a mistake to assume that all the white students in a classroom have similar backgrounds; some might be first-generation students and require additional support and resources to be on the same page as their peers. Many of the examples differentiating between equity and equality share this perspective. We must provide a variety of resources so all individuals have the ability to succeed.

We also need to understand that individuals also belong to certain socially constructed groups based on a variety of characteristics. It might be race, ethnicity, gender, ableness, language abilities, sexual orientation, socio-economic, geographic origin, etc. We must not confuse the socially constructed category that might define or characterize an individual as the reason why they have or do not have access to particular resources. In the context of the above example, we would be wrong if we treated all white students in that classroom equally. A lens of equity will help us address personalized needs, giving all the opportunity to succeed.

A recent National Academies Report states this very succinctly: “based on decades of research and analysis, racial disparities in STEM careers do not rest on individual deficiency in candidates or even primarily on the individual racism of institutional and organizational gatekeepers. Racism is embedded in our society” [11].

4 Proposed definition of equity in CS education

In this section, we present our proposed definition of equity adapted for computing education from a definition of equity in health [9] proposed by Braveman and Gruskin [9], presented in section 2.1, and in parallel with the other definitions of equity discussed in section 2.2.

Paraphrasing the health definition for computing education gives us:

Equity in CS Education is the absence of systematic disparities in educational outcomes between social groups who have different levels of underlying social advantage/disadvantage.

Here we highlight and discuss a few parts of this definition as they are relevant to our discussion.

4.1 Absence of systematic disparities

Absence of systematic disparities acknowledges that systematic disparities exist and the goal of an equitable education is to eliminate these disparities in the educational outcomes and help those students “stuck in the shallow end”[44]. For example, students who come from underfunded high schools are more likely to struggle in college. Students from low socio-economic backgrounds are more likely to hold jobs limiting the time available to attend office hours, for example. Students from underrepresented racial/ethnic groups have fewer role models and often don’t see their group represented in front of the classroom, be it faculty or teaching assistants. Women of color often struggle to find a home with other women groups (often composed of mostly white women) or among students of color groups (often composed of mostly men). Ignoring these

disparities allows the inequity that exists in society to seep into college classrooms and have a negative effect on educational outcomes. To achieve equity, we must counterbalance the systemic disparities that affect our students.

4.2 Educational outcomes

Equity is defined in terms of educational outcomes. The outcomes can be defined, for example, as passing grades, course completion, graduation rates, or employment after graduation. Eliminating systemic disparities in educational outcomes does not mean everybody should get an A, or that students of particular social groups should have a special curve. Instead, it means that the distribution in the outcome should not favor a particular group. That is, students of different backgrounds should be equally represented in the outcomes (e.g., pass/fail rates, grade distribution). If there are differences in the outcomes based on the social groups of concern, then we must explore if this is a systemic issue (i.e. one group always does worse than other groups) or if the result is just a one-off simply due to the randomness of who was in our classroom on a particular semester. If it is a systemic issue, we need to address it by providing appropriate support (e.g. extra office hours) and resources so all have the same opportunity to succeed.

4.3 Social advantage/disadvantage

Our society is composed of individuals who belong to social groups with different levels of underlying social advantage/disadvantage. Not everybody agrees that underlying social reasons cause differences in educational outcomes. After all, a common refrain is “I went to college and kept two jobs and graduated with honors, why can’t they do it too?” Some might even have objections to providing different attention to different groups, demonstrating a confusion between equity and equality [4, 5, 6]. Braveman and Gruskin explains this succinctly: “A selective concern for worse off social groups is not discriminatory; it reflects a concern to reduce discrimination and marginalisation” [9, p. 255].

Braveman and Gruskin [9] place the concept of equity deep in the center of the discussion about ethics. They consider equity to be an ethical principle “consonant with and closely related to human rights principles” [9]. We wholeheartedly agree.

5 Conclusion

We have presented our argument for the need for a definition of equity in computing education that avoids the pitfalls and challenges we have observed. In computing, equity has become a significant challenge as the lack of diversity in our fields continues to remain unchanged, in spite of much effort to make a change. This is particularly pressing because computational devices can have a significant impact on society and not having a diverse workforce has produced products and services that discriminate against certain groups. If recent history is a predictor, we are concerned that the power computing is not being used in an equitable way (e.g., consider facial recognition, software classifying resumes, computer-aided sentencing, etc.) and it is further differentiating between groups with different social advantages/disadvantages.

Based on the presentation and our proposed definition, we recommend that, at the very least, computing programs consider doing the following steps as part of some equity assessment.

- Define social groups that exemplify different levels of social advantage/disadvantage for your particular program. For example, a Historically Black College (HBCU), which typically has 90% of their population African-American, might not be interested in seeing differences across racial groups (they are pretty homogeneous). Instead, their social groups might include first-generation, gender, or other social markers.
- Evaluate the outcome of your educational mission according to the social groups that you serve. The outcome could be grade distribution in your introductory courses, enrollment vs graduation, retention rate, and even first employment after obtaining a degree from your program. You should not find disparate outcomes across social groups.
- If you determine that there are differences in the outcomes across the social groups of interest, then you have work to do. Assess what the students of those groups are missing so you can provide resources and opportunities for them. The goal is to give them the opportunity to succeed at a similar level as students from other groups, thus reducing the gap that might exist in outcomes between social groups.

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