Forging a Path: Faculty Interviews on the Present and Future of Computer Science Education in the United States

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Computer science education (CSEd) is a growing interdisciplinary area that continues to gain momentum from students, researchers, and educators. Yet, there are few formal programs or degree options for students interested in pursuing graduate work in CSEd. This article explores the existing state of CSEd in the United States (U.S.) through semi-structured interviews with (n = 15) faculty engaged in CSEd research. Thematic coding of the transcripts revealed the complexities involved in the development of formal programs, the distinct considerations for faculty, and the value of having strong ties to both computer science and education. The themes described positive aspects of support and cohesion within the larger community and opportunities to expand knowledge across fields. Applying Cornell and Parker's principles of interdisciplinary science to the field of CSEd, we provide recommendations for ways forward and discuss the potential impact on institutional structures, research capacity, individual and group identities, and teaching and learning. The findings from this investigation not only inform on the present state of CSEd in the U.S., but also offer guidance for CSEd-focused graduate programs.

CCS Concepts: • **Social and professional topics → Computer science education;**

Additional Key Words and Phrases: Computing education, Computer science education, CSEd research

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1 INTRODUCTION

Computer science education (CSEd) continues to grow as a distinct and highly interdisciplinary field [25, 36, 39, 51]. CSEd researchers exist across a kaleidoscope of domains, departments, and schools such as education, learning sciences, social sciences, engineering, and computing—which

51

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we consider as encompassing computer science (CS), information science (IS), and information technology (IT) [27, 29, 51]. As a result of the diverse backgrounds and expertise of those involved, there are also differing ontologies, epistemologies, and methodologies employed by researchers [4, 27].

The diversity of disciplines involved in CSEd has led to a growth in the types of research pursued within the field. Research has expanded beyond the development of CS curricula and assessment of pedagogical approaches and learning progressions in university level computing courses [28, 48, 51, 61]. More recently, CSEd research has also focused on examining other topics such as mechanisms to broaden participation in computing, computational thinking and use of computing tools to enhance learning, and areas of CS with the potential to broadly impact society (e.g., artificial intelligence, human-computer interaction, security, privacy, and ethics) [14, 19, 48, 61, 66].

In addition to the diversification of topics explored, over time, there has been a heightened investment in CSEd as its own field of study and an increase in the number of PhDs conducting research in CSEd [28]. For CSEd-centric graduate students, their teaching, learning, and community are distinct from those with a monodisciplinary focus in CS or those solely concerned with teaching computing. Yet, few (if any) formal graduate programs exist in the United States (U.S.). To explore the pathways of CSEd graduate students and the faculty that advise them, we conducted semi-structured interviews with 15 faculty from 4 PhD-granting institutions. We sought to answer the following research questions (RQs):

- **RQ1:** What factors motivate faculty to pursue research, teaching, advising of graduate students, and learning in CSEd?
- **RQ2:** What personal, curricular, and institutional obstacles do researchers focused on CSEd encounter?
- **RQ3:** What makes advising graduate students in the interdisciplinary area of CSEd unique?

While other scholars have discussed the benefits, challenges, and considerations of interdisciplinary research and programs more broadly [11, 20, 31, 41, 47], our work focuses on addressing the current state of CSEd. We acknowledge that the term "computer science education research" includes a broader area and has been used interchangeably with computing education and information technology education. We use CSEd deliberately, in alignment with our focus on higher education in the United States.

Although we are not the first scholars to consider how to support and grow the CSEd research community [19], this investigation offers a new perspective from the vantage point of well-regarded faculty from different departments and institutions. Our study advances the field by identifying the distinctive needs of CSEd advisors and it provides insight into opportunities in the discipline. We also consider the issues affecting interdisciplinary knowledge communities, as described by Cornell and Parker [20], in the context of CSEd. In particular, this includes addressing concerns related to institutional structures, individual and group identities, teaching and learning, and research capacity.

In the rest of the article, we first present the framework for this work and relevant background information in Section 2. We then describe the methods employed, including the interviews and their analysis in Section 3. We present the results of the work in Section 4, and then discuss what these findings could mean in Section 5. Next, we present the limitations in Section 6. Finally, in Section 7, we present our conclusions.

2 FRAMEWORK AND BACKGROUND

CSEd is a form of **discipline-based education research (DBER)**, which refers to research that "integrates the disciplinary knowledge and practices employed by scientists and engineers with

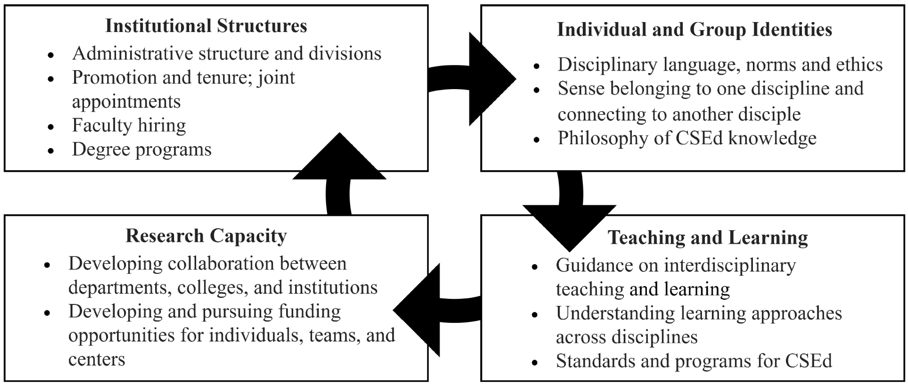

Fig. 1. Interdisciplinary experience considerations for CSEd, adapted from [20].

research on human learning and cognition to address the needs of STEM education" [8, p. 3]. Some examples of other DBERs are mathematics education, physics education, chemistry education, and **engineering education research (EER)** [21].

Unlike some other DBERs which tend to be centralized within a college (e.g., physics education), CSEd researchers often exist in many departments and schools. They often belong to CS, education, and/or engineering education and computing education topics may be integrated into curricula through the humanities, science, or mathematics [19]. Given the placement of CSEd in higher education, our research explores what unique issues faculty face for their research, teaching, and mentoring of graduate students.

To situate our study pertinent for developing the field of CSEd, we apply Cornell and Parker's [20] model for interdisciplinary research (Figure 1). This framework accounts for the needs of the community and knowledge integration which may shape the academic experience. It considers the "known issues with interdisciplinarity that often yield self-reinforcing virtuous (or vicious) cycles" in terms of institutional structures, individual and group identities, teaching and learning, and research capacity. We employ these same divisions within the context of CSEd and describe each sub-component further as applicable in the sections that follow. Our intent is to better understand how these sub-components interact and the experiences which may affect those engaged with this interdisciplinary field. This focus propelled the choice of methodology and the decision to conduct semi-structured interviews with CSEd faculty.

2.1 Institutional Structures

We consider institutional structures as the scaffolding which may influence a researcher's appointment within departments of institutions and the professional opportunities such affiliations may afford. These structures can have a number of implications for educators and students, from oversight of degree programs to hiring opportunities [49]. For graduate students in a DBER discipline, institutional structures may affect degree requirements, advisors, and eventually career options. For faculty, this includes the administrative structure and divisions that shape their professional experience. It involves not only where they are hired and the potential for joint appointments, but also the expectations for promotion and tenure.

Previously, Borrego et al. [11] articulated the challenges inherent in interdisciplinary graduate education, such as challenges surrounding departmental ownership of graduate courses, advisor eligibility, and "a need for external monetary support in addition to and beyond NSF funding" [11, p. 871]. Additionally, they mentioned the necessity of addressing concerns that, for faculty, resources and incentives are often structured around contributions to a specific discipline and can influence promotion and tenure through the need for publications. To work to ameliorate these challenges, they argued for the need to address organizational structures along with the values that define the culture in the field. They emphasized how change requires collaboration across disciplinary and departmental boundaries, consideration of policies and norms, and building "supportive allies to effect first normative and eventually cultural-cognitive change" [11, p. 880]. While such suggestions may generalize to CSEd-focused faculty, we sought to confirm and expand on these findings to obtain a better understanding of the professional, political, and social implications of conducting CSEd research in the absence of designated departments.

In this article, we frame our semi-structured interview questions broadly to learn about the academic departments which may support students engaged in CSEd research and the future plans for development at the institutions (see the appendix for a complete list of items included in the protocol). While our inquiry does touch on the administrative structure and divisions, we do not focus on the nuances of individual units or appointments. However, we do consider how faculty affiliations can impact promotion and tenure, new faculty hiring, and degree programs.

2.2 Individual and Group Identities

Individual and group identities refers to the components that can define connections to a field. For doctoral students, interactions and experiences can shape their sense of belonging to a particular discipline, or across disciplines. Students' development into independent scholars shifts throughout the course of their program as they socialize and engage in "scholarly acitivies" [30, p. 28]. Often advisors play a critical role in this development, guiding students on their path to a career and providing psychosocial mentoring (e.g., encouragement) [52], which can also influence persistence in programs [9, 32].

Advisors are not the only influence on students' identity. Instruction and coursework [71], and networking with peers, professors, and other faculty [16], can also impact students' disciplinary knowledge and connections made during the doctoral program. For those looking to pursue a career in academia, observations of faculty members and their interactions with others in the department may inform ideas about expectations and values [7, 22].

Meanwhile, the collective (i.e., group) identity for the field includes establishing disciplinary language, norms, and ethics for the community and building the philosophy of DBER knowledge. This entails integrating knowledge across disciplines to define approaches to learning and research. Group identification with standards and disciplinary knowledge is also articulated and defined through acceptance in peer-reviewed publications.

Publications in CSEd tend to span multiple areas, departments, and institutions [26]. Given the interdisciplinary nature of the field, publications exist in a range of venues. There are CSEd-focused journals such as ACM Transactions on Computing Education (TOCE), IEEE Transactions on Education (ToE), or the Computer Science Education Journal (CSEJ) [3, 27, 35, 39]. Researchers also publish at CSEd-specific ACM conferences like the Technical Symposium on Computer Science Education (SIGCSE TS), the International Symposium on Computing Education Research (ICER), and the conference on Innovation and Technology in Computer Science Education (ITiCSE), or at the Computer Science Education Research Conference (CSERC) or Koli Calling [3, 77]. Additionally, CSEd researchers may publish in alternative venues such as TechTrends, Computers and Education, IEEE Frontiers in Education (FIE), the American Society for Engineering Education (ASEE) conferences, the Psychology of Programming Interest Group (PPIG), or the American Council on Education (ACE), among others, reflective of their home department and familiarity [27, 44]. Over time, these conferences have expanded in offerings and scope, to share knowledge on "what to teach and how to teach computer science, with a large focus on introductory programming and more recently on computing in K-12" [64, p. 24].

While publication outlets and professional societies can contribute to developing a group identity for the field, we sought to cultivate a deeper understanding of individual and group identities in terms of the CSEd philosophies that faculty believe are needed to establish disciplinary knowledge. We also describe the community, within an institution and more broadly, to learn about faculty perceptions of a sense of belonging.

2.3 Teaching and Learning

The needs of graduate education in CSEd varies with respect to teaching and learning as faculty and students typically have different backgrounds including CS, education, and the social sciences. Researchers in other DBER fields have argued that [42, 63] drawing on the research of Lev Vygotsky, Jean Piaget, Jerome Bruner, Benjamin Bloom, and other scholars that have influenced education can offer models for teaching, learning, and practice. Consideration of varied pedagogical approaches and styles can help tailor curricula to the needs of diverse populations of students to help them develop knowledge and skills. To achieve learning goals, it has been suggested that teams of teachers from different engineering disciplines should collaboratively work to construct problems and projects [74]—advice that can be beneficial for CSEd as well.

Interdisciplinary teaching and learning can have unique ramifications for students, their experiences, and for mentoring. Researchers have emphasized that often a curriculum is described as interdisciplinary when it actually is multidisciplinary, drawing on different perspectives without "any support for the integration of disciplinary knowledge throughout the curriculum" [69, p. 266]. As a result, students may struggle to develop an understanding and necessary interdisciplinary skills without "specific support and learning tasks" and proper scaffolding [69].

A global report on the current state-of-the-art in EER illustrated the difficulty of finding ways to measure how much students are learning [31]. Interviewees also described "the paucity of reliable and comparable data by which the quality of an institution's education could be assessed" [31, p. 14]. Instead, educational impact quality was often measured using metrics like staff-to-student ratios or statistics on graduate employment, a concern which may be further exacerbated in CSEd in the absence of formal programs or departments in the U.S.

Standards and programs to define what and how interdisciplinary CSEd content is taught should be considered separately from the monodisciplinary area of CS. Given that students and faculty focused on CSEd research may have distinct needs, more information about preferred learning approaches and courses could be beneficial to this population. In our investigation, we seek to provide an updated view of faculty perspectives on what this could entail.

2.4 Research Capacity

Within the context of research capacity, we consider developing collaborations between departments, colleges, and institutions; and developing and pursuing funding opportunities for individuals, teams, and centers. While competition is considered valuable from the perspective of driving innovation, it has been suggested that collaboration is imperative to addressing larger societal issues and can be especially valuable when approached through an interdisciplinary perspective [75].

As with other fields, CSEd still requires additional development. Evaluation of publications at CSEd venues, specifically ITiCSE, ICER, and TOCE, illustrated a predilection for regional or national collaborations, rather than international [53]. In particular, ACM CSEd venues also demonstrated a need to expand collaboration networks beyond North America [53, 77]. It is unclear how CSEd researchers seek out partnerships, or what barriers may exist within institutions when working with faculty in other fields, something we sought to further understand through our study.

3 METHODS

Qualitative research can play an important role in investigating social phenomena in CSEd [37]. In this study, interview transcripts were analyzed using thematic analysis. Thematic analysis is a research methodology that structures qualitative data into themes corresponding to a particular research question [13]. The theme is the outcome based on the categorization of the codes themselves [65]. Thematic analysis is a valuable data analytic technique to examine the perspectives of varied participants and to obtain insight [58].

3.1 Participants

To understand the present and future of CSEd, the last two authors collaboratively conducted semi-structured interviews with CSEd faculty from four different public higher education institutions. All the faculty belonged to institutions with an R1 designation. This designation implies that, apart from their focus on teaching, the Carnegie Commission on Higher Education classifies them as doctoral institutions that have "very high" research activity [54, 73]. The institutions were chosen to reflect geographic diversity. They were also selected based on their research capacity, taking into account rankings determined by the number of CSEd publications each institution has had over the last 6 years [50, 53]. This criteria was included since these numbers were reflective of recent activity in the discipline.

The interviewees were established CSEd researchers in the field [50]. All participants involved signed a consent form and agreed to have their interviews recorded for later analysis. In these interviews, there was a total of 15 participants, 7 men and 8 women (based on the faculty members' self-references). In addition to belonging to CS departments (7), faculty interviewed also resided in education (5) and engineering education (3). They were either on the research track (tenured or tenure-track) or on the teaching track at their institutions. The majority of them were tenured (10).

3.2 Data Collection

A total of 12 interviews were conducted between August and November of 2020 (NOTE: Some faculty from the same institution were interviewed together). The interview time ranged between 32 minutes and 54 minutes, with an average of 46 minutes. The interviews were conducted and recorded through Zoom.

The appendix contains the questions asked during the semi-structured interviews. The interviewers first began by asking about the participants' backgrounds and pathways to CSEd research or programs. Questions then shifted to focus on components from Cornell and Parker's framework, seeking to elicit their conceptions and to learn more about their institutional structure. Follow-up prompts were asked to obtain more details when appropriate. Lastly, we inquired about whether or not their institution planned to develop a formal CSEd graduate program.

3.3 Data Analysis

Audio recordings of the interviews were captured using Zoom and transcribed using Otter. The transcripts were also manually validated. The qualitative validation and analysis were completed by the first two authors using NVivo (version 12).

These authors applied systematic guidelines previously established for qualitative research and thematic analysis [34, 55, 58]. First, they independently familiarized themselves with the data by listening to all of the recordings. In parallel, they also read through the transcripts of interviews, using an iterative process to determine provisional codes. With each round of review (three in total), they clarified codes observed in the initial phase and removed any that were insufficient to address the research questions. Then, to further refine the codes and solidify their interpretation of them, the authors tentatively coded one transcript.

Afterwards, the coders employed peer debriefing and discussed their codes, their interpretations, and how each had labeled sentences. After negotiating until they reached a consensus agreement [55], they established their codebook, which included a total of 48 codes. Then, they separately coded the transcripts. They obtained a Kappa statistic of 0.7428 and an inter-rater reliability of 88.51%. This Kappa value is considered a "substantial agreement" (per Landis and Koch) [46].

Upon completion, these same two coders independently established tentative themes, diagramming to make sense of potential connections between codes. They then met to discuss and agree on the categorization they had established. Together, the researchers collectively finalized the emergent codes into themes, collapsing items along their dimensions of similarity. Items were not grouped based on the number of occurrences, but rather, the hierarchy corresponded to the factors involved in faculty and students' pathways in CSEd. In total, seven themes emerged from the complete set of codes. We present the codes themselves, the count of their appearances in the transcripts, the themes identified, and their definitions in Table 1.

3.4 Positionality

Previously, scholars have described how power relations in education, pedagogical foci, and social experiences can impact qualitative research [67, 76]. Given the nature of the content and that interpretation may be sensitive to individual experiences and unique perspectives, we feel it is important to disclose the elements of the researchers' backgrounds that could influence the communication and analysis. At the time of the interviews, the two researchers that conducted the interviews were a Professor of Computer Science in the Department of Computer Science and a Professor of Educational Psychology & Educational Technology in the College of Education. As such, they were able to build a rapport with the faculty interviewed, having experience in the realm of CSEd and familiarity with supporting graduate students conducting research within the discipline. They also had an understanding of the interdisciplinary nature of CSEd, the obstacles faced, and the distinctive pathways of students and faculty.

The two researchers who led the analysis both conducted research in the area of CSEd. One was a postdoctoral fellow who recently graduated from a CS department, and the other was a non-tenure track teaching faculty member serving in a CS department who was completing an advanced degree in education. Accordingly, both were more familiar with the unique nature of the field, coursework, and other aspects of the graduate student pathway and had less familiarity with some of the political barriers and challenges faced by tenured faculty.

4 RESULTS

We applied thematic analysis to explore faculty perceptions of the pathways for graduate students. In the sections that follow, we discuss each of the seven themes that emerged across the codes: Cohesion, Uniqueness, Obstacles, Faculty Commitments, Student Responsibilities, Opportunities, and Moving Forward. We would like to note that, given the bias towards personal narrative in the responses, we focus on defining aspects representative of the theme rather than presenting them based on the codes' counts.

4.1 Cohesion

The theme of cohesion refers to how faculty or graduate students conducting research in CSEd may have established their own community on campus, or across institutions, to share knowledge and develop their understanding. Faculty frequently formed collaborations with faculty in other disciplines, departments, or institutions to reconcile their needs and those of their students. Our

Table 1. Codes and their Counts, Along with Resultant Themes

Theme	Code	Description	Count
Cohesion	Community for Faculty	Refers to the need/relevance of creating a community for faculty working in CSEd	69
	Specialized Program Related to CSEd	May not be a CSEd program at university specifically but they offer a pathway that is similar or distinct from traditional CS or education (Ed) degree	40
	Benefits of Program	Benefits of the program that currently exists, which is not a traditional CS or education pathway but also not a CSEd pathway	37
	Community for Students	Refers to students feeling like they have support and a community to lean on	17
	Research Group CSEd	Relevance and importance of having a group where students and/or faculty are connected	7
Uniqueness	CSEd Coursework Needs	The classes that are needed for CSEd students to develop skills in the field	72
	Distinction between CS and CSEd	Differences in interests of CS and CSEd students and/or department	58
	CSEd Contributions to Field	Refers to contributions made, or things that are accepted as contributions that are different than other areas	46
	Distinction between Ed and CSEd	Differences in interests of education and CSEd students and/or departments	28
	Distinction from Engineering Ed	Differences in interests of engineering education and CSEd students and/or departments	28
	Distinction between CS and Ed	Differences in interests of CS and education students and/or departments	26
	Interest in Education	Refers to students' interest in education	17
	Different Student Interests	The unique foci of students in CS, education, and/or CSEd	7
Obstacles	Career Pathways - Concerns	Refers to concerns about what PhD students can do after graduation	42
	Lack of Community	Refers to feelings of isolation or not having a community for CSEd students	16
	Financial Concerns	Professors' lack of funding or worries about how to pay for graduate students	15
	Lack of Visibility	Refers to program or opportunities not being well advertised or known about	9
	Research Non-CSEd	Non-CSEd focused research being undertaken by professor or in the lab	9
	Hiring Faculty Not in CSEd	Refers to hiring made by the school for a non-CSEd role such as engineering education faculty	7
	Hiring for CSEd Faculty - No	When the university is NOT looking to hire more faculty specifically in CSEd	7
	Barriers to Engineering or STEM Education Path	Refers to obstacles faced in the engineering or STEM education path	6
	Career Pathways - Unknown or Unspecified	Refers to uncertainty surrounding a career in CSEd	8
	Desire to Stay Linked to CS	Describes the desire for graduates to stay connected to the field of CS	6
Faculty Commitments	Research Focus	The topic of study for faculty and/or students	149
	Faculty - Advising Students	Faculty responsibilities or role as an advisor or mentor to students	42
	Pedagogical Focus	Teaching strategies or educational approach of faculty	34
	Faculty - Teaching	Descriptions of teaching a particular class or classes	33
	Faculty - Non-Advising or Teaching	Refers to other faculty responsibilities beyond advising and/or teaching (e.g., serving on committees)	31
	Finances - Have Funding, Have Students	When faculty has funding but struggles to find students	14
	Co-Advising	Interdisciplinary focus of CSEd, advising students from different departments	14

(Continued)

Table 1. Continued

Theme	Code	Description	Count
Student Responsibilities	Graduate Students Coursework	Refers to the courses that the students take	47
	Finances - Students Finding Funding	Refers to the ways students obtain own funding to support their research or cover expenses (e.g., other jobs)	24
	Developing Competencies	Competencies students have or are developing	15
	CS Identity	How students develop their identity in the discipline	6
Opportunities	Pathways - Faculty	An individual's pathway in academia to faculty position or to obtain tenure	275
	Hiring for CSEd Faculty - Yes	When an institution plans to hire more staff in CSEd	68
	Career Pathways - Academia	Refers to the options for a PhD student post-degree, either pursuing a career in academia or continuing to teaching after they finish their CSEd-focused dissertation	55
	Recruitment - Getting Graduate Students	Faculty strategies to obtain graduate students, whether through active recruitment or passive methods (e.g., student reaches out to faculty)	39
	Pathways - Graduate Student (Generic)	When a faculty describes a students' educational pathways or development without specifying if the student was focused on CS, education, or another discipline	29
	Pathways - Graduate Student (CS)	The path a student took to become a graduate student with a research focus in CSEd, either previously having a background in CS or currently being part of a CS department	27
	Career Pathways - Preparation	How faculty may help to position their PhD students for careers after graduation, or students' own attempts to develop skills for future careers	18
	Pathways - Graduate Student (Ed)	The path a student took to become a graduate student with a research focus in CSEd, either previously having a background in education or currently being part of an education department	15
	Career Pathways - Industry	Students plans or actions of going into industry after finishing their PhD	12
	CSEd - Informal Opportunities	Opportunities outside of classes and in the lab that can enable students' professional development	7
Moving Forward	CSEd Pathway - Way Forward	Ideas from faculty about how to develop a CSEd specific pathway or what one could look going forward or descriptions of opportunities where such a path was previously considered at the institution	201
	Benefits of CSEd Path Creation	Refers to why it could be useful to have a designated CSEd path or the desire to establish such a program	42
	Future Goals	Objectives going forward	24
	Engineering or STEM Education Pathway - Way Forward	Ideas from faculty about how to develop an STEM or engineering education specific pathway or what one could look going forward or descriptions of opportunities where such a path was previously considered at the institution	20

respondents described how students working within a lab, or lab groups that conducted CSEd research, typically found social and academic support for exchanging ideas and submitting publications. As one faculty member described:

> *I feel like they [my graduate students] have lots of community [. . .] we have a critical mass. Like SIGCSE is a big thing, ICER is a big thing, ITiCSE is a big thing. It's like, oh, it's a deadline and everybody's in the lab working on papers — or at least they used to be in the lab working on papers [pre-Covid] — and there was these, like 'Oh, let's swap papers. Let's talk about these things.' So I think that we have a pretty good community.*

Cohesion also addressed how institutions might offer designated tracks or opportunities for graduate students to take coursework more tailored to the needs of CSEd students or the individual interests of students. In terms of the relevance of having a community:

> *And so that's what I think one of the big advantages is, you get the stacking [of] the fact of more students, you have them taking classes together, both within or out of the strand that allows them to learn as a community. Right now, we're just on the edge. We don't really have a community of learners.*

4.2 Uniqueness

The theme of uniqueness considers how the interdisciplinary area of CSEd is distinct from other monodisciplinary fields (i.e., education or computer science) or DBERs (i.e., engineering education). It also describes how students may have different interests and identities from others focused solely on computing or education. For example, students may want to develop teaching skills and/or study how to improve pedagogy in computing. As one faculty member described:

> *The other thing that I would put out there is balancing the appropriate skill set for who would be considered a grad of CS education. When I look at traditional CS programs and their qualifying exams and required courses, and stuff like that, they're talking about compilers and database engines and automata and complexity theory, and all that stuff. That is very important to what CS is. I don't deny that. But that is not important to what necessarily CS education is. And so I think a balanced profile, ensuring that they have rigorous methodological training in the social sciences, a good amount of theoretical grounding in learning, for selecting appropriate theoretical structures to explain their ideas and build on theory, and then an appropriate amount of skills in computing itself, is also important, because I don't want to send out a student with a credential in CS education that can't write code.*

Faculty spoke of the specialized coursework needs of their CSEd-focused students (e.g., research methodologies). Since few formal courses existed, students were often advised about what to take from their advisor, who frequently put together their own curriculum, selecting courses from different schools/departments or teaching their students themselves. As one faculty member discussed:

> *For the most part we've been having them take most of the research methods courses there [in education]. I've been offering a course that's just kind of like a . . . here is broad brush-strokes on what we know about the intersection of the learning sciences and computer science. Just lots of reading and a little bit of synthesis. And [faculty name] is teaching a course this semester on 'What do we know about learning' but specifically more focused on giving students tools to do qualitative research. And so for the most part we're relying on either the College of Ed to give our students some basis in qualitative and quantitative research methods that are appropriate for the field, and/or our HCI, human-computer interaction, colleagues who have some similar research methods.*

Faculty interviewed remarked how the discipline has options to contribute to the knowledge base in CSEd focused publications and/or presentations (e.g., at SIGCSE, ITiCSE, ICER, TOCE, the Journal of Computing in Higher Education (JCHE)), and that it is also possible to publish in other domains. As such, students pursuing research spanning multiple fields could benefit from more expansive opportunities for publication. One faculty mentioned:

> *[The student] has been working on trace data analytics around being able to understand students' programming behaviors and learning outcomes through these sort of analytics. And [the student] will be able to publish both on [the student's] algorithmic developments in addition to classroom interventions.*

4.3 Obstacles

The theme of obstacles speaks to the hurdles faculty discussed around conducting research or working on a dissertation in CSEd, such as having a lack of understanding in the community within an institution about the research. When considering how the unique publication options may be interpreted by departments and committees and their impact on graduate students, one participant commented:

> *[Faculty member] is in a very inclusive department that is very supportive and open to these areas. But that may not always be true for students graduating with a CSE[d] focus going into a College of Ed, where the standard of measure is a journal article. I can probably count on one hand how many good journals we have with a CS education focus, like ACM Transactions on Computing Education, IEEE['s journal inclusive of] CS Education [ToE], and JCHE. [. . .] So that is a big barrier for a lot of these students, in some cases, to be able to articulate the value of their work.*

Obstacles also included concerns about funding and career opportunities, and the challenges for graduates to obtain a tenure-track position in academia, should they wish to do so. For promotions and tenure in education, faculty mentioned how publication requirements in their monodisciplinary department could pose a barrier since evaluators were unfamiliar with CSEd norms and practices. Apart from publishing in different venues, the definition for the types of publications might not align with their departmental expectations. One of the participants elaborated:

> *So for example, in our annual reviews, there has never been a place for these conference proceedings, right? So you've got your journal articles and presentations, and SIGCSE is kind of both, right? So that is definitely a challenge, and so it requires a lot of communication.*

CS faculty interviewed stated that their students prefer to stay linked to CS departments since it could improve their chances of finding positions in other CS departments in the future. In terms of their interests, as one faculty member described:

> *For the ones that are more technically oriented, meaning they really enjoy teaching, and they just are really solid on the CS because they've been lecturers and they've been teaching basically all of our degree programs, they want to stay in CS department.*

Faculty also spoke to how students graduating from computer science may not always want to stay in academia:

> *. . . these folks in computer science. It's kind of like engineering, you can make a lot of money in industry. So why would you go into education? And that's one of the challenges we have is convincing these professionals to read, reorient, take themselves to academia,*

and think about an academic position or something like that. That's a huge challenge for them, they could make so much money in industry, yeah.

4.4 Faculty Commitments

CSEd researchers in computing departments are typically either tenured/tenure-track (T/TT) or teaching faculty (generally without tenure). While T/TT faculty are expected to have funding and an active research program, expectations beyond teaching varies considerably for teaching faculty. A significant portion of CSEd research is done by teaching faculty and many view their classes as their research lab. However, research of teaching faculty often does not get the same level of support in a department. Teaching faculty are often heavily involved in curriculum design and revisions and developing certificate programs. These duties occurred in addition to the usual commitments all faculty have such as advising (or co-advising) and committees responsibilities. Teaching faculty seeking external funding for CSEd research found it to be very competitive, as one faculty member described:

Maybe if you could add an eighth or ninth day onto the week. [. . .] We're just scrambling to keep our grants going. [. . .] If we're gonna set time aside for meeting, it's going to be for that dear [CSEd topic] proposal that's going to fund our grad students.

4.5 Student Responsibilities

The theme of student responsibilities considered the expectations for graduate students in CSEd and how students were expected to develop competencies and complete often diverse coursework. In the absence of research funding, many students served as course instructors or as teaching assistants to cover the cost of their studies. Since students pursuing a CSEd graduate degree often have different backgrounds, they often have to develop their own understanding of CSEd and relevant foundational knowledge.

Students with a background in computing had to acquire knowledge in research methodologies and the importance of theoretical frameworks to publish successfully in CSEd-specific venues. As one faculty member mentioned:

One of the biggest problems that, at least I've identified, having conducted meta analyses and stuff on the literature base from CS education, is that, CS professionals aren't taught how to do social sciences research rigorously.

Students with backgrounds in education may have varying levels of technical proficiency. From the perspective of a faculty member based in the College of Education, the advisor could serve to assist their students by assigning readings which may help to develop their understanding and skills. However, it was considered the students' responsibility to gain this knowledge, as described:

So what do they read? They read what they need to read, based on what our research questions are, and what we're looking at. It's like if we're looking at pair programming, I'll start them off with 20 articles here [. . .] You know, there's not a class, there's not a syllabus. There's not a set way for all the students

4.6 Opportunities

Opportunities addressed how students and faculty became involved in CSEd research and the career options for students graduating with CSEd-focused PhD. While a few faculty were hired directly into CSEd positions, the majority sought more general positions in a CS or education department and identified their research focus as CSEd. According to the faculty, some of their students pursued academic positions and some students took positions in industry. Overall, faculty were optimistic that their students would find positions. As one participant described:

> *Once they get a degree, where will they go? So far, all my students have been placed in great positions; many of them go into postdoctoral positions and faculty positions. So far, I don't know any of my students who haven't been able to find a job. Of course, not all those jobs are in computing education, but also they have a formation that is flexible enough and interdisciplinary enough so that they can perform in multiple jobs.*

Many faculty expressed that with increased interest in CSEd topics, graduate student recruitment was often hands-off. Frequently, students identified advisors and departments on their own among the small number of faculty pursuing CSEd research. As one participant described:

> *To be honest, I've never recruited any of the PhD students that I've had. They've always found me. [. . .] Like my very first PhD student, I met her at Tapia. [. . .] And then, other than that, it's like people are looking for CSEd, and they see my website on the [Institution] page and they reach out to me, we have some conversations, or they've taken a class [. . .] they fall in love with research and CSEd. And we work through maybe a master's thesis or master's project and then they join my lab as a PhD student, so that's kind of been my pathway for recruitment, very laissez-faire.*

4.7 Moving Forward

Moving forward referred to the ways faculty wanted to encourage the creation of departments, programs, or formal tracks for graduate students in CSEd. Frequently, they spoke of how CSEd-focused graduate programs could be highly beneficial for their students and what it could mean for their professional development. As one faculty member stated:

> *Just like for any other program, if somehow we could magically hit some sort of critical mass of a dozen plus programs across the country. Now, we can both recruit students into a formal program and perhaps convincingly tell them that there will be faculty opportunities for them when they graduate at these other institutions. I can imagine if we were able to tap researchers who have done work on the growth of engineering education, [Institution name] certainly being a leader in this area, and look at their growing pains and their strategies that they pursued, that a lot can be learned in terms of what CS education might need to do to get to that next level.*

In the absence of formal departments, the participants also articulated the need for having an interdisciplinary program for graduate students to to be successful long term. As one participant stated:

> *The graduates aren't going to go into a Department of Computer Science Education, so they are going to need to be able to teach courses in computer science education, but also in whatever, like whether it's educational technology or curriculum and instruction. And so, having that specialization in computer science education, but also being able to teach across the wider discipline, is something that they need to have.*

5 DISCUSSION

Our findings touch upon the complexities of establishing designated CSEd pathways and strategies to address the interdisciplinary nature of the research. The overarching goal is to enhance our understanding of the affective, cognitive, institutional, political, and other barriers and opportunities for CSEd students and faculty. The faculty reflections highlight a number of key issues and consider how the field can best continue to flourish. Below, we discuss the implications of each research question separately for faculty and graduate students. Then, we discuss commonalities and potential ways forward.

5.1 RQ1: What Factors Motivate Faculty to Pursue Research, Teaching, Advising of Graduate Students, and Learning in CSEd?

5.1.1 Faculty Pathways. As described under the theme of opportunities, there are multiple pathways for a faculty member to become a CSEd researcher. Some faculty transitioned into CSEd from engineering or STEM education. More senior faculty in CS typically started their careers in another core CS research area. As additional CSEd-related funding options became available, conference opportunities expanded, and interest in how to teach, motivate, retain, and engage students increased, so did interest in CSEd as a research area. Faculty in education mentioned they often transitioned into CSEd based on research to improve pedagogy surrounding technology and/or efforts to develop computational thinking. They also highlighted the distinction between technology users and developers and a desire to improve computing interactions. This focus aligns with the objectives of CS research under the purview of human-computer interaction (HCI). HCI is a design-focused discipline that explores the influence of people on technology, and vice-versa. It considers users' needs and experience in terms of a system's usability and functionality [6, 43]. It is thus not surprising that in a number of schools, faculty working on CSEd research in CS fell within the sub-area (or sometimes distinct department) of HCI. The variety of entry points to CSEd was further influenced by the existing departments, degrees, and available job options.

Hiring for CSEd faculty positions fell under the themes of opportunities and obstacles. The faculty interviewed mentioned that while interest in CSEd and improving teaching and learning is rising in CS, few CS departments have open tenure-track hiring positions in CSEd. To meet the heightened teaching demand arising from increased CS major enrollment [68] and interest in CS courses from non-majors [18] almost all R1 CS departments have open teaching faculty positions (academic rank but not tenure-track). When applying for (non-tenured track) faculty positions in CSEd, candidates may face hurdles trying to convince monodisciplinary faculty, hiring committees, and chairs who may not understand their work and research area. Teaching faculty working in CSEd often use their classes for their research, making a position in a CS department attractive even if it is not a tenure-track position. The number of education departments hiring faculty in CSEd is currently paltry, and CSEd joint appointments between education and another computing department are not common. For some CSEd researchers, applying to a position in a department or program focused on engineering education can be an option. However, the number of such programs and departments are small and CSEd may not be a focus area. PhDs seeking a CSEd faculty position often have a limited number of options. The uncertainty, with respect to adequate support for CSEd research, can be a challenge for applicants.

5.1.2 Graduate Students' Pathways. The majority of CSEd graduate students come from degree programs in CS (or related computing fields) or education. As faculty mentioned in the interviews, PhD students with a background in education may already be lecturers, and their research builds on their prior teaching experience. Some graduate students learned about CSEd as a discipline through courses they took or as a result of working with a CSEd researcher. Undergraduate students who pursued CSEd research and wanted to continue their studies in a graduate program often found advisors through contacts at conferences.

Overall, the participants expressed that it may be challenging for students to identify departments and advisors. While many faculty remarked on the value of Amy Ko's blog[1] as a resource,

[1] http://faculty.washington.edu/ajko/cer.

they mentioned the need to better "advertise" CSEd as a research area along with its researchers. Departments and organizations seeking to promote "CSEd for All," could increase promotion and improve engagement of CSEd to the broader community.

5.2 RQ2: What Personal, Curricular, and Institutional Obstacles do Researchers Focused on CSEd Encounter?

5.2.1 Faculty. Time is an issue for all faculty. For teaching faculty with a heavy teaching load and often additional teaching-related obligations, the time for research, supervision of graduate students, and proposal writing can be especially limited during the semester. For teaching and T/TT faculty, the lack of courses needed for research and the lack of a focused curriculum for PhD students often add an additional layer of effort as preparing students may not count as teaching. In CS departments where CSEd students have to fulfill general CS course requirements, a significant amount of course work had little relevance to their research. In addition, CSEd courses might not even count towards their degree. In such environments, the training of graduate students can be a significant additional workload for a CSEd faculty member.

While many CSEd researchers felt that the lack of formal programs may impact student recruitment and preparation, they did express that there was a CSEd community. Cultivation of an individual disciplinary identity and connections to the group identity for the field were often perceived as a result of collaborations or connections made through CSEd-designated conferences and workshops. Other researchers have similarly suggested that establishing opportunities to engage with interdisciplinary communities of practice can enhance a sense of belonging to a field through networks established external to home departments at an institution [2, 23]. Apart from more formal research publication outlets or professional development workshops, sustainable communication, such as through brown-bag lunches or blogs, is recommended to establish spaces for researchers to find support [23].

5.2.2 Graduate Students. Several themes discussed earlier already addressed uniqueness and student responsibilities. Publishing in CSEd requires having an understanding of multiple disciplines, a common issue in DBER. As others in the field have suggested, it can be valuable for students preparing to teach CS to avail themselves of reading on CSEd research, and to contribute to the community with their own projects [38, p. 284]. As described by research capacity in Cornell and Parker's model [20], this can include opportunities for collaboration and also contributing to the knowledge base in the field.

Other scholars have also spoken to the benefits of engaging in interdisciplinary research and mentioned how it can serve to cultivate new connections and synergistic perspectives that can work to address "multifaceted problems" [59, p. 2]. Increasingly, this may entail drawing from theory in other disciplines as well such as learning sciences, education, and/or psychology [57]. Such expectations may be challenging for graduate students unfamiliar with the required methodologies and conventions since they come from varied disciplines which may not have applied the same standards. This results in a need to develop core competencies that may be distinct from those required for students that focus solely on computing or education. Many advisors encourage their students to take additional courses in other disciplines as part of their studies, which is common in interdisciplinary environments [10]. As mentioned, in the absence of such options, and depending on the institution and program requirements, frequently the onus for ensuring understanding falls on advisors.

To reconcile these challenges, and aid in CSEd-focused students' development as independent researchers, we suggest that faculty encourage students to engage with and seek guidance from the CSEd community, rather than relying solely on their advisor. Building a network through participation and external connections can help to learn more about expectations and terminology common within a field [7]. Such interactions and collaborations are considered valuable for students to develop autonomy, cultivate personal and professional skills, and to foster their individual disciplinary identity [24].

5.3 RQ3: What Makes Advising Graduate Students in the Interdisciplinary Area of CSEd Unique?

5.3.1 Faculty. Scholars have mentioned how diverse interests and experience may serve to assist faculty when advising students whose dissertation research topics might fall under a broad umbrella [33], a phenomena that occurs in CSEd. We observed that faculty who were not in CS may have had very few students that were interested in CSEd research, meaning they were required to traverse not only their monodisciplinary field but also a range of interdisciplinary knowledge domains for this subset of students. To effectively serve the different needs this can entail tailoring goals and feedback despite needing divergent epistemologies and methodologies [74]. As Boden et al. [10] have previously described, for professors seeking promotion and tenure, it is important to work in an environment supportive of "conducting interdisciplinary research or supervising interdisciplinary theses and dissertations" [10, p. 745], something that many faculty members described as challenging in the absence of dedicated programs.

There were several other issues with being involved with advising in an interdisciplinary field as well. The theme of faculty commitments speaks to the expectations beyond instruction. Although commitments may vary by professional level and institution, they were also highly dependent on the individual faculty member. Such findings align with O'Meara et al.'s research on the variable nature of faculty commitments and their workloads. Given the differing, and potentially inequitable loads, which can impact a faculty member's perceived productivity within a department, it can be valuable to develop clear metrics and guidelines for faculty promotion and tenure for those engaged in interdisciplinary research. Along with established committees, it could be worthwhile to potentially seek external evaluators (e.g., researchers from other departments or institutions, organizations, industry) to gauge inclusivity of criteria used to determine the merit of activity. When seeking advancement, faculty could also offer their own personal statements, potentially synchronized with an annotated CV, that describes the objectives, importance, and relevance of their commitments and work to advancing the larger body of knowledge. While such a requirement could pose an extra hurdle, it could also provide an opportunity for CSEd faculty to highlight significant contributions in situations where others in the department may not be aware of the value of such items.

5.3.2 Graduate Students. Frequently, faculty spoke about the uniqueness of advising students focused on graduate research in CSEd relative to students from EER, education, or CS. While students were expected to understand the fundamentals of CS and to develop computing competencies, CSEd students also needed to have a broader understanding of educational topics and theoretical frameworks (as described by the theme of student responsibilities). Such expectations are not uncommon in an interdisciplinary field, and other scholars have encouraged faculty to offer training that encourages collaboration and recognition of the different norms, assumptions, and preferences across disciplines [70]. Inclusion of these types of lessons and acknowledgment of the benefits of engaging in an interdisciplinary area can help students to foster their identity in CSEd and to build their support network as they develop into independent researchers.

Although existing across fields may come with its challenges, there are potential benefits for graduates that can do so well. Prior research demonstrated that students who conducted dissertation research in an interdisciplinary field published more than their monodisciplinary peers and were also more likely to obtain academic positions [56]. We suggest that institutions with graduate students in CSEd should consider these potential advantages, and find new opportunities for to support students' personal and professional development. We encourage explicit training on the consideration of different disciplinary perspectives and an additional focus on professional skills such as communication and emotional intelligence. Other scholars have shown that such skills are vital for students develop, particularly in interdisciplinary collaborations and environments [70]. It is also imperative to imbue creative approaches while navigating through moral and ethical issues [72]. Doing so could not only help to understand the complexity of different perspectives, but also consider novel approaches while promoting responsible conduct.

5.4 Commonalities and Ways Forward

As evident from our interviews, structural, organizational, and cultural barriers make successful research and degree options challenging for CSEd graduate students. Future solutions could include the creation of designated CSEd graduate programs, pathways, and courses. This strategy has made engineering education research a successful DBER discipline [17].

Developing a graduate program could entail offering a separate degree for CSEd, whereas a pathway could entail a specialized track with designated courses within another, already established, degree. Alternatively, a more radical option (from the institutional structure standpoint), would be to develop an autonomous CSEd department, with its own set of requirements and courses. Below we discuss these options further.

5.4.1 Creating CSEd Programs, Pathways, Courses, and/or Workshops. Creating a new program requires effort, dealing with administrative obstacles, and addressing institutional structures (as described by Cornell and Parker's framework [20]). Establishing a new program can also be controversial in terms of geography and/or ownership. Untenured and teaching faculty in our study felt reluctant to take the lead. A number of tenured faculty with established and active CSEd research programs were not convinced it was necessary. In addition, it was not clear to the faculty in our study which department or school the program would belong to and what the course requirements for students should be. Faculty also expressed their fears that more formal paths may serve to pigeonhole students and limit their future options. When considering making major reforms such hesitation is fairly common, and scholars have previously described the impact of psychological aversion to change [5]. It has been mentioned how, "As with any profound institutional change, skeptics abound and outright resistance exists" [5, p. 6]. Accordingly, it is imperative to consider the psychological barriers that may exist to enact appropriate strategies when approaching potential program of pathway creation.

Supporters of developing a formal program argued that, rather than being limiting, such programs could be responsive to student interest, may offer new opportunities, and could serve to broaden participation [1]. Having designated CSEd degrees within a department could allow students to strengthen their individual identities within the discipline and form connections with their peers as they develop domain-specific knowledge. As an alternative to an entirely separate program, pathways (or tracks) could be established within existing programs. To balance general education needs with more specialized knowledge, departments could include core foundations from the discipline along with upper-level courses more focused on CSEd concepts and principles. As an initial step, offering new standalone courses could provide targeted opportunities for enhanced understanding of CSEd knowledge for existing students and could potentially attract new students to the field.

Faculty expertise on the norms, jargon, and ethics of CSEd could yield guidance for students' learning, leading to pedagogical approaches that imbue the quality standards for students looking to pursue research or teaching upon graduation. Establishing regular meetings, seminars, or workshops for students interested in learning more about CSEd and its philosophy of knowledge may represent a valuable first step. Ideally, departments should provide some initial funding. Meetings and workshops have been proven to successfully enhance interdisciplinary doctoral education and team cohesiveness [12]. Several of the faculty we interviewed mentioned that students found connections within their own laboratories, but that students belonging to smaller groups or working only with their advisor often lack such support.

5.4.2 Creating Autonomous CSEd Departments. Another alternative would be to establish a formal department for CSEd. Faculty recognized that creating a CSEd department was difficult, expensive, and contentious—although such a unit was judged to be worthwhile. While a joint department could bring together faculty from different disciplines and academic departments, others thought a better way forward would be a department independent of the ownership of any preexisting departments. One concern expressed was potentially unequal ownership that could have ramifications for the students. Scholars have noted that interdisciplinary departments developed from "marginalized fields" can serve to develop "sound scholarship, curriculum, and teaching" that challenges the traditional disciplines they emerged from [45].

A successful CSEd department could help establish professional development opportunities and lead to tenure-track positions in CSEd. Having such career incentives could define an institutional structure for CSEd, could bolster individual and group identities, and could develop increased research capacity. Interviewed faculty often spoke of concerns about the job market in higher education. Several described their observations that CSEd doctoral students from education departments struggled to obtain academic appointments in a computing department, as they were frequently viewed as lacking CS background. Meanwhile, students whose training was grounded in CS were not likely to get positions in schools of education and instead obtain appointments in CS departments. CS positions were often at the teaching track level, and new hires frequently became instructors for large introductory courses. While the faculty interviewed suggested they had perceived students from CS most often wanting to stay linked to CS, those interested in transitioning to education frequently struggled to convince education departments that they had the expected pedagogical foundations. As such, designated departments and initiatives could serve to overcome many of these limitations and work towards developing more sustainable opportunities for CSEd researchers and students [40].

5.4.3 Supporting Interdisciplinary Efforts. Future opportunities for CSEd graduate students would benefit from a concerted effort to bring the discipline together and share expertise and decision-making. Interdisciplinary and collaborative teams could draw upon the diverse mindsets and interpretations of what is needed to enhance research capacity, determine competencies for students, and develop learning objectives. Working collaboratively, these faculty could discuss and define standards for requirements (courses, publication venues, etc.), expectations, and map out what such programs could look like (as described by Cornell and Parker [20]). Creating a culture of openness and communication among experts could serve to benefit institutions, and through discussions between institutions, the broader field (and its group identity). Institutions should offer support for the organization of an interdisciplinary curriculum or program [15]. This could include consideration of incentives such as promotion and tenure when designing more formal programs, pathways, and departments [62].

6 LIMITATIONS

Our research provided valuable insight into the pathways that presently exist in CSEd for faculty and graduate students, but we also had several limitations. Although we sought to achieve saturation in our understanding, we do not claim that interviews with 15 faculty are representative of the situations of those existing at all institutions. While faculty from different departments and institutions were considered, interviews with faculty from additional institutions, departments, and at different stages of their careers could yield further insights. Future research may also want to contemplate expanding to understand the nuances of opportunities that exist for graduate students in CSEd internationally.

Another potential concern is the subjective nature of the codes and categorizations into themes. The analysis presented does not attempt to claim these results can be generalized to all institutions or programs. Instead, we sought to understand the experiences of some faculty who are conducting research in this area, and to learn about their experiences and what they observed for the students they advised. Moreover, we acknowledge that interviewing people in pairs or in groups of three or more can influence results, both negatively (such as when respondents may stay silent over points of disagreement) and positively (by eliciting more thoughts and elaboration on points of agreement, or if participants are equally situated, in challenging ideas to generate further description and justification).

7 CONCLUSION

Our goal was to understand existing pathways for CSEd graduate students and faculty members. The 15 faculty members described the state of the field and potential opportunities for development and new research. In the last decades, the CSEd community has grown, interest in CSEd has increased, and publication venues have expanded. CSEd is an interdisciplinary field and departments may not recognize it as a distinct 'discipline' that should develop its own courses, curricula, and fiscal support. The current situation has some advantages which include bringing together methods and lines of inquiry from different fields in creative, gestalt ways to address real issues—like identifying approaches to effectively improve technical preparation for students and broadening participation—in a socially and historically impactful, lucrative field. The field also faces obstacles, such as a lack of entry points into programs for students from different backgrounds, limited job opportunities, and difficulty defining tenure and promotion expectations for CSEd faculty that are accepted in traditional academic structures.

The faculty interviewed highlight options for the field: stay in the current space, create degree programs within existing colleges, or become a formal 'discipline' independent of departmental ownership. Change requires faculty willing to take the lead and to tackle potential administrative battles and logistics. Our findings reveal that, in the absence of such programs, many working in the field seek out opportunities and means to build their own community. Going forward, we suggest expanding our work further to explore the situations of faculty at additional institutions and to consider the perspectives of graduate students. The inclusion of an international perspective could also help to extend the transferability of the findings to the larger computing education community. Our study provides a look at the realities CSEd researchers face and also presents an optimism that we can continue to grow and improve to meet the needs of future generations of students.

APPENDIX

Section	Questions and Additional Probes
Personal Background	1. Please tell us briefly about yourself. a. How are you currently involved with Computer Science Education research or programs? b. Do you teach CSEd related courses? c. How did you get involved with computer science education research?
	2. Do you advise/mentor graduate students in CSEd? If so, how many? What degree programs are they enrolled in?
	3. Do you advise/mentor graduate students who do not focus on CSEd?
	4. In your experience, how does advising/mentoring CSEd graduate students differ from advising/mentoring graduate students whose work does not focus on CSEd? a. Are there challenges specific to advising/mentoring CSEd graduate students? May include funding, course requirements, community of peers, etc.
About the CSEd Pathways at your Institution	5. What degree programs are CS education graduate students enrolled in? a. Describe the program(s) b. How is recruiting and admission targeted at CSEd students? c. Do students have unique CSEd requirements in their graduate program? If not, what should those requirements be? d. How are students engaged in CSEd research supported? What is the TA to RA ratio? e. Based on your experience, what are some issues faculty face within their academic unit in pursuing CSEd research? f. What are some issues that students face within their academic unit in pursuing CSEd research? g. In your view, what challenges exist for CSEd graduate students in the broader community?
	6. What partnering academic units at your institution are engaged in supporting students engaged in CSEd research? a. What formal or informal relationships exist among these units? b. What relationships would you like to see and would find helpful? c. If your institution has Engineering Education, what relationships do CSEd faculty have with them?
	7. Please describe how each of the following elements are supported at your research institution or your program: a. Developing a program of study b. Identifying and becoming engaged in research c. Advising and/or mentoring (skip if discussed before) d. Gaining financial support (TA, RA, Fellowships) (skip if discussed before) e. External funding i. Existing external CSE related funding in your unit/group ii. How do you view opportunities for CSEd research funding? f. Career guidance g. Being engaged in teaching experiences
	8. Has your institution considered formal CSEd graduate programs? a. If so, what and who were involved? b. If not, would your institution consider developing a new CSEd graduate program? c. What do you consider to be the main issues that would need to be addressed in order to have a formal CSEd graduate program? i. What are the benefits of a CSEd graduate program? ii. What are some of the challenges to developing a CSEd graduate program? iii. What approvals are needed?
	9. What national organizations are available to your students? What support do they provide for students? Which organizations have a focus on CSE research?
	10. Anything else you want us to know about that we haven't already discussed.

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