Paper ID #42526

Barriers to Conducting Primary and Secondary Computing Education Research.

Miss Isabella Gransbury, North Carolina State University
Monica M. McGill, Institute for Advancing Computing Education

Monica McGill is President & CEO of the Institute for Advancing Computing Education. Her area of scholarship is K-12 computing education research with a current focus on supporting computing education for all students and improving the quality of research.

Leigh Ann DeLyser

Barriers to Conducting Computing Education Research Through the Lens of the CAPE Framework

Isabella Gransbury White[1], Sarah Heckman[2], Monica M. McGill[3], Leigh Ann DeLyser[4], and Jennifer Rosato[5]

[1,2]North Carolina State University
[2]sarah_heckman@ncsu.edu
[3]Institute for Advancing Computing Education
[3]monica@csedresearch.org
[4]CSforAll
[4]leighann@csforall.org
[5]Northern Lights Collaborative
[5]jrosato@umn.edu

Abstract

Motivation. With the growth of primary and secondary computing education research (CER) comes challenges and barriers to conducting this research. Despite previous research investigating barriers to CER focused on diversity, equity and inclusion, there has not yet been an investigation of barriers to conducting CER through the equity lens of the Capacity, Access, Participation, and Experience (CAPE) Framework. Therefore, our project's objective for was to systematically examine the different levels of barriers that researchers in the primary and secondary CER community face when conducting research.

Research Questions. Our research questions were: RQ1) *What barriers do researchers face in the CER community when investigating the four components of CAPE (Capacity, Access, Participation, Experience)?*and RQ2) *What barriers do researchers face in the CER community when investigating marginalized groups in their research?*

Research Methods. We distributed a survey to over 1,500 authors of published CER that asked about the barriers they face when conducting research focused on K-12 computing education.

Results. Using thematic analysis, we were able to identify 20 barriers researchers face. The most common themes were funding, time/timing, access to research populations, and lack of CER for administrators. Another interesting result is that funding is the greatest barrier faced by all involved in primary and secondary CER, regardless of role.

Implications. Our findings provides insight into why there is minimal research studying certain

topics and groups. To address these barriers, the CER community can focus on creating materials, workshops, and professional development initiatives to inform researchers about resources as well as methods for mitigating these barriers.

1 Introduction

The addition of computer science (CS) into primary and secondary schools (K-12) had led to the growing field of K-12 computing education research (CER). This addition is still in its beginning stages, as is the research in K-12 CER. CER scholars, among other research, investigate educational outcomes for a wide range of students, including those historically underserved and marginalized within society as well as the educational system. However, it has previously been reported that research into CER has some growing pains, and the capacity of researchers for conducting research in this area has additional room for growth [1, 2]. Despite efforts being made to provide research resources and workshops to current K-12 computing education researchers [3, 4], previous studies have shown that there is a need for additional areas of study within in K-12 computing education for it to be comprehensive [5–7]. The CAPE Framework is a tool used to help individuals who play a role in CS education, such as educators, policymakers, and researchers, assess equity in CS ecosystems (see Figure **??**. It is comprised of four components, **Capacity**, **Access**, **Participation**, and **Experience** that build upon each other [8]. The main idea of the framework is that equity must be assessed at every level to exist in an entire entity.

An investigation of the barriers K-12 computing education researchers are facing through the lens of the CAPE framework can provide further insight into the types of research that exists and the research that still remains under examined. Accordingly, the main goal of this paper is **to investigate the barriers those in the K-12 CER are facing through an equity lens using the CAPE Framework**. The research questions answered in this paper are: *What barriers do researchers face in the CER community when investigating the four components of CAPE (Capacity, Access, Participation, Experience)?*and *What barriers do researchers face in the CER community when investigating marginalized groups in their research?*

2 Equity in CER and The CAPE Framework

The concept of equity was elevated by the broadening participation in computing movement, which sought out ”talented” students in underrepresented students in computer science at post-secondary institutions [9–11]. The goal of the movement has since shifted towards CS ”for all” more focused at the K-12 level [12, 13]. This shift began with a focus on changing systems put in place for CS education, instead of focusing on identifying students who best fit the systems [14]. A tool that has been developed by computing education researchers to establish equity in computing education is the CAPE Framework [8]. The CAPE Framework allows CS ecosystems to be developed through an equity lens, which includes the components **Capacity, Access, Participation**, and **Experience** [8]. Prior research using the CAPE Framework includes assessing CS in a high school extracurricular program [15], disaggregating schools’ initiatives for equitable CS education [16], and evaluating **Capacity** in K-12 CER literature [17].

The CAPE Framework can also be used as a framework for dissagregating an entity or ecosystems against equity outcomes across all four components [8]. Blikstein and Moghadam defined **Capacity** as the ”implementation considerations” related to ”systemic obstacles” as mechanisms for equitable CS education [18]. Research focusing on **Capacity** has found that district leaders have not had the training to define CS and sometimes have difficulty conceptualizing how broadening participation in computing and equity fit into their district plans [19]. The literature focused on capacity continues to grow to address the systemic barriers that affect education outcomes of historically marginalized populations in CS [20, 21].

The second component in CAPE, **Access**, is defined as student's access to courses, extracurricular activities and AP exams. Equitable Access means that these courses would be offered equitably across various subgroups and within and across schools, districts, and states[8]. The range of Access includes equitable access regardless of private or public status, Title I designation, urbanicity (rural, town, suburban, urban), and course admission policies (GPA, class standing, prerequisites). An example of an Access issue is a current trend in the United States where suburban schools are more likely (57%) to offer a CS course than rural (43%) schools [22]. Typically, literature about **Access** is included in studies about **Capacity**, but solely studying **Access** may shed light into why there are gaps within schools, districts, and states.

The third component, **Participation**, is defined as students' awareness of and enrollment in courses, extracurricular activities, and AP exams. Equitable Participation pertains to the diversity of student enrollment in courses, matching the diversity of the school [8]. Previous research on equitable Participation includes examining prevention of participation in high school CS courses [23] and the participation of girls in a CS after-school program [24]. A majority of the research conducted in Participation focuses on high school aged students compared to other age groups [25]. Therefore more research needs to be conducted in Participation investigating other age groups like middle school and K-5 to understand how many students know about CS opportunities in the community and their schools.

Experience, the final component of CAPE, relates to students' outcomes from CS courses and activities. Examples of these outcomes include cognitive gains, interest, and awareness of computing careers. Equitable Experience means that these outcomes are equitable across student subgroups [8]. Prior research in Experience investigated student content in an introductory CS courses [26–28], interest in computing [29], attitudes [24], and relevance of computing in the lives of underrepresented students [30]. Although this is the most studied component of CAPE, there are also gaps in areas that have been shown to impact academic achievement [31].

3 Research Methods

To answer our two research questions, we designed a survey, sent it to K-12 computing education researchers, and then analyzed the results.

3.1 Survey Design

We began our survey design by modifying the survey used by McGill et al. due to its similar nature of exploring barriers in CER [32]. Our survey differs by explicitly considering barriers in K-12 computing education.

Our survey had four primary sections: Research Background, CAPE Research Focus, Barriers to Conducting Research, and Participant Demographic Characteristics. In the Research Background section participants were asked what age and school group they conducted research with, what role(s) they identified as in the K-12 CER community, and what communities (e.g. Historically Marginalized Racial Groups) they investigated in their country. In the CAPE Research section, we asked participants to complete four matrix style questions (each corresponding to a CAPE component) to identify their research experiences with each CAPE component[17]. Participants were instructed to select statements, such as Published manuscript(s) in this area, invited to contribute in this area, etc for each question.

Participants were also asked to complete two open-ended questions. The first asked participants about barriers they were experiencing when conducting K-12 CER. The second asked participants what barriers they were experiencing when publishing K-12 CER (if they had had a manuscript rejected). Finally, participants were asked questions about their self-identified demographics. This included gender, location, and race/ethnicity. Before distribution our survey showed evidence of internal face validity, having gone through intensive review by highly experienced K-12 computing education researchers in our research group. Our survey also showed evidence of external face validation through think aloud interviews with computing education researchers with various experience levels in K-12 CER. A change made from the think aloud interviews included adding more specific definitions of each CAPE component and more specific language for the open ended question prompts.

3.2 Participant Recruitment

We distributed our survey to the CER community through the ACM SIGCSE, IEEE Collaboretec Forum, NSF INCLUDES forum, and CSTA Discussion Forum. We also recruited participants from the CS Graduate Student and CSforALL slack channels. Finally, we emailed 889 authors of published K-12 CER literature from the publicly available article database on the K-12 Computing Education Research Resource Center [25]. The survey was distributed on January 4th, 2023 and closed on January 25th, 2023. If participants completed the survey and gave their email address, they were entered into a random drawing for one of four $50 dollar gift cards.

3.3 Participants

For a participant's response to be included in the final analysis, the participants had complete the open-ended barrier question in the survey. Overall we received 214 survey responses with 95 of these fully completed and included in the analysis. In Tables 1 and 2 we show the gender, race, and ethnicity of study participants. In Table 3, we display the years of experience the participants had in investigating CER. The responeses indicate that most of the participants had moderate to high experience, with more 50% having between 4 to 10 years of experience.

3.4 Thematic Analysis

To identify the barriers of conducting (and publishing) K-12 CER, we analyzed open-ended questions using thematic analysis [33]. First, participant responses were tagged using emergent coding by two researchers independently. Then, the researchers met after coding to remedy any disagreement or inconsistencies in their codes. Next, the two researchers grouped their codes together to develop themes. This process resulted in 19 themes - or barriers - to conducting K-12 CER (see Table 4).

4 Results

In this section, we describe the results of our survey with respect to our research questions: *What barriers do researchers face in the CER community when investigating the four components of*

Table 1: Self-identified gender of participants.

Gender	Count of Participants
Prefer not to say	33
Cisgender Woman	43
Cisgender Man	16
Non-Binary	3

Table 2: Self-identified race and ethnicity of participants.

Race/Ethnicity	Count of Participants
White	41
South Asian	9
Hispanic	7
East Asian	6
Black	4
Southeast Asian	2
Middle Eastern	2
Prefer not to say	24

Table 3: Experience (years) of participants in the CER community.

Years of Experience	Count of Participants
1 year (this is my first year)	4
2-3 years	18
4-5 years	26
6-10 years	28
11-15 years	11
16-25 years	7
More than 25 years	1

CAPE (Capacity, Access, Participation, Experience)?, and *What barriers do researchers face in the CER community when investigating marginalized groups in their research?*.

4.1 RQ1:Barriers And CAPE

There were four common barriers identified across all components of the CAPE Framework: Access to Research Populations, Resistance of Administrators, Funding, Research Interest, Low Study Participation, and CS Teacher Aspects. In Table 4, we show the count and percent of participants who discussed the most common barriers for each component of the CAPE framework (Capacity, Access, Participation, and Experience).

For those who conduct Capacity research, the most common barriers were Funding (52%), Time/Timing (19%), Access to Research Populations (14%), and Lack of Admin Training in CER (24%). The most common barriers for Accesses researchers were Funding (46%), Time/Timing (37%), Access to Research Populations (28%), and Lack of Admin Training in CER (26%).

Next, for those who conduct Participation research, the most common barriers were Funding (51%), Time/Timing (43%), Lack of Admin Training in CER (30%), and Access to Research Populations (24%). Finally, when conducting Experience research, the most common barriers were Funding (46%), Time/Timing (39%), Lack of Admin Training in CER (27%), and Access to Research Populations (24%).

Table 4: Count and percentage of participants who discussed each barrier in their survey and the CAPE component(s) they investigate in their research.

	Capacity		Access		Participation		Experience	
Barrier	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Acceptance of CER	5	10%	3	7%	4	11%	3	7%
Acceptance of Methods	5	10%	5	11%	5	14%	5	12%
Access To CS Resources	2	4%	2	4%	2	5%	2	5%
Access To Research Populations	14	28%	13	28%	9	24%	10	24%
COVID	3	6%	3	7%	2	5%	3	7%
CS Teacher Aspects	5	10%	5	11%	3	8%	6	15%
Curriculum	2	4%	2	4%	2	5%	4	10%
Data Not Accessable	4	8%	4	9%	4	11%	4	10%
Equity Variations	1	2%	1	2%	1	3%	1	2%
Funding	26	52%	21	46%	19	51%	19	46%
Language	1	2%	1	2%	1	3%	2	5%
Low Study Participation	8	16%	8	17%	8	22%	8	20%
Publishing Challenges	6	12%	5	11%	4	11%	5	12%
Research Ethics Approval	8	16%	8	17%	4	11%	6	15%
Research Interest	7	14%	7	15%	4	11%	7	17%
Lack of Admin Training in CER	12	24%	12	26%	11	30%	11	27%
Social-Familial Influences	4	8%	3	7%	3	8%	4	10%
State Policies	2	4%	0	0%	0	0%	0	0%
Time / Timing	19	38%	17	37%	16	43%	16	39%

4.2 RQ2: Barriers of Research Investigating Equity Groups

In Table 5, we show the percent of participants who investigate student groups (Rural students, students with disabilities, bilingual students, students of historically marginalized races, students of historically marginalized genders, and school socioeconomic status) and the barriers they face when conducting their research.

For participants that investigate rural students, students with disabilities, students of historically marginalized races, students of historically marginalized genders, and school socioeconomic status the most common barrier is Funding. While Time/Timing is the barrier with the highest percentage for participants that investigate bilingual students.

Closer inspection of results shows that researchers investigating students of historically marginalized races and school socioeconomic status are faced with all 19 barriers identified from thematic analysis of the survey responses. This indicates that these researchers can face a broader range of barriers when conducting research than others.

However, when taken together, these results indicate that all groups identify with more than three quarters of the barriers found in survey responses. This speaks to a larger barrier in the K-12 CER community of conducting research designed to focus on underrepresented populations. These results seem to be consistent with other research investigating barriers CER researchers face when

Table 5: Percentage of participants who discussed each barrier in their survey and the student groups they investigate.

Themes	Rural	Disabilities	Bilingual	Race	Gender	SES
Acceptance of CER	3%	4%	0%	5%	5%	4%
Acceptance of Methods	6%	0%	0%	6%	8%	7%
Access To CS Resources	6%	0%	3%	1%	0%	3%
Access To Research Populations	19%	12%	16%	9%	11%	12%
COVID	3%	8%	6%	4%	5%	3%
CS Teacher Aspects	9%	0%	0%	3%	5%	5%
Curriculum	6%	0%	6%	3%	0%	3%
Data Not Accessable	0%	0%	0%	4%	3%	3%
Equity Variations	3%	0%	0%	1%	2%	1%
Funding	31%	54%	16%	28%	34%	25%
Language	6%	4%	3%	1%	2%	3%
Low Study Participation	13%	12%	6%	6%	8%	8%
Publishing Challenges	3%	0%	0%	5%	5%	3%
Research Ethics Approval	3%	4%	6%	5%	6%	4%
Research Interest	6%	8%	3%	8%	6%	4%
Lack of Admin Training in CER	9%	8%	16%	5%	6%	11%
Social-Familial Influences	6%	4%	0%	3%	3%	5%
State Policies	3%	0%	0%	1%	2%	3%
Time / Timing	16%	31%	29%	18%	23%	13%

conducting research [32].

5 Discussion

The goal of this study was to investigate the barriers researchers in the K-12 CER community are facing using the CAPE framework. We identified 19 barriers through thematic analysis of participant responses from a survey that assesses the barriers people face when conducting K-12 CER. We determined the barriers researchers face when investigating the four components of CAPE and when investigating underrepresented student groups in the K-12 CER community from our analysis.

Our first finding indicates that those who investigate Capacity, Access, Participation, and Experience all have similar barriers. These are Funding, Time/Timing, Access to Research Populations, and Lack of Admin Training in CER. This gives the community insights into which barriers need to be addressed so there can be further growth of research in critical areas of building a CS education ecosystem for all students.

Our second finding indicates the barrier of Funding is the greatest barrier faced by all involved in K-12 CER, regardless of role. We hypothesize there is a need for more funding in K-12 CER that is not being met. It is also possible this may be due to funding resources for K-12 CER not being widely known. In general, more funding is needed for computer science holistically in schools, not just for research purposes.

Our final finding indicates those who investigate students of historically marginalized races and school socioeconomic status face the largest range of challenges. This is not meant to discount investigations in other student groups but to shine a light on the difficulties these researchers are facing.

In summary, we have found several barriers to conducting K-12 CER that are affecting the quality and quantity of work in K-12 CER. This work brings attention to the challenges researchers are facing and issues we need to address as a community to have equitable and holistic research in our corpus.

5.1 Limitations

This study is limited by the relatively small sample size of 95 participants. However, there are many valuable insights into how to improve the quantity and variety of research in the K-12 CER community. Another limitation of this study is the lack of detail in many of the participant responses. We recommend distributing the survey to the community at a different time, possibly during a heavily attended event, for an increase in responses.

6 Conclusion

This study was designed to determine the barriers researchers face when conducting K-12 CER. We were able to identify 19 different barriers using thematic analysis on participant survey responses. Our findings give members of the K-12 CER community information on why there is a low amount of research studying certain topics and groups and indicate that funding is the most common barrier for all roles in the community. To address these barriers, we suggest creating materials, workshops, and professional developments to specifically inform the community about resources and methods to mitigate these barriers.

This research expands our knowledge on problems that affect the quantity of research in K-12 CER and the challenges of those conducting research on underrepresented communities in CS. The findings of this research will be useful to the entire CER community that wish to conduct research in K-12 CS settings and for those who want to create materials and professional developments for the CER community. Future research involves diving deeper into the different components of the CAPE framework to determine barriers facing specific topics in the areas of Capacity, Access, Participation, and Experience.

Acknowledgements

This material is based upon work supported by the U.S. National Science Foundation under Grant Nos. 2122212.

References

[1] Ahmed Al-Zubidy, Jeffrey C Carver, Sarah Heckman, and Mark Sherriff. A (updated) review of empiricism at the sigcse technical symposium. In *Proceedings of the 47th ACM Technical Symposium on Computing Science Education*, pages 120–125, 2016.

[2] Monica M McGill, Adrienne Decker, and Zachary Abbott. Improving research and experience reports of

pre-college computing activities: A gap analysis. In *Proceedings of the 49th ACM Technical Symposium on Computer Science Education*, pages 964–969, 2018.

[3] Sarah Heckman, Jeffrey C. Carver, Mark Sherriff, and Ahmed Al-zubidy. A systematic literature review of empiricism and norms of reporting in computing education research literature. *ACM Trans. Comput. Educ.*, 22 (1), oct 2021. doi: 10.1145/3470652. URL `https://doi-org.prox.lib.ncsu.edu/10.1145/3470652`.

[4] Monica M McGill, Jake Baskin, Miles Berry, Quinn Burke, Leigh Ann Delyser, Shuchi Grover, Colleen Lewis, Briana B Morrison, and Davina Pruitt-Mentle. K-12 computing education and education research resources. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education V. 2*, pages 1033–1033, 2022.

[5] Monica M McGill and Adrienne Decker. A gap analysis of statistical data reporting in k-12 computing education research: Recommendations for improvement. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, pages 591–597, 2020.

[6] Monica M McGill, Tom McKlin, and Errol Kaylor. Defining what empirically works best: Dynamic generation of meta-analysis for computer science education. In *Proceedings of the 2019 ACM Conference on International Computing Education Research*, pages 199–207, 2019.

[7] Bishakha Upadhyaya, Monica M McGill, and Adrienne Decker. A longitudinal analysis of k-12 computing education research in the united states: Implications and recommendations for change. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, pages 605–611, 2020.

[8] Carol L Fletcher and Jayce R Warner. Summary of the cape framework for assessing equity in computer science education, 2019. URL `Retrieved from https://www.tacc.utexas.edu/epic/research`.

[9] Susan Bergin and Ronan Reilly. Programming: factors that influence success. In *Proceedings of the 36th SIGCSE technical symposium on Computer science education*, pages 411–415, 2005.

[10] Pat Byrne and Gerry Lyons. The effect of student attributes on success in programming. In *Proceedings of the 6th annual conference on Innovation and technology in computer science education*, pages 49–52, 2001.

[11] Marcos Román-González, Juan-Carlos Pérez-González, Jesús Moreno-León, and Gregorio Robles. Can computational talent be detected? predictive validity of the computational thinking test. *International Journal of Child-Computer Interaction*, 18:47–58, 2018.

[12] W Richards Adrion, Sarah T Dunton, Barbara Ericson, Renee Fall, Carol Fletcher, and Mark Guzdial. Us states must broaden participation while expanding access to computer science education. *Communications of the ACM*, 63(12):22–25, 2020.

[13] Education Development Center. Broadening participation in computer science education: Why is it important to address issues of equity in computer science (cs) education?, 2020. URL `https://edc.org/sites/default/files/uploads/CSEdBrief.pdf`.

[14] Jill Denner and Shannon Campe. Equity and inclusion in computer science education: Research on challenges and opportunities. *Computer Science Education: Perspectives on Teaching and Learning in School*, page 85, 2023.

[15] Monica M McGill, Eric Snow, and April Camping. A theory of impacts model for assessing computer science interventions through an equity lens: Identifying systemic impacts using the cape framework. *Education Sciences*, 12(9):578, 2022.

[16] Expanding Computing Education Pathways. Three models driving ecep & ecep state efforts., 2020. URL `https://ecepalliance.org/news/three-models-driving-ecep-ecep-state-efforts`.

[17] anonymous. anonymous. In *anonymous*, anonymous.

[18] Paulo Blikstein and Sepi Hejazi Moghadam. Pre-college computer science education: A survey of the field. 2018.

[19] Rafi Santo, Leigh Ann DeLyser, June Ahn, Anthony Pellicone, Julia Aguiar, and Stephanie Wortel-London. Equity in the who, how and what of computer science education: K12 school district conceptualizations of equity in 'cs for all'initiatives. In *2019 research on equity and sustained participation in engineering, computing, and technology (RESPECT)*, pages 1–8. IEEE, 2019.

[20] June Ahn and B Quarles. Technology and education in the united states: Policy, infrastructure, and sociomaterial practice. In *Convergence: US Education Policy Fifty Years After the ESEA and the HEA of 1965*. Harvard Education Press, 2016.

[21] Anthony S Bryk, Louis M Gomez, Alicia Grunow, and Paul G LeMahieu. *Learning to improve: How America's schools can get better at getting better*. Harvard Education Press, 2015.

[22] CSTA & ECEP Alliance Code.org. State of Computer Science Education: Illuminating Disparities, 2020.

[23] Ryan Torbey, Nicole D Martin, Jayce R Warner, and Carol L Fletcher. Algebra i before high school as a gatekeeper to computer science participation. In *Proceedings of the 51st ACM technical symposium on computer science education*, pages 839–844, 2020.

[24] Dana McFarlane and Elissa M Redmiles. Get paid to program: Evaluating an employment-aware after-school program for high school women of color. In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*, pages 212–218, 2020.

[25] Monica M. McGill and Adrienne Decker. Computer science education resource center, 2017. URL `https://CSEdResearch.org`.

[26] Mazyar Seraj, Eva-Sophie Katterfeldt, Serge Autexier, and Rolf Drechsler. Impacts of creating smart everyday objects on young female students' programming skills and attitudes. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, pages 1234–1240, 2020.

[27] Monique M Jethwani, Nasir Memon, Won Seo, and Ariel Richer. "i can actually be a super sleuth" promising practices for engaging adolescent girls in cybersecurity education. *Journal of Educational Computing Research*, 55(1):3–25, 2017.

[28] Lauren E Margulieux, Briana B Morrison, Baker Franke, and Harivololona Ramilison. Effect of implementing subgoals in code. org's intro to programming unit in computer science principles. *ACM Transactions on Computing Education (TOCE)*, 20(4):1–24, 2020.

[29] Kirsten Mork, John Wilcox, and Zoë Wood. Creative choice in fifth grade computing curriculum. In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*, pages 252–258, 2020.

[30] Madeline Hinckle, Arif Rachmatullah, Bradford Mott, Kristy Elizabeth Boyer, James Lester, and Eric Wiebe. The relationship of gender, experiential, and psychological factors to achievement in computer science. In *Proceedings of the 2020 ACM conference on innovation and technology in computer science education*, pages 225–231, 2020.

[31] Monica M McGill, Angelica Thompson, Isabella Gransbury, Sarah Heckman, Jennifer Rosato, and Leigh Ann Delyser. Building upon the cape framework for broader understanding of capacity in k-12 cs education. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1*, pages 577–582, 2023.

[32] Monica M McGill, Sloan Davis, and Joey Reyes. Surfacing inequities and their broader implications in the cs education research community. In *Proceedings of the 2022 ACM Conference on International Computing Education Research-Volume 1*, pages 294–308, 2022.

[33] Moira Maguire and Brid Delahunt. Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education*, 9(3), 2017.