

Surfacing Inequities and Their Broader Implications in the CS Education Research Community

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ABSTRACT

Problem. Diversity, equity, and inclusion (DEI) need to be embedded throughout the computer science education (CSEd) research community in order to achieve empirically-based strategies in CSEd that is responsive to the needs of all of its constituents. However, there are no comprehensive studies that investigate what the barriers and challenges to DEI are among CSEd researchers.

Research Question. *When considering DEI among the CSEd research community, what barriers and challenges do different CSEd researchers face when conducting research?*

Method. We conducted a systematic literature review, developed a survey from the literature, and analyzed the quantitative and qualitative data from participants (n=72).

Findings. Beyond finding that over half of the participants reported the COVID-19 pandemic as a barrier to engaging in research, participants reported that working more than an average 40-hour work week each year was a challenge. The lack of computing education being recognized as a subdiscipline within CS departments also was a barrier. Participants also reported that a lack of 1) awareness and adoption of practices from other education research fields and 2) general educational research theory were significant challenges for the CSEd research field. With respect to DEI, participants noted that lack of diversity among CSEd research partners/collaborators, among CSEd researchers in the community and among CSEd research community leadership are challenges for the community.

Implications. Employing cultural competence is integral to CSEd research as we, as a community, inherently navigate differences in identities among researchers, and between researchers, practitioners, and participants in the currently unrepresentative and inequitable state of our field. As we grow our attitude, awareness, knowledge, and skill in cultural competence, we produce better-equipped allies, and greater resilience and belonging among community members from historically marginalized groups. We urge the community and relevant stakeholders to understand how to remove the barriers and challenges identified in our study.

CCS CONCEPTS

• **Social and professional topics** → **Computing education; Computing education programs; Computer science education.**

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1 INTRODUCTION

The history of oppression against marginalized groups in the computing ecosystem gives us reason to doubt that it is likely that diversity, equity, and inclusion (DEI) in computer science education (CSEd) will be achieved spontaneously [28, 46, 74]. For the field of CSEd research to consistently deliver quality evidence-based, promising practices that are meaningful and effective for all learners, there is an immediate and critical need for equity-focused CSEd research. Achieving this is not possible through individual actors or interventions; however, our community has a unique opportunity to conduct equity-focused research earlier in the history of CSEd than in other education fields. Given that technology and CSEd evolve exponentially faster than other disciplines, proliferating equity-focused research is critical for ensuring inclusive involvement and practices across researchers and learners, as well as empowering CSEd practitioners as researchers.

Based on an estimation of 39,561 CS professors at 2,869 universities in Canada and the U.S., women comprise 26% of CS instructors (e.g., professors, lecturers), Black men and women comprise 1%, and Hispanic men and women comprise 5% [34]. Though it is unknown what percentage of CS faculty engage in CSEd research, one only needs to look around the room at major conferences (including Association of Computing Machinery (ACM) International Computing Education Research (ICER)) and leadership roles in the CSEd community to understand that the majority of presenters are from dominant groups, and the majority of research topics and participants are not inclusive of the experiences of all CSEd learners and practitioners. Women in academic research circles also have been addressed across the decades, with Leathwood addressing the feeling of women as interlopers in UK academic leadership positions [47]. Frierson Jr wrote about the crisis of the lack of Black educational researchers in 1990 [33], and yet we find ourselves 32 years later asking for greater introspection within our community to address these same issues.

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Whenever possible, language referring to an individual’s identities should be as precise as possible and defined by the individual in their own terms. While “historically marginalized group” is an imprecise, general term, we use it within to correctly position groups as the subjects of active marginalization rather than passively experiencing underrepresentation. Use of “historically marginalized group” aims to reflect the many dimensions among which people have been historically marginalized in computing (e.g., gender, race/ethnicity, disability status, etc.). We acknowledge that marginalized dimensions vary based on context (e.g., geography, institution, subfield, etc.)

Diversity, equity, and inclusion throughout the research community is a necessary precursor to achieving empirically-based strategies in CSEd that are responsive to the needs of all of its constituents. This includes an examination of the infrastructure and processes in place that favor certain researchers and research designs over others. As interventions must be grounded in the unique needs of the learner and practitioner populations they serve, the research supporting the intervention must be grounded in strong and aligned practice. Therefore, we conducted a study based on the following overarching question: *When considering DEI among the CSEd research community, what barriers and challenges do different CSEd researchers face when conducting research?*

To examine this question, we conducted a systematic literature review to understand barriers and challenges conducting CSEd research. We then launched a survey based on the literature review and additional background literature to help identify which challenges our community faces and to what degree. The results of this study are important for surfacing barriers and challenges that are mostly rooted in inequities in an effort to motivate meaningful change.

2 SYSTEMATIC LITERATURE REVIEW

To conduct our systematic literature review (SLR), we used the framework created by Khan et al., which consists of framing the question for the SLR, identifying relevant publications and selection criteria, assessing the quality of the literature, summarizing the evidence, and synthesizing the findings [44].

2.1 Step 1. Framing the Question

Our free-form question for this SLR was: *Is there research on issues related to equity among CSEd researchers?* To provide more context for the question, we identified the following:

- Populations: CSEd researchers
- Interventions or exposures: Environments and challenges related to CSEd research
- Outcomes: Whether or not there are challenges for various subgroups within CSEd researcher communities
- Study designs: Quantitative, qualitative, mixed-methods, position papers (all)

2.2 Step 2. Identifying Relevant Publications and Selection Criteria

We identified the following relevant sources to conduct our searches: the ACM Digital Library, the Institute for Electrical and Electronics Engineers (IEEE) Xplore Digital Library, and Google Scholar. The

Table 1: Search keywords for each search conducted.

Search	Keywords
1	“Education research” AND challenges AND (computing OR “computer science”)
2	“Education research” AND needs AND (computing OR “computer science”)
3	“Education research” AND climate AND (computing OR “computer science”)
4	“Education research” AND (community or environment) AND (computing OR “computer science”)
5	“Education research” AND barriers AND (computing OR “computer science”)
6	“Education research” AND (equity OR diversity OR marginalized OR Black OR Hispanic OR Disabled) AND (computing OR “computer science”)

Table 2: Six searches were conducted on each library prior to duplicates being removed.

	Search	N	# meeting criteria
ACM Digital Library	1	100	15
	2	100	20
	3	100	7
	4	100	21
	5	100	8
	6	100	17
IEEE Xplore Digital Library	1	100	5
	2	100	5
	3	94	0
	4	100	5
	5	100	2
	6	100	5
Google Scholar	1	100	17
	2	100	13
	3	100	8
	4	100	13
	5	100	7
	6	100	19

keywords we used in the selection process are shown in Table 1. For each search, we included the first 100 results. If the result returned fewer than 100 results, we included all articles returned. Table 2 shows the number of articles found.

We placed articles from different venues into their own spreadsheet, which left us with 38 articles from ACM, 20 from IEEE and 39 from Google Scholar. After combining these remaining 97 articles, we removed 13 duplicates, leaving 84 articles. We then used the following to review each article more thoroughly:

- Must meet this criteria:
 - Article content is specific to CSEd research
- Must meet one of these criteria - article content provides insight into:

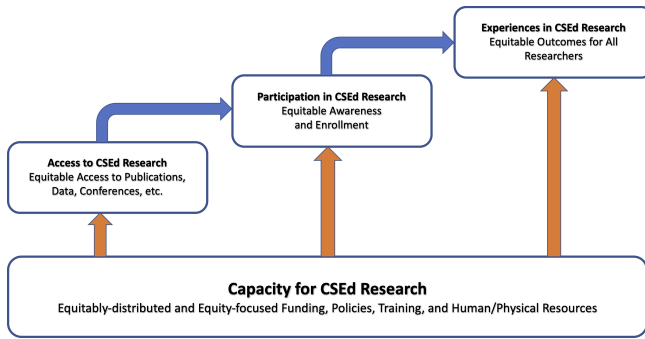


Figure 1: The CAPE framework revised to disaggregate the equity challenges in computer science education research.

- Barriers (or challenges) researchers face in CSEd Research
- Climate of the CSEd Research community (defined as any group of individuals conducting CSEd research in any area; involves researchers (and their collaborators - e.g., teachers), their beliefs and the community influences around them)
- Equity-focused issues related to CSEd research (e.g., identifies barriers for a certain individual/group to conduct CSEd research)

2.3 Step 3. Assessing the Quality of the Literature

We considered that the ACM and IEEE digital libraries were sound and involved primarily peer-reviewed publication venues. While the Google Scholar articles were sourced more openly, once we removed those that did not meet the criteria in Step 2, our quality assessment was to examine each article to see what it contained. At this point, we removed several panels and editorials that did not sufficiently meet the rigor of being a paper.

3 EQUITY AND RESEARCH WITH FINDINGS FROM THE SLR

Steps 4 and 5 of the Khan et al. SLR methodology calls for summarizing the evidence and interpreting the findings, respectively.

To help define some of the challenges that we face in the CSEd research community, we use the CAPE framework, [32]. CAPE is designed to examine aspects of equity across CSEd in order to better determine the challenges and outcomes of learners by exploring the *capacity* for, *access* to, *participation* in, and *experiences* of equitable CSEd. We adapted the framework to examine equitable CSEd research through the four components of CAPE (see Figure 1). We highlight some of the unique and more pressing challenges across CAPE in the following sections.

As researchers, we bring our own perspectives and experiences into our work. Artis et al. ground their research “...on the tenet that one cannot effectively serve or impact a community until [they] genuinely understand the issues and challenges facing the people who are its members” [3, abstract]. Researchers who do not fully understand the cultural phenomena that surround a group of learners may produce research that has biases and misconceptions

that could skew or invalidate findings in the best case [35, 71, 72]. In the worst case, this could cause significant harm to learners, particularly those from historically marginalized groups. What each researcher values and the experiences they bring to their research can influence their research design, measurements they choose, data they choose to collect, how they store, protect, and analyze the data and how they interpret the results.

Reflexivity statements in publications acknowledge researchers’ experiences and thought processes in order to present (in part) potential biases they have that may influence the research process [54, 67]. Reflexivity statements are a best practice for qualitative studies since complete objectivity is not possible [27, 67]. However, even in quantitative data, researchers’ perspectives can influence their choice of research questions, the participants included in the study, the choice of content in survey instrumentation and/or assessments, and the interpretation of the data [35, 69, 72]. As such, there has been recent discussion to include reflexivity statements in quantitative research reports as well [29, 53, 62, 86].

3.1 Capacity for CSEd Research

Capacity reflects the critical foundation for creating, implementing, and maintaining an equitable ecosystem in the CSEd research community. This includes equitably-distributed and equity-focused funding, policies, training, and human/physical resources. To build the capacity for more equitable support for, and representation among, education researchers, barriers and challenges within the community must first be identified to be addressed.

3.1.1 Systematic Literature Review Findings. Funding. Several studies found that a major barrier to conducting research is funding [16, 19]. At a 2014 summit held at Stanford University, researchers agreed that CSEd research does not receive the same funding opportunities as traditional CS research and that it is difficult for CSEd doctoral students to receive grants [16]. Additionally, Crick found that CSEd research, particularly in the UK, is an underfunded discipline and that the UK currently does not “provide the critical mass necessary to drive forward computer science education research.” [19, p.18]

Collaboration. A common theme in many studies was collaboration [16, 19, 20]. Cooper notes how it is hard for CS faculty advisors to find a co-advisor in education. One reason for this is because interdepartmental collaboration is already difficult, but even more so for departments in different colleges. Further, CSEd researchers in the UK reported that there is an “absence of computer science education research groups and the related infrastructure to promote the importance of computer science education” [20, p. 35]. Even when researchers do find opportunities to work with others, there are still barriers to effective collaboration, such as conflicting schedules and technical issues [31].

Lack of Publication Venues. Another challenge common to CSEd researchers was difficulty publishing [14, 16, 43]. One reason for this is the limited venues that CSEd research offers [16], which likely due to the newness of the CSEd research field.

Limited Job Prospects. Both PhD students and faculty members in CSEd face institutional barriers in hiring and promotion practices [16, 17]. Cooper found that only some schools would hire a tenure track faculty member in CSEd or do joint hires. A common theme

held among participants was that interested CSEd faculty “would need to build a business case for hiring” in CSEd research [16, p. 16]. Because of the scarce career pathways for CSEd research, graduate students often do not view it as a viable option to pursue [17].

Time Constraints (Teaching vs Research). Professors of all disciplines are subject to time constraints, but especially those at institutions that primarily focus on teaching who may be precluded from engaging in research [14]. Cooper et al. also noted that of the few CSEd faculty appointments, some “have higher teaching loads and/or are primarily expected to teach rather than to conduct research (or support graduate students)” in CSEd [17, p. 4].

Departmental Issues. In 2014, Cooper noted how, despite 150 schools in the US offering doctoral programs in CS, CSEd was not recognized as a sub-discipline within any of their CS departments [16]. Though this may be starting to slowly change, a number of issues arise from this where neither the subject matter of CSEd nor the students and faculty who study it have a clearly delineated base in the CS and/or Education departments [16].

Barriers to Certain Research Methods. There are barriers to conducting longitudinal, outreach, qualitative, and replication studies. Scientists view outreach research as “volunteer work, auxiliary to their other responsibilities, not valued by their home departments, and not money-making for the university and, therefore, of lesser value” [22]. They also “perceive that there is little reward for science outreach work, especially in the tenure process” [22, p. 156]. Further, the promoted criteria of including theory as a basis for all research may inhibit researcher’s search for better designs or even new theories [65].

Long-term impacts of outreach activities are hard to identify, especially given the difficulties that already come with longitudinal research. For instance, time commitments can be prohibitive, especially if the study is experimental and will require a control group to be tracked. The difficulties in tracking participants brings its own challenges as families can move, contacts can change, and participant responses can decrease [22].

There are also challenges conducting replication studies [1, 36]. Many researchers, institutions and publication venues do not value replication studies to the same degree as novel, original work. For instance, Guzdial “noted that a recent attempt to publish a replication of an important instrument for measuring introductory computer science knowledge met initial resistance” [1, p. 3]. In addition to negative perceptions, some researchers are unable to replicate due to lack of detail in the original research [1, 36].

Qualitative research is also difficult due to the nature of CS departments. CS departments rarely use qualitative approaches, and even neighboring departments like psychology and cognitive sciences mainly use quantitative methods [37].

Lack of Respect for CSEd. There is a current lack of respect for CSEd. Cooper et al. advocates for a cultural change in order to make CSEd a “first-class citizen” in CS departments. [20] has found that some academics in the UK felt that their home universities held negative perceptions towards CSEd. At a Stanford University summit in 2014, researchers also agreed that there is a general lack of respect for CSEd and many do not view it as a rigorous discipline [18].

Barriers Related to Tools/Instruments. CSEd researchers also have trouble accessing tools, instruments, and best practices, such as a lack of validated assessment instruments [82].

Other Barriers and Challenges. It has been reported that there are challenges finding relevant literature [43], that CSEd researchers may not know which areas to research [24], and that there is a lack of CSEd faculty mentors for doctoral students [17].

3.1.2 Capacity Summary. Capacity requires us to consider the entire ecosystem of our community of practice and how it does or does not favor individuals within our community. Wenger’s three key dimensions of a community of practice, as presented by Fincher and Tenenbergh in the context of building capacity in CSEd research, include joint enterprise and shared repertoire. Wenger describes joint enterprise as the “...community is sustained through emergent projects and plans that the members themselves negotiate and hold one another accountable to.” Shared repertoire is described as community members developing “a shared set of routines, words, tools, ways of doing things, stories, gestures, symbols, genres, actions or concepts that the community has produced or adopted in the course of its existence and which have become part of its practice” [89, p. 83] [30, p. 2]. Both ensure that existing ecosystems are built from the inside-out, relying heavily on central and active members over those who are on the periphery. Negotiating changes to the CSEd research ecosystem among the current, core members *without the inclusion and input of prospective and marginalized members* will only serve to reinforce the existing ecosystem along with its systemic challenges.

In addition to the above, there is a recognized need for more diversity in leadership within the ACM, ACM Special Interest Group on Computer Science Education (SIGCSE) and SIGCSE-related conference leadership [88]; for more knowledge on conducting high-quality research; for creating accessible publication venues; and the need for more researchers and reviewers with broad backgrounds and life experiences. To build capacity for CSEd research, a broad range of DEI criteria should be acknowledged, including engaging researchers in R1 and non-R1 institutions, researchers focused on K-12 and community colleges, researchers from institutions outside of academia (e.g., non-profits, private enterprise), and researchers of different races and ethnicities, physical abilities, gender identities, and socioeconomic backgrounds. Capacity also includes resources and training that enable the leveling of the knowledge field so that all researchers can produce high-quality research with best practices (e.g., use of statistical data analysis) [57].

To summarize, Table 3 encapsulates capacity-related barriers and challenges for CSEd researchers.

3.2 Access to CSEd Research

3.2.1 Systematic Literature Review Findings. When analyzing the data from the SLR, we found limited research on access to publication venues, networking, or dissemination. One article, Hellas et al., highlighted the difficulties recruiting participants with no programming experience from crowdsourcing using MTurk [38].

3.2.2 Access Summary. Access often starts with ensuring access for those with disabilities, which is a known issue in our field [4, 5, 88]. Access includes the need for greater accessibility at conferences

Table 3: A sampling of capacity-related barriers and challenges to achieve equity across the CSEd research community.

Capacity Needs in the CSEd Research Community
Community, institutional support [60]
Conflicting views in CSEd community on priority research areas [18]
Creation and dissemination of high-quality, equity-focused resources, tools, best practices, instruments, assessments [9, 39, 55, 59, 85]
CSEd not recognized as a sub discipline within CS departments [16]
Difficulties conducting qualitative research [37]
Difficulty in deciding which department students should be apart of (Computing or Education) [16]
Diversity in collaborators, leadership, researchers [8, 88]
Equal opportunities for networking
Flawed peer review bidding processes [68]
Funding, incentives, recognition, awards [16, 19, 42, 81, 84]
Gaps in pay, publication, promotion
Importance of conferences vs journals [43]
Insufficient publication venues [16, 17, 43, 58]
Lack of CSEd faculty mentors for PhD students [17]
Lack of infrastructure to support CSEd [19, 20]
Lack of qualitative research/prioritization of quantitative [18, 37]
Lack of replication studies (undervalued for publication, promotion, prestige over original work) [1, 36]
Lack of research questions in regards to research practitioners [25]
Lack of respect for CSEd [16, 17, 20]
Lack of validated assessment instruments [82]
Limited job prospects [16, 17]
Limited opportunities to collaborate [16, 19, 20]
Local publications devalued in favor of global research [14]
Increased workload and lack of compensation for peer reviewers [68]
Methods for linking research to practice and practice to research [41]
Outreach viewed as a feminine task with less legitimacy [22]
Personal costs (time, training, financial burden of higher education, unpaid labor, etc.)
Proliferation of methods (longitudinal research [22], replication studies [1, 36])
Removal of physical and other inequitable barriers to publish at and participate in conferences
Research that does not match needs of practitioners [24]
Strict use of theory requirement in research can stymie the search for better curriculum design [65]
Time constraints (teaching vs research) [14, 17]
Tension between empowering less-established academics while anonymous and open reviews [68]
Unclear recruiting practices for academic peer review [68]

and workshops and within publications, and access to attend and participate in conferences virtually. It also includes the open access of research artifacts (e.g., publications, data, instrumentation, etc.) [6]. With granting institutions moving to require sharing of research data [26, 63], there is a need to further explore what this means for CSEd research. Equal access to publish and use existing data not only benefits research in general, it also benefits individual researchers who contribute data [26, 70].

Access also includes an adequate number of publication venues that will accept and publish a broad set of work. In 2020, only 22% of the publications were focused on K-12, yet 77% of PreK-16+ learners are in primary or secondary schools [58], indicating a discrepancy and a potential bottleneck for valuable research in this space. This relates to the capacity that membership organizations (e.g. ACM, IEEE) have to provide these venues and the willingness of program

chairs and editors to accept publications that traditionally have not been accepted.

In lieu of a lack of distributed CSEd research-centered institutions [49], access to readily-available resources and training for conducting CSEd research could be a useful tool in enabling and promoting higher-quality CSEd [7, 57]. Further, this could provide a bridge between the separation of CSEd researchers from general education research theories and findings [76]. Likewise, access to diverse sets of participants or models of research that involve learners from a variety of backgrounds can enable a broader understanding of promising and equitable practices for all learners [40, 75].

To summarize, Table 4 encapsulates access-related barriers and challenges for CSEd researchers.

Table 4: A sampling of access-related barriers and challenges to achieve equity across the CSEd research community.

Access Needs in the CSEd Research Community
Access to diverse participants (CS: [83], Non-CS: [40, 75])
Accessible conferences and workshops [88]
CSEd research programs of study (e.g., PhD, MS)
Distributed research locations across a variety of institutions [49]
Research publications that broadly and consistently value equitable research
Resources and training for conducting high-quality CSEd research [57]
Research datasets to investigate
Research conferences and journals for publication

3.3 Participation in CSEd Research

Participation refers to the full, active participation of all who want to engage in the CSEd research community. Access is closely related to participation.

3.3.1 Systematic Literature Review Findings. Only limited information in the SLR was found that related to participation. Clear found that CS journals “are less likely than educational or Information Systems journals to accept research with a critical perspective” [14, p. 13].

3.3.2 Participation Summary. In Clancy et al., Fincher states that the “...new researcher needs to be able to participate in discussion and debate in order to contribute to discourse which defines and refines the thinking in [the] field” [13, p. 337]. Invisible barriers to participation in the CSEd research community are researcher bias [48, 88] and a lack of well-defined, robust criteria for publications that promote both objectivity and quality [68]. This takes on the form of research related to equity being met with denigration from reviewers [88] and subjectivity overshadowing objectivity among poorly-defined measures of publication and meta-review quality [56, 68].

This combination contributes to researchers who focus on equity feeling shut out—in other words, *marginalized*. These points illustrate the need for more diversity among the community leadership, which will bring more of these issues to the forefront and, at a minimum, open them up for broader discussion and awareness. Diverse leadership sends clear signals to the community that regardless of a researcher’s personal identities, they are welcome. Diverse leadership also has the potential to change some of these processes in a way that will ensure that there is greater participation by a diverse set of researchers and research topics in conference and journal publications, and in conference and workshop presenters and attendees. Further, across the board there is a need for greater diversity of researchers participating in conducting PreK-16+ CSEd research and bringing their perspectives and personal life experiences into that process [88].

To summarize, Table 5 encapsulates the barriers and challenges of researchers’ participation in CSEd.

3.4 Experiences of CSEd Researchers

3.4.1 Systematic Literature Review Findings. Experiences of CSEd researchers are difficult to find, and most experiences are framed as deficits within the capacity level. In addition to the capacity deficits

related to CSEd researcher experiences, research has found that researchers may have difficulty selecting the appropriate conference or journal to submit their work. For example, Joy et al. noted how interdisciplinary research, especially research that combines social science and pure science, makes it difficult to publish in traditional journals and conferences [43].

3.4.2 Experiences Summary. With respect to experiences of CSEd researchers, many of the same areas of focus we place on learners can be a framework for exploring issues impacting researchers focusing on equity and researchers from historically marginalized groups. Impostor phenomenon among researchers, for instance, is closely tied with self-efficacy and confidence, which can be influenced by repeated rejection and burnout [11, 42]. Rejection is a norm in academia, but for already isolated or marginalized researchers it can have a more significant impact—particularly when rejection occurs due to bias from reviewers. This can lead to researchers choosing to leave the field due to poor career satisfaction [80]. Even if researchers stay in the field, their feelings of isolation can grow [56, 88], further diminishing their research careers.

To improve the experiences of CSEd researchers, Fincher and Tenenberg define mutual engagement as a key dimension in a community of practice. This is “...enacted through the dynamic and continuous interactions on issues of shared interest and meaning” [30, p. 2]. Isolation can be combated by re-imagining and re-structuring a research community of practice that is supportive and inclusive—where all researchers, regardless of their personal or professional identities, are interested in and are able to attend and engage in conferences and workshops, publish within our community, and contribute to the community just as dominant groups have to date. Yet, many experiences of researchers from diverse backgrounds remain unexplored in the field of CSEd research, particularly along researchers’ intersectional identities (e.g., Black women in computing [8, 74]).

Cultural competence, originating in social work and counseling psychology, refers to a system of attitudes, behaviors, and policies that enable effective cross-cultural interaction. Employing cultural competence is relevant to CSEd research individual researchers inherently navigate differences in identities among researchers, and between researchers, practitioners, and participants in the currently unrepresentative state of our field. As our community grows our attitude, awareness, knowledge, and skill in cultural competence, the community can produce better equipped allies,

Table 5: A sampling of participation-related barriers and challenges to achieve equity across the CSEd research community.

Participation Needs in the CSEd Research Community
Ability to attend/present/publish at conferences, journals, workshops [88]
Awareness of venues/expectations for publication in other disciplines (e.g., psychology)
Awareness of high-quality resources, tools, best practices, instruments, assessments [9, 39, 55, 59, 85]
Participating in community leadership positions [88]
Pursuing professional development

and greater resilience and belonging among community members from historically marginalized groups [87].

To summarize, Table 6 encapsulates the barriers and challenges of researchers' participation in CSEd.

4 METHOD

Once we finished our literature review, we created a cross-sectional survey, *Barriers and Challenges to CS Education Research Equity Survey*, based on the SLR and our general review.

4.1 Data Collection

The Barriers and Challenges to CS Education Research Equity Survey, available at <https://csedresearch.org/resources/evaluation-instruments/tool/?id=265>, asked questions related to all four CAPE components with a specific set of questions focused on equity within the field. We collected both quantitative data based on the SLR and ample open-ended questions for researchers to share their own unique barriers and challenges to conducting CSEd research.

After receiving ethical board approval, we recruited participants through several channels to reach the population of CS education researchers. This included posting participant invitations on the the ACM SIGCSE listserv, the IEEE Collaboratec Forum for K-12 education, and the National Science Foundation's INCLUDES Network forum. It also included an international CS education evaluation network (Google group), the CSforALL community slack channel, the CSEdGrad cohort mailing list, and the NSF-sponsored RPPforCS (Research Practice Partnerships for Computer Science) newsletter. Given the wide variety of ways that we shared the survey link, we are unable to provide either the number of CS education researchers in total or the number that the invitation actually reached. However, we provide a description of the respondents to provide representation information about the participants.

In total, 72 surveys were fully completed. Of these, participants were more likely to focus on CSEd among undergraduates (23%), followed by secondary school (14%) and historically marginalized racial/ethnic groups in their country (13%) (see Table 7). No participants studied post-doctoral learners and only 3% focused on rural learners.

Participants' affiliation was significantly tilted towards research-oriented (42%) and teaching-oriented (32%) colleges/universities (see Table 8). The majority of participants have been conducting research for 11-15 years (24%) and 6-10 years (21%) (see Table 9). The majority of participants conduct research within the U.S. (88%). To understand potential cultural differences in barriers and challenges, we asked participants whether or not they conduct research outside their country of origin, we found that 92% of participants conduct

research in their country of origin, 7% outside of their country of origin, and 1% did not respond.

With respect to gender identity, the majority of participants identified as cisgender female (50%) and cisgender male (36%). The majority of participants (73%) identify as being of white/European descent.

We asked participants *Do you have a long-lasting or chronic condition (such as physical, visual, auditory, cognitive, emotional or other) that requires ongoing accommodations for you to conduct daily life activities (such as your ability to see, hear or speak; to learn, remember or concentrate)?* 11% of participants answered Yes, 82% answered No, and 7% preferred not to say.

We asked participants *Do you consider yourself a member of the Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, and/or Asexual (LGBTQIA) community?* 10% responded Yes, 88% responded No, and 3% preferred not to say. Finally, we asked participants to select the age range in which they belonged (see Table 13). The majority of participants responded in the 36-45 year old (39%) and 46-55 year old (22%) ranges.

4.2 Data Analysis

In this particular study, we analyzed the survey using descriptive statistics. We present the number of participants for each item and the percentage. Future analysis will include comparing responses by demographic data to see if any correlations emerge. We received hundreds of responses in the "other" box for each question asked. We also intend to analyze this qualitative data in the near future to share with the community.

4.3 Researcher Positionality Statements

One of the authors has been formally trained in both quantitative and qualitative education research methods and has extensive experience working as a CSEd researcher at the primary, secondary, and post-secondary levels. This co-author has recently worked more closely in the area of supporting CSEd researchers in ways that enable more equity-focused research to be conducted and shared to the wider community. The perspective that this co-author brings to this study is one of deep respect for both research and practice and a commitment to building a more inclusive research community.

Another author is studying teacher education at a post-secondary institute and is being mentored by one of the authors in research methods. This co-author has training in qualitative and ethnographic research methods and has classroom experience working with students at the secondary level. Both the research and classroom experience has helped inform this author's commitment to improving the quality of education research.

Table 6: A sampling of barriers and challenges to equitable experiences across the CSEd research community.

Experience Needs in the CSEd Research Community
Content knowledge of CSEd and education research
Engaging in conferences, journals, workshops, etc.
Finding the appropriate publication venue [43]
Impostor Phenomenon [11, 42]
Interest in attending future CSEd research conferences
Interest in professional development (e.g., completing PhD programs, attending PD)
Interest in contributing to the body of knowledge (e.g., publication, presentations)
Professional Burnout [42]
Self-efficacy and confidence
Sense of belonging
Sense of support
Stress and strain [56]

Table 7: Research focus areas of participants.

Research Focus Area	N	%
Undergraduate	49	23%
Secondary School (i.e., 9th-12th, high school)	29	14%
Historically Marginalized Racial/Ethnic Groups in your country	28	13%
Primary School (i.e., K-8th, elementary school, middle school)	22	10%
Historically Marginalized Gender Groups in your country	19	9%
Learners from families with lower socio-economic standing	16	8%
Graduate	14	7%
Learners with Disabilities	9	4%
Learners learning the language of your country (e.g., bilingual/multilingual learners)	8	4%
Community College	7	3%
Rural Learners	6	3%
Adult learners (outside of formal education setting)	2	1%
Other	1	0%
Post-Doctoral Learners	0	0%

Table 8: Participants' affiliation.

Affiliation	N	%
Research-oriented colleges/universities	30	42%
Teaching-oriented colleges/universities	23	32%
Other	9	13%
Non-profit organization outside academia	5	7%
For-profit organization	5	7%
Public organization (e.g., departments of education, government entity)	0	0%

Table 9: Participants' years conducting research.

Years conducting research	Count	%
I have not yet conducted any research	1	1%
1 year (first year)	3	4%
2-3 years	7	10%
4-5 years	12	17%
6-10 years	15	21%
11-15 years	17	24%
16-25 years	9	13%
More than 25 years	8	11%

Another author has led interventions for equity in CSEd from the private sector for over seven years, producing research in partnership with various faculty and evaluator collaborators. This co-author does not have formal quantitative or qualitative research training, nor formal training in CS or education, but has learned through hands-on experience and mentorship. As a research and evaluation-driven practitioner, this co-author is personally compelled to improve the capacity for, access to, participation in, and

experiences of CSEd research, particularly for those from non-traditional backgrounds and outside of academia.

5 RESULTS

We looked at several barriers and challenges that researchers face within the CSEd research community. First, we present personal challenges that are related to conducting research but that are

Table 10: Participants' country.

Country	N	%
United States	59	88%
United Kingdom	2	3%
India	1	1%
Ireland	1	1%
North Macedonia	1	1%
Italy	1	1%
Sweden	1	1%
Brazil	1	1%

Table 11: Participants' gender identity.

Gender Identity	N	%
Cisgender Female.	36	50%
Cisgender Male	26	36%
Transgender Female	1	1%
Transgender Male	0	0%
Non-Binary	3	4%
Prefer not to say	3	4%
Other	3	4%

focused on the individual researcher (Table 14). The majority of participants noted that issues related to COVID-19 pandemic were a challenge (81%). With respect to time, 64% noted that they work more than an average 40-hour work week, which is an aspired time to work for traditional work situations in the U.S. (and may be different in other countries). This may or may not be related to time constraints with respect to research and their other commitments (such as teaching) (53%). 43% of participants noted that they experience low self-efficacy for conducting research (e.g., Impostor Phenomenon) and lack of a sense of belonging as a researcher (36%). Caretaking responsibilities were a challenge for 40% of participants.

Participants described additional personal barriers and challenges to conducting CSEd research and evaluation (Table 15). In addition to the time constraints between teaching and research, grant writing, administrative tasks, and project management aspects of the research endeavor compete for CSEd researchers' time. Specifically, 43% noted an increased workload due to conducting peer review and 40% faced barriers to effectively collaborating with other researchers. Notably, 39% noted their lack of knowledge in general education research theory and non-CS education as challenges for them personally. Participants also described challenges around their work being perceived as valid, both in-and-of itself and for tenure and promotion, especially for conference publications as opposed to journal publications.

Results indicated that 61% of participants noted the lack of computing education being recognized as a subdiscipline within CS departments as a challenge for the community (Table 16). 58% noted the lack of awareness and adoption of practices from other education research fields as a challenge, while 54% noted the lack of knowledge of general educational research theory as a challenge. In open-ended responses, researchers of smaller-scale interventions,

from smaller and/or non-R1 institutions and evaluators struggle to publish their work, and many described a sense of tension, competition, or lack of respect or fit for their work relative to peers within their institution or the CSEd research community. This can be minimal belonging between "educational researchers, computer scientists, and instructors/teachers/professors of computing," inability to synthesize one's "previous experiences and theoretical backgrounds" outside of CS, lack of departmental support to teach CSEd courses, lack of recognition for research outside of core computing content (e.g. programming, "pedagogical content knowledge/strategies, curriculum content, classroom interventions" vs "equity in course enrollment, access to CSEd"), and insular communities unwelcoming and/or inaccessible to newcomers. Additionally, participants described the need for centralized information about how to access and participate in professional development, such as a "centralized calendar" of conferences, workshops, talks, working groups, etc. Finally, participants described the barriers posed by costs for paying research teams, conference registration and travel, software and tools, and training.

While many of the above mentioned barriers and challenges may be impacted by various inequities, we also asked participants to identify barriers and challenges more specifically related to diversity, equity and inclusion (Table 17). Overall, 43% of the participants noted a lack of diversity among CSEd research partners/collaborators and among the community (in general) and community leadership (in particular). Affecting the design of research, 36% of researchers noted that there lack equitable representation among identities of participants in studies. Equal opportunities and equal pay were seen as less of an issue, but nonetheless an issue for some.

6 DISCUSSION

Participants validated many of the findings from the SLR, and provided further context for the many barriers and challenges to conducting CSEd research. As demonstrated by Figure 1, barriers to equitable capacity for CSEd research impact all other CAPE dimensions. Therefore, rather than analyze the results using CAPE, we focus on the the barriers and challenges at the capacity level as they pertain to foundation of access, participation, and experience.

6.1 COVID-19

Certainly, the greatest challenge universally experienced in education research in the past two years is the disruption caused by the COVID-19 pandemic [23]. The same appears to be true based on our results, radiating impacts across four dimensions of the CAPE framework in CSEd research. This is evidenced by 81% of participants indicating it as a challenge (the highest percentage of any item), and this aligns with previous research indicating a nearly 50% decrease in publications in the first year of the pandemic [61]. Not only has the pandemic impacted our capacity to execute education, outreach, and research initiatives, as the CSEd research community collectively shifted a variety of activities to new formats and tools amidst a vast unknown, it has disrupted access to these initiatives for educators and learners (e.g. virtual events outside local timezone, lack of personal devices), negatively impacting their

Table 12: Participants' race/ethnicity.

Race/Ethnicity	N	%
Black/African descent (having origins in Sub-Saharan Africa)	5	6%
Central Asian (e.g., Kazakhstan, Afghanistan, etc.)	0	0%
East Asian (e.g., China, Japan, Korea, etc.)	2	3%
Hawaiian Aboriginal Descent	0	0%
Hispanic / Latino / Latinx (e.g. identify as Hispanic or Latino with ties in Latin America)	4	5%
Indigenous (e.g. Aboriginal Australian, Aboriginal New Zealander, Alaska Native, First Nations, Native American, Native Hawaiian, Samoan)	0	0%
Middle Eastern/North African (including the Middle East, North Africa and the Arab World)	3	4%
South Asian (e.g., India, Pakistan, etc.)	1	1%
Southeast Asian (e.g., Thailand, Vietnam, Singapore, Indonesia, etc.)	0	0%
White/European Descent	58	73%
Prefer not to say	5	6%
Other (please specify)	1	1%

Table 13: Participants' self-reported age ranges.

Age Range	N	%
18-25	1	1%
26-35	8	11%
36-45	28	39%
46-55	16	22%
56-65	12	17%
66-75	3	4%
76-85	1	1%
85+	0	0%

participation (e.g. fewer registrations, lower response rates) and experience (e.g. screen fatigue, social isolation).

Thinking through the lens of equity, those with fewer resources and more constraints on their time struggled most during COVID-19. When we layer that onto findings from the SLR and survey, CSEd researchers at institutions with less capacity/support for CSEd, with less access to statistical training and the knowledge base of CSEd, and with increased workloads from teaching, caretaking, and pivoting all activities to post-COVID modes suffered in their CSEd research endeavors. As Decker and McGill note, historically marginalized groups who conduct research perceived to be "peripheral" already have their work marginalized, and the pandemic may have pushed this work to be even further marginalized or discounted. While there is little the CSEd research community can do to address COVID-19 directly, its impacts on the CSEd research community's work highlights many of the capacity, access, participation, and experience challenges that we face and must address to ensure greater resilience and equity in our future efforts.

6.2 Capacity for Rigorous Practice

Both the SLR and findings from the survey reinforced the challenges to rigorous research practice in CSEd. The SLR identified barriers to conducting longitudinal, outreach, qualitative, and replication studies [1, 22, 36, 37], and lack of access to validated instruments [82]

and relevant literature [43]. This was echoed by many participants (Table 15).

Additionally, previous work has identified that methodological content, descriptive statistics, inferential statistics, and key variables (e.g., activity components, instructor and learner demographics) are underreported [2, 73, 78]. An ACM ITiCSE 2018 working group review of over 700 articles in introductory programming concluded that few of the studies outlined sufficient context to enable replication, or even for educators to gauge whether the intervention and outcomes described were relevant to their institution [50].

Many evaluation instruments in CSEd research are designed ad-hoc by researchers with minimal reporting of validity or reliability, with one study finding this to be the case for 74% of 76 K-12 CSEd research articles [59]. The CSEd research community continues to align on constructs known to be critical for learner and practitioner success (e.g., self-efficacy, sense of belonging) while splitting our understanding of them across new and unique measures, hampering our ability to benchmark across interventions, metrics, and disciplines. Previous work has substantiated that CSEd research survey instruments shared across a variety of intervention sites and designs (e.g., localized research-focused workshops for undergraduates and K-12 teacher professional development) can measure statistically significant change [77] with reliability [21]. Inaccessible instruments, research publications and datasets make it difficult to share data and related findings, and often researchers without access are placed at a disadvantage.

The opportunity within CSEd research to adopt methodological and reporting standards common to other fields increases the validity and generalizability of our outcomes, our ability to identify gaps (particularly among needs of learners and practitioners from identities historically marginalized and communities historically underserved), and our ability to respond to them as contexts of CSEd change [10, 79]. However, as this paper has demonstrated, CSEd researchers struggle to identify those standards.

6.3 Inclusion of CSEd Researchers

Multiple participants, from researchers who identify as Black to K-12 practitioners who do not hold PhDs, described not being "taken

Table 14: General personal barriers and challenges to conducting research.

Challenges personally experienced	N	%
Issues related to COVID-19 pandemic	58	81%
Working more than an average 40-hour work week each year	46	64%
Time constraints with respect to teaching vs research	38	53%
Low self-efficacy for conducting research (including Impostor Phenomenon/Imposter Syndrome)	31	43%
Care-taking responsibilities	29	40%
Lack of a sense of belonging as a researcher	26	36%
Stress and strain related to publishing	26	36%
Other personal commitments	21	29%
Lack of recognition for engaging in research on outreach activities (e.g., not counted for tenure or promotion)	15	21%
Stress and strain related to tenure or promotion	12	17%
Lack of recognition for other research that you conduct	11	15%
Burden of education loans	8	11%
Physical barriers to participate in conferences	8	11%
Physical barriers to publishing (e.g., accessible submission processes)	3	4%

Table 15: Content-specific personal work-related barriers and challenges to conducting research (general).

Challenges personally experienced	N	%
Increased overall workload due to conducting peer reviews	31	43%
Barriers to effective collaboration on CSEd research	29	40%
Lack of knowledge of general educational research theory	28	39%
Lack of knowledge about (non-CS) education research	27	38%
Lack of funding to conduct education research	23	32%
Difficulty getting research published	21	29%
Lack of access to diverse participants for research studies	21	29%
Difficulty accessing relevant literature	18	25%
Lack of funding to attend conferences	17	24%
Lack of funding to publish open-access articles	16	22%
Lack of opportunities to participate in professional development in CSEd research	16	22%
Lack of access to research publications (e.g., paywalls)	15	21%
Lack of knowledge about computer science	12	17%
Unsure which areas of research to explore	11	15%
Lack of opportunities in contributing to the body of CSEd research knowledge	10	14%

seriously" in their CSEd research, an experience that stacks the existing lack of fit that many CSEd researchers feel across departments, publication venues, and other organizations [16, 17]. As a community, we so often focus on the critical influence that sense of belonging has for the persistence of the learners in our interventions, particularly for those from historically marginalized groups, but do not initiate similar inquiry into the sense of belonging among CSEd researchers and practitioners; a barrier for 36% of our participants (Table 14). For members of our community who hold multiple identities that have been historically marginalized in computing, this only compounds the personal experience of a lack of sense of belonging (as it does for students [12, 45, 51, 66, 77]), in addition to an objective underrepresentation of those identities among the CS professoriate [34, 90], CSEd researchers and practitioners,

and our own participants. It is disheartening that so many participants pointed to the disciplinary tension that results in their CSEd research not being perceived as "real research."

When asked what accommodations would help them be fully engaged in the CSEd research community, some participants described needing support for their physical, mental, and social needs. When CSEd research content is not accessible via screen reader or captions, or when networking events center around food or alcohol, many members of our community are unable to participate at all, or without disclosing personal details about their disabilities, religions, and preferences.

Our community must reflect on which of our processes and interactions reinforce systemic barriers that cause members of our community (43% of our participants (Table 14)) to experience impostor phenomenon that undermines their self-efficacy in CSEd research.

Table 16: Community barriers and challenges to conducting CSEd research.

Community barriers and challenges	N	%
Lack of computing education being recognized as a subdiscipline within CS departments	44	61%
Lack of awareness and adoption of practices from other education research fields	42	58%
Lack of knowledge of general educational research theory	39	54%
Lack of respect for CSEd research as a field	37	51%
Lack of replication, reproducibility, and/or meta-analytic studies	30	42%
Lack of incentives for conducting CSEd research	29	40%
Lack of respect for qualitative CSEd research	29	40%
Finding researchers to conduct quality peer review	26	36%
Lack of funding for PhD programs in CSEd	26	36%
Lack of CS education research faculty mentors for PhD Students	25	35%
Lack of PhD programs in CSEd research	25	35%
Lack of funding for conducting CSEd research	24	33%
Lack of breadth across CSEd research topics	23	32%
Lack of distributed CSEd research locations across a variety of institutions	21	29%
Lack of free high-quality resources, tools, best practices, and instruments	20	28%
Limited opportunities to collaborate on CSEd research	20	28%
Lack of research designed to meet practitioners' needs	19	26%
Lack of journals for publishing CSEd research	18	25%
Lack of researchers from other fields interested in attending CSEd research conferences	18	25%
Lack of methods for linking research and practice	17	24%
Lack of awards for exemplary CSEd research	15	21%
Lack of publication venues that broadly and consistently value equitable research	13	18%
Lack of secondary research datasets to investigate	12	17%
Lack of respect for quantitative CSEd research	8	11%
Lack of conference venues for disseminating CSEd research	6	8%

Table 17: Community barriers and challenges specifically related to DEI.

Barriers and challenges related to DEI	N	%
Lack of diversity among CSEd research partners/collaborators	31	43%
Lack of diversity among CSEd researchers in the community	31	43%
Lack of diversity among CSEd research community leadership	29	40%
Lack of equitable representation among identities of participants in studies	26	36%
Lack of equity-focused CSEd research in the literature	22	31%
Lack of equity-focused resources, tools, best practices, and instruments for conducting CSEd research	21	29%
Lack of acceptance of equity-focused CSEd research	19	26%
Lack of equal opportunities for networking	17	24%
Lack of equal opportunities for promotion/tenure	16	22%
Lack of equal pay compared to peers in my organization	11	14%
Lack of equal pay compared to peers in CSEd research	7	10%

6.4 Relationship of Time, Research Integrity, Career Progression, and Well-being

One respondent described the need for "the time and money to implement interventions at scale and then measure their long term impact" in order to produce more meaningful CSEd research and evaluations. Arguably, this is the fundamental baseline we should expect from ourselves as a research community, but some of our peers struggle to achieve it.

Across the SLR and responses to our survey, we observed the challenges of connecting CSEd researchers to literature and datasets,

to one another for collaboration, to mentors for professional development, to technical training on data analysis and instrument validation, to gaps in knowledge and practitioner needs, and to funding. Many of these challenges lead to practices that plague the integrity of education research: over-collecting and selectively reporting data, consciously or otherwise, until the hypothesis and/or previous findings are supported; direct use and meta-analysis of randomized-controlled experiments and quasi-experimental design; and post-hoc hypothesizing, instrumentation design, and evaluation after the intervention was delivered or data were collected

[15, 36, 41, 52]. However, overwhelmingly, the greatest challenge described by participants and the literature is a lack of time.

If individual researchers are consistently expressing the constraint of time, balancing teaching/research/administrative/service/project management/caretaking responsibilities, and a weekly workload well over 40 hours, researchers must consider not only how that impacts their participation and experience when executing their own research, but also how this impacts volunteer participation in the CSEd research community (e.g. conference chair, program committee, peer reviewer, etc.). When experiencing these competing demands, it is difficult for individuals in those volunteer roles to show up with an intentionally inclusive strategy that can sustainably gauge and meet the needs of CSEd researchers, and researchers are even indirectly disincentivized to participate in these roles, knowing that they do not positively impact our career trajectories.

The barriers and challenges of multiple issues of capacity within the CSEd research community produce stacking effects of impostor phenomenon, rejection, burnout, isolation, and systemic barriers and inequities that compromise the satisfaction and impact of members of the CSEd research community [11, 42, 56, 80, 88], particularly for those from historically marginalized groups.

6.5 A Need for Central Leadership

One participant described a need for "more of a commitment to self-examination and self-improvement" within the CSEd research community, which is a succinct and inviting summary for how the community might overcome the noted barriers and challenges. As a young, evolving, and fractured field, there is recognition that measures of collective impact can be put into place (e.g., the U.S. National Science Foundation's Shared Measures initiative [64]) to help assess and guide leadership through a continuous improvement model and to recognize the outcomes of changes that are made over time. Washington and DeLyser provided a springboard for our study and for leadership to address some of the barriers and challenges within the ACM SIGCSE community. Adding the results of our survey can provide more context of the work to be done as well as a strong justification for doing so.

Further, centralized leadership in CSEd research that embodies cultural competence [87] can compile information on events, resources, training, and publication venues; set standards for events and media (e.g. accessibility requirements for screen readers, captions, quiet spaces); form affinity groups for networking (e.g. a CSEd research equivalent of organizations like Latinx in AI); and elevate the prestige of volunteer activities and conference publications. Central leadership can direct professional development to address both authorial and editorial biases [72]. Incentivizing and recognizing participatory design, pre-registration, reproducibility, replication, and meta-analysis studies, and open and large-scale collaborative science can encourage CSEd researchers to adopt these methods [7]. A unified voice from relevant stakeholders can orient researchers across identities, institutions, and geographies, and equip them to establish working groups that can influence institutions' practices in CSEd.

6.6 Limitations

While the study presents significant insights into some of the systemic barriers and challenges CSEd researchers have when conducting research, the results could be further strengthened and more complete by making sure that participants are more representative. This includes additional representation of voices from different countries, novice researchers, researchers from historically marginalized groups, and those researching post-doctoral learners, rural learners, and adult learners. Additional responses across various groups will also provide us with sufficient data to conduct correlations of responses among different subgroups.

Likewise, for-profit and non-profit organizations outside of academia are not as well-represented, meaning that these results may not reflect their unique environments and circumstances. Since we would like to be able to ensure representation across a cross-section of identities and experiences, we will continue to hold the survey open and continue reaching out to researchers in these groups so we can ensure their voices and needs are represented.

A limitation of the data as presented in this paper is the exclusion of most of the open-ended responses that asked in what other ways participants' face barriers and challenges. These thoughtful responses reflect careful consideration of these issues and we look forward to fully analyzing and reporting on these in the future.

7 CONCLUSION

Barriers and challenges, particularly those that are systemic, can have serious impact on CSEd researchers and our community at a time when there is a great need to understand promising practices for implementing in the classroom. This can cause feelings of frustration, stress, anxiety, and impostor phenomenon impacting researchers' self-efficacy, interest in conducting research, output, and career progression. While there has been extensive discussion between multiple disciplines regarding supporting education researchers across a multitude of factors, there is particular urgency in CSEd as the capacity, access, participation, and experiences of its learners, practitioners, and researchers continues to be stunted by this array of barriers.

As reflected in our study, this is due in part to systemic exclusion and perpetuation of inequities toward our members from historically marginalized groups. CSEd research is (comparatively) new enough that researchers, particularly novices, those from historically marginalized groups, and those who are under-resourced, may be unaware of or may feel unwelcome at certain venues, and may be disadvantaged when it comes to CSEd professional and career development. We owe it to ourselves as a community to further identify these barriers and challenges and prioritize those that are most likely to inhibit the identification of promising educational practices. We must work to find actionable and sustainable solutions from a unified perspective as an inclusive community that is responsive to the various needs of all of our members to ensure that we positively facilitate the capacity for, access to, and participation and experiences in CSEd research.

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