Designing and Developing a Resource Center for Primary and Secondary Computing Education Researchers

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***Abstract*—This full research paper considers the resources needed to meet the research and evaluation needs of the many efforts to incorporate computing education throughout primary and secondary schools. In order to support these efforts, we developed csedresearch.org, a site designed to serve as a resource center for primary and secondary computing education research. We first considered criteria and recommendations for resource centers previously established by others. We provide a general description of the purpose of the csedresearch.org as well as a description of how we used quantitative and qualitative methods over numerous phases of development (pre-concept/research, concept, alpha, and beta, launch) to ensure that it meets the needs of potential users. We discuss how the current product compares against the general criteria for resource centers, its original intentions and expectations, and how it has fared through the phases of development one normally expects from a digital resource center. As the resource center evolves, we continue to seek feedback and resources to further meet the needs of the community. We also discuss the data that is being collected and could be collected to further benefit the community to define not only what educational practices work best overall, but what works best for particular demographic groups, including underrepresented groups in computing. And finally, we are faced with the challenge for maintaining the information so that remains robust and current.**

I. Introduction

There is a shortage of skilled technology workers across the globe with current and near-future demand far exceeding supply [1], [2], [3], [4]. In the eyes of the "CS for All" movement, which in the United States means teaching computational thinking and computer science concepts across all demographics, particularly in primary and secondary grades, increasing the number of individuals participating meaningfully in computing does not simply mean getting more of the same people involved [5]. Rather, it means bringing in groups who have been underrepresented in computing, including women, racial and ethnic minorities, and persons with disabilities [6], [7]. As a result of this movement, a large number of various intervention and curriculum programs for students at all academic levels have been developed and promoted, which have included outreach activities, new and revised curriculum and informal learning opportunities [8], [9], [10], [11], [12], [13], [14], [15].

As a field, CS education at the primary and secondary level is relatively new when compared to other STEM subjects, which have been taught to students for decades. Computing is only recently being mandated both nationally and regionally [16], [5]. Since computing education is so new, many of these initiatives have not been closely coordinated and questions remain about which interventions are most effective across various populations of [17], [18]. Efforts to ensure that computing education is equitable and culturally responsive have demonstrated that there is a need for better understanding of how to properly adapt interventions to specific classroom contexts [19], [20]. There is a need to consolidate the existing evidence in CS education and enable the coordination of future studies so that finding promising practices becomes easier.

Addressing the challenges described above requires the construction of considerable new infrastructure to support not just CS education research, but also the instrumentation used to evaluate CS education initiatives. This infrastructure must be geared toward making such research and evaluation both more rigorous and more uniform, primarily by:

- Increasing the coordination of intervention efforts (i.e. ensuring that fewer practitioners are operating in isolation) and helping to grow consensus on what intervention practices are most effective.
- Fostering a solid, shared understanding among researchers and evaluators of how to effectively conduct research and evaluation into CS education programs.
- Creating a shared resource center that can be used to conduct larger-scale research and validate new and existing studies. This would partially be facilitated by housing the vast majority of relevant research literature and evaluation instruments that the community agrees are of value.

Creating this infrastructure requires a data-centered approach and a framework for hosting this data. A resource center like this must be created based on review of general software development practices that are user-centered as well as an examination of previous research on building resource centers for computing education [21], [22].

In this paper, we discuss a resource center to support CS

education researchers, project evaluators, policy makers and stakeholders, and primary and secondary educators and administrators. For its development, we considered the following overarching research question: *What would be included in a resource center designed to meet the needs of primary and secondary CS education researchers, project evaluators, policy makers, and administrators and educators?* To answer this question, we worked with users throughout the development phase (pre-concept, concept, alpha, beta, and launch builds) to determine user needs and how the site met those needs.

This paper is relevant for potential users of and contributors to the resource center as described above as well as others who are building similar resource centers. This paper describes our design and development process, including the development of the functional requirements. Section 2 provides a background of related content and design topics. Section 3 describes our methodological approach to building the resource center. Section 4 describes the results of each phase. Section 5 discusses the current status and future plans of the site.

II. Background

In this section we discuss resource centers for computing, some of the challenges facing resources centers and standard practices for software and usability testing.

A. Resource Centers in Computing Education

Sanders et al. (2008) documents a desire by computing education researchers to create a resource center that would enable them to supplement their existing data and/or repeat past studies [22]. Participants in the study asserted that such a resource center would need to be carefully structured and the resources contained in the resource center would need to be described with adequate contextual information to help users understand whether or not a given item was relevant to their work. This resource center could remove barriers to participation in research and change the scale at which research could occur.

As computing grows in primary and secondary education, there are a number of constituencies to consider when proposing a resource center. Beyond serving as a platform for researchers and evaluators to enhance their work, the resource center could also be useful for pre-college CS teachers. As computing continues to expand into K-12, new CS teachers are especially likely to search for new resources and a CS education resource center could serve as a central location for finding these resources as well as a way to form a community of teachers [21].

There are several examples of resource centers available for different aspects of teaching and learning about computing. For teaching resources, examples include the National Center for Women & Information Technology's (NCWIT) EngageCSEdu (https://www.engage-csedu.org/), Project Quantum (https://diagnosticquestions.com/Quantum) from United Kingdom's Computing at School (CAS) organization, and AP teacher communities from the College Board (https://apcommunity.collegeboard.org/web/apcompsci/home; https://apcommunity.collegeboard.org/web/apcsp/home).
A key feature these resource centers share is that they are sponsored by an existing organization. There are also resource centers dedicated to specific technologies and tools like Scratch (https://scratch.mit.edu/) or Alice (http://www.alice.org/community/). Each of these resource centers is tied closely to a tool and encouragement of its use.

B. Challenges to creating resource centers

While there are several examples of resource centers for teaching computing and providing resources to both researchers and educators, they seem to be highly desirable, yet underutilized [23]. Often, they are transient and disappear due to a number of reasons. For example, a syllabus repository for computer science courses designed to help teachers create syllabi and compare them to current curriculum standards [24] no longer exists due to shifts in faculty appointments and university resources (M. Perez-Quinones, personal communication, 2019). Mitchell and Lutters (2006) give examples of three repositories, CITIDEL, CSTC, and SWENET [23] in which only one (SWENET) is still accessible (http://swenet.org), though the last posting to its forums was in 2011.

Of the six resource centers discussed in Fincher et al. (2010) (SIGCSE Education Links, Kinesthetic Learning Activities, Technology Educators of Computing Hail, Computer Science Unplugged, CITIDEL, and ENSEMBLE), only two (Computer Science Unplugged (https://csunplugged.org/en/) and ENSEMBLE (http://www.computingportal.org/)) are currently maintained [25]. The authors provide criteria to consider when designing resource centers:

- Curation - getting the data into the resource
- Content - what data is available
- Contribution - who puts in data
- Community - how to engage or create community
- Catalogue - how to find material
- Control - who is in charge of maintaining the center

Armbruster and Romary (2010) discuss a wide range of challenges and barriers with regard to online resource centers/repositories that echo Fincher, et al's list, including: identification and deposit of materials/data, access and use, and sustainability and preservation [26]. Efforts to overcome the challenges must be made in the design and deployment of these systems to make them viable to the communities they serve. Chief among them may be maintenance and long-term viability of the resource center. Of the examples of resource centers detailed in section 2.1 that have been available and maintained for several years, the key feature of their ongoing success is support by an organization or product team. This support provides stability for maintenance and growth. ///

C. User-centered Software Development Practices

These challenges must be addressed when designing resource centers. Several best practices in software engineering and user-centered design (UCD) can be used to help ensure that the system meets the users needs. In terms of general software design, user centered design is focused on specifying

the context of use, identifying requirements, creating design solutions, and evaluating designs [27]. These phases are coupled with several recognized UCD methods. In a survey of UCD practitioners, Vredenburg et al. (2002) gave a ranked list of the methods the practitioners felt were most valuable in the development process: field studies, user requirements analysis, iterative design, usability evaluation, task analysis, focus groups, formal heuristic evaluation, user interviews, surveys, and participatory design [28]. For each of these methods, it is vital to consider product users and to create a cohort of participants that can represent the target user group as accurately as possible [29].

Borgman et al. (2005) describe a process for gathering information for the design of a digital library [30]. This process includes semi-structured interviews with potential users about the type of information they would like to see on the site, the ways in which they need to search for information, and the way they want information presented. Through these interviews, they were able to uncover valuable information about how their potential users would like to interact with their project.

D. Summary

It is important to address these challenges (Table I) when designing a resource center. In prior work, the authors have discussed how, though there is considerable time and effort being placed to create and administer K-12 CS education activities, there is relatively little work that has been done to understand the long-term impacts of these activities [31]. There is great potential value that a central resource center of research studies in pre-college computing education could have on improving access to research and quality of future research produced, a fact that is reiterated by the Armbruster and Romary work [26].

A central storage location for data associated with computing education activities at the pre-college level could open up new doors for researchers attempting to do rigorous work in this area of computing education. As such, we present the methodology, design considerations, and testing that have gone into the creation of csedresearch.org [32].

III. Methodology

To address the question of what would need to go into a resource center, we followed traditional qualitative and quantitative methods as well as user experience (UX) methods to include the user from the project start. We identified several stages for this, including:

- Research phase
- Concept phase
- Alpha phase
- Beta phase
- Official release/launch

Through each phase, appropriate protocols for IRB Review were undertaken at the respective researcher's institution where the study was conducted. Two researchers oversaw the research/pre-concept phase), one researcher and one undergraduate student trained in user testing oversaw the collection of data. One researcher provided input and oversight on the study design as a whole and at specific phases, including the development of instruments to collect the data. All researchers had previous experience with quantitative, qualitative, and mixed methods studies and one researcher had experience in software user testing.

A. Research Phase

During the research/pre-concept phase, we created a virtual, asynchronous focus group that convened for a period of ten weeks to answer prompts and hold discussions on what could be included. The study was developed using methods from Liamputtong, Patton, and Onwuegbuzie, et al., and included six participants, all educational researchers involved in computing education [33]. The overarching research question for this part of the study was: What type of data might be usable and useful for educational researchers, evaluators, and practitioners when measuring the impact of pre-college computing activities? [34, p. 1]

Participants were recruited based on their experiences within the computing educational research community, their willingness to participate, and their availability. Four were computing education researchers employed as faculty at geographically diverse locations in the U.S., with two at public post-secondary institutions, one at a private post-secondary institution, and one in an education area of a for-profit company. At least one had designed and implemented middle-school computing outreach activities.

Since the majority of the work conducted in this research phase is described in great detail in [34] we provide only a brief description about this phase. In this phase, weekly discussion was guided by prompts that encouraged the discussion of variables important for evaluating activities, the resource center's design and content, gaps in data collection and reporting in relevant research, a system for rating research and discussing how to enable the creation of quality research, and the value and feasibility of quality standards, including what basic criteria might be universally acceptable as well as objectively attained. The discussions among the participants were analyzed and coded (which is further described in the previous conference proceedings [34]) and after the four passes through coding the data were finished, four categories evolved: Design and Content, Content Quality Measures, Challenges, and Functional Requirements.

B. Concept Phase

After analyzing the research data, we began the concept phase. The primary purpose of the concept phase was to get early feedback on the design prototype and the vision for the content based on a paper-prototype model. In this phase, to recruit participants we developed a screening questionnaire using Qualtrics that contains the targeted demographic details and contact details for the participant, then issued an invitation to participate on the ACM SIGCSE-members listserv as well as computer science education social media sites. Of the 39 responses, we then chose eight participants from the pool

TABLE I
LITERATURE REVIEW SUMMARY

Overall Design	Resource Center	UCD Practices
Carefully structured	Catalogue resources so they are easy to find/search (use of data)	Field studies
Determine content and focus of resources (proper scoping)	Contribution of data: who contributes data and how carefully is this controlled (deposit of data)	Focus groups
Engage/create community (allow and encourage access to data)	Data curation (identification of data)	Formal heuristic evaluation
Maintain resource center (sustainability and preservation)	Describe data with adequate contextual information to help users understand its relevance	Iterative design
		Participatory design
		Surveys
		Task analysis
		Usability evaluation
		User interviews
		User requirements analysis

based on representation of profession (educator, researcher, evaluator, other), years of professional experience, and geographic location. We contacted potential participants and scheduled an appointment to conduct the study. After the study was completed, participants received a $50 stipend.

C. Alpha Phase

During the alpha phase, developers worked to gain an understanding of the resource center through usability tests conducted via online meetings. We began by recruiting potential participants, identified through the ACM SIGCSE-members listserv and social media sites related to Computer Science Education Research. We then sent a screening questionnaire to those 32 individuals who responded and asked prospective participants for background information about the type of organization they work for and their experience level with K-12 CS interventions and research. This information was used to determine if an individual was suitable to take part in the study and also establish which phases the individual was willing to participate in. As in the concept phase, we then chose a set of 15 users in such a way as to get a broad range of representation. Five primary and secondary teachers, 5 researchers, and 5 evaluators participated in the study. One of the evaluators did not complete the study, so our final participant count was 14.

Respondents participated in individual testing sessions via Skype video call lasting approximately 30-40 minutes each. For their participation, each individual was presented with a $35 Amazon gift card in appreciation for their time. During these calls, each participant was asked to log onto the website and share their screen. Users then accessed a questionnaire that walked them through a series of tasks to perform on the website while the researcher observed and asked questions about the usability and content of various features. The users entered some data on their own for one portion of the study and then the interviewer asked them to respond verbally to a series of qualitative questions about their experience.

D. Beta Phase

In January of 2018, the Beta version of the site was active and ready for testing. The call for participation was posted electronically through the ACM SIGCSE-members listserv and other broad, pre-populated email lists to individuals who are known to be active in computer science (CS) education, either as researchers, project evaluators or practitioners (e.g. K-12 teachers). These individuals were asked to do a thorough site review, testing features and thinking about how it might answer the types of CS education questions they typically address. At the end of their experience, the website directed them to participate in an online survey. The survey primarily asked participants questions in the following areas:

- Their background and work in CS education
- Possible ways they/colleagues would use the site
- Feedback about usefulness and design of its major elements
- General suggestions for improvement

The survey also asked respondents if they would be willing to participate in a follow-up phone interview to elaborate on their survey responses. Individuals who expressed interest were taken to another survey to provide their contact information for follow-up. Interviews lasted 20-30 minutes.

Due to the nature of the email lists used for the invitations, it is difficult to know the exact number of individuals who were reached. The invitation likely went to approximately 2,000 individuals who participate in groups like SIGCSE, the Computer Science Teachers Association, and Facebook communities for CS educators and researchers . Website analytics indicate that approximately 200 individuals visited the site, and 26 provided usable responses, indicating that about 10% of those invited chose to participate. Within the 26 responses, 13 were actually partial responses that did not complete the survey in its entirety. These survey results should not necessarily be viewed as being representative of the broader population of CS education community.

Among survey respondents, most identified as either working in higher education (17) or K-12 education (5) ((Table II). They were engaged in a variety of activities related to CS education, especially research, program implementation and teaching at a university. A total of five individuals expressed a willingness to be interviewed. Of those, three responded and participated in an interview. Each interviewee had a

considerably different background, one who was a recent PhD graduate in CS education, one who was a K-12 CS teacher and one who helped organize and evaluate teacher professional development for a large organization.

TABLE II
BETA USERS CURRENT WORK ENVIRONMENT.

Role	Count
Higher Education	17
K-12 Education	5
Industry	1
Non-profit	2
Other (Please Describe)	1

E. Post-Launch

To determine the extent to which the resource center is starting to serve its purpose, we have gathered individual responses about the site from users. We created a two-question survey for users to take when visiting the site during a three-week period in April-May 2019. This survey collected data regarding who was using the site and what their primary purpose was. In total, we had 154 users complete one or both questions to the survey out of 721 visitors to the site (21.4%).

IV. RESULTS

A. Research Phase

The asynchronous virtual focus group was a qualitative study of six experts in computer science education and resulted in four basic categories: Design and Content, Content Quality Measures, Challenges, and Functional Requirements. Though fully described in citemcgill2018defining , the categories, described in Table III, relate to criteria suggested in previous research on creating such shared resources.

In addition, participants had several discussions around the quality and integrity of any stored data. For data quality, participants went from suggesting having a rating system for articles to a usage rating (i.e., number of views of the abstract and summary data) to importing Google citation numbers. In the end, a five-star rating system was problematic since all of the articles have already undergone a double-blind review process. Another issue with a rating system is that what is meaningful (5 stars) to one researcher may not be meaningful (1 star) to another. Even having an independent rating for study design, literature, and reporting of data for each article was of concern again due to the fact that the articles have already undergone previous review. However, what was stressed throughout the evolution of these discussions is that the integrity of the data is very important and should be considered.

The functional requirements included user experience related issues and content related to resources and guides for researchers to learn how to improve their research skills. We also were able to identify which data should be included in the website and how that data should be filterable.

B. Concept Phase

During the concept testing phase, only qualitative data was collected from the eight participants. Participants were asked to walk through how they would complete five different tasks given to them ranging from finding an article with specific criteria (”find articles that include data on middle school girls in a summer camp”) to finding evaluation instruments that might be useful for them. They were asked to find information on how to write a research question.

Participants were also asked to provide feedback on the sample page layout for the Resource Center. They provided feedback on issues around some of the language used on the site (e.g. using terms ”educator” or ”teacher” in place of ”practitioner”). Others suggested having ”a place where people can say ”I’m looking for an activity about X but there isn’t one?” and to provide ”links to what is out there, what is going on, newest research, DoEd, state standards” and to ”highlight some recent research. Maybe I think I want to study XYZ topic, but someone just did exactly what I’m interested in. I’d like to read that before I jump in and reinvent the wheel, or just look at theirs so I know if I want to replicate that or if there’s some twist I’d like to add to my research.”

They offered feedback on how to structure some of the menus and filtering options, including different ways of categorizing content. One participant suggested a ”filter for experience level of teacher/instructor” and the ability to ”search by grade ranges, not just particular grade (e.g. 3-6)”. Another suggested collecting ”information about accessibility of activity for different disabilities”.

Respondents had a considerable amount of feedback on the Research Guides section. They wanted to see a more thorough set of resources included around research methods, from understanding the basics of qualitative and quantitative methodology to explaining important considerations around sample size and how to navigate concerns related to Institutional Review Board and Research Review Board requirements around consent and assent. For example, one participant stated that ”I think if I were new to the computing education community, exemplars would be really helpful, and maybe even just a little bit of orientation.” and another stated ”One thing as a K-12 educator, I’d like information about kind of ethics and liability, how do we conduct research with students who can’t consent to be researched, what types of things do we need to be concerned about there.”

C. Alpha Phase

During alpha testing, both qualitative and quantitative data was collected. The alpha phase was the first time a prototype of the website was operational and able to be tested. Given this, much of the feedback from the 14 participants in this phase of the study was related to technical issues with how the features of the site functioned. Participants uncovered issues around problems with the search bar (i.e. that it was providing unexpected results) as well as the filtering criteria such as age and race/ethnicity (e.g. that the filters appeared to be keeping articles that were not necessarily in-line with

TABLE III
USER-DEFINED CATEGORIES

Category	Subcategory	Description
Design and Content	Functionality & Content	Search capability should be granular and powerful; data on articles (venue, year, title, etc) should be stored; data should include study framework/design, ethics considerations; stated outcomes; types of instruments used in the study; whether study was a replication of previous work
	Variable Identification	Add data from studies including participant demographics, instructor demographics, noncognitive and cognitive factors, intervention data, results of studies
Content Quality Measures	n/a	Create and enable users to drive the quality of research higher
Challenges	Data Management	If collecting raw data, privacy and confidentiality of participants would be highest priority
	Project Feasibility	Set boundaries to make sure that the resource center is successful and usable, then build upon it as resources allow
	Project Value	Do not reevaluate and rate previously published studies
	Project Sustainability	Consider transitioning to volunteer reviewers similar to journals
Functional Requirements	User Experience (UX)	Consider user experience and user interface throughout
	Guides for Researchers	Add a section of "how to" guides specifically oriented towards computing education research

the constraints they had placed). Participants also suggested that the navigation bar at the top of the page be made more prominent and that certain color selections be changed. Some participants offered feedback on the "research guides" section. Those who found this section were unclear on its purpose and thought it needed more explanation and prominence.

Questions related to the overall ease of using the site ranged from 1.64 to 3.14 on a 7 point Likert scale (1 = Strongly Agree and 7 = Strongly Disagree), with participants in fairly strong agreement that this site is easy to use (Mean = 2.50, SD=1.59) and they would use the site in the future (Mean = 1.93, SD=0.80). They would also tell others about the site (M=1.64, SD=1.04) and said that the visual design of the website is pleasant and modern (M=1.86, SD=0.64). We also asked participants if they might be interested in have a copy of the actual database to conduct analysis on the data. The mean was 3.77, with a variance of 4.33. Participants were either very interested or not interested at all in having data access.

D. Beta Phase

Many of the 26 participants worked in multiple capacities, such as in a university (teaching CS) and conducting research in CS education (see Figure 1). Prospective users of the site were mostly enthusiastic and viewed the resource center as a useful and potentially impactful project. Having all of these resources in one place with structured information about each one was seen as a significant improvement over traditional searches, though the evaluation tools were more difficult to navigate than the articles. The site was seen as a suitable tool for helping to answer questions from researchers, evaluators and practitioners, though it may be useful to have a more explicit way of identifying resources relevant to K-12 educators and other practitioners. They viewed evaluation instruments to be the most useful part of the site (Figure 2).

Those who searched through the resource center found the results to be generally in line with what they were expecting, though some noticed missing items. There were few technical issues with the site, indicating that its structure is sound, although there were some suggestions to clarify or modify the filters and enhance the capability of the search function. Overall, users indicated that they would probably continue to use the resource center in the future, especially if it is consistently updated. Table IV shows the results of the quantitative portion of the study.

Though useful in its present state, several users commented on its potential value to CS education community in the future. This was seen most readily in the research guides, which could possibly be made more prescriptive and substantial and turned into a standard approach for how CS education research should be done (e.g., an exemplar for others to attempt to match). These users noted that if the resource center can be more thoroughly populated and then marketed not just as a useful resource but as a standardized framework for how CS education should be done (possibly with the assistance of NSF), it will be able to significantly advance the prestige of the CS education field. This may also solve the issue of how to make the site sustainable, by creating a solid user base who relies on it and is willing to consistently add new resources.

E. Post-Launch

The post-launch micro-survey conducted during a three-week period in April-May 2019 with 154 (21.4%) users responding (of 721 visitors). The survey indicated that users primarily work in K-12 environments (44.2%) and in higher education (37.5%). The majority of users are implementing a CS education program (22.7%), conducting research on cs education (20.8%), supporting teacher professional development (16.9%), and evaluating CS education programs or initiatives (14.3%) (see Tables V and VI).

Both oral and written feedback from a variety of users includes adding features, articles, and evaluation instruments, and users state that the site is already providing them with helpful information. One user wrote "I totally love the site, use it *all* the time and recommend it to others all the time. Thanks for the great work!" with others also writing to praise its usefulness ("This is wonderful! I'm looking forward to using this.", "Very useful & informative. Thanks for putting this together.", and "This is a great resource, even if a project is not using this type of assessment right now. Thanks for creating the repository!!"). We also were advised of a user

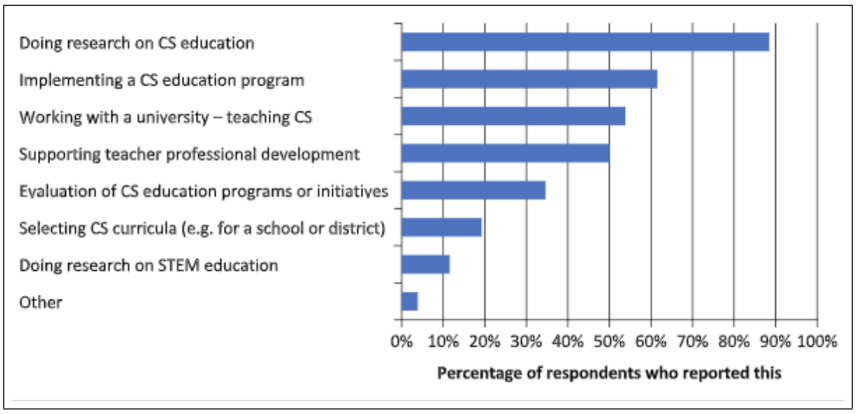

Fig. 1. Beta users roles.

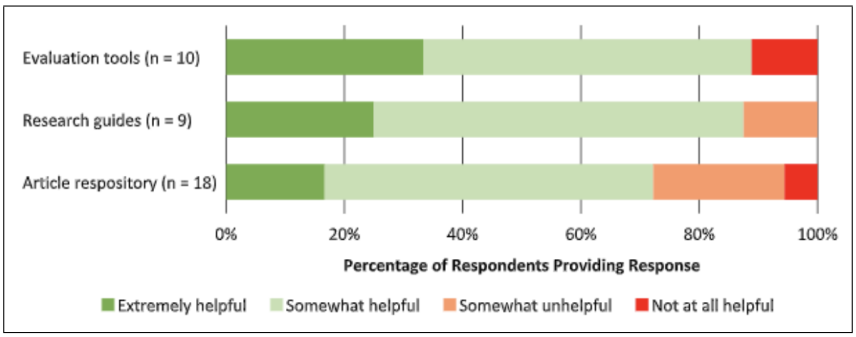

Fig. 2. Perceived usefulness of site content.

TABLE IV
QUANTITATIVE FEEDBACK FROM THE BETA REVIEW. ** INDICATES MEAN WAS INVERTED FOR ITEM POSED IN THE NEGATIVE.

Item	Mean	SD
The website responds quickly.	6.3	0.70
I would need to ask questions to know how to use this website. **	6.3	0.82
I would tell others about this website.	6.3	0.93
This website is easy to use.	6.0	0.97
I would use this website in the future.	5.9	1.39
Most people would figure out how to use this website very quickly.	5.8	1.15
Using the website is frustrating. **	5.7	1.53
The information returned from the repository is helpful.	5.6	1.31
The website has a very attractive presentation.	5.6	1.36
I found the website unnecessarily complex. **	5.5	1.46
The information for each article entry will be helpful to me in my position.	5.4	1.09
This web-site is well-organized.	5.3	1.29
I felt that I had to click too many times to complete typical tasks in the website.	5.3	1.89
The website is interesting and engaging.	5.2	1.11
I found what I was looking for quickly.	5.1	1.39

TABLE V
PRIMARY WORK ENVIRONMENTS OF USERS.

Work Environment	N	%
Primary and Secondary	46	44.2%
Higher education	39	37.5%
Non-profit	13	12.5%
Industry	2	1.9%
Governmental Agency	2	1.9%
Other	2	1.9%

TABLE VI
FOCUS OF WORK AMONG USERS.

Focus of Work	N	%
Implementing a CS education program	35	22.7%
Conducting research on CS education	32	20.8%
Supporting teacher professional development	26	16.9%
Evaluating CS education programs	22	14.9%
Conducting research on STEM education	14	9.09%
Selecting CS curricula (e.g., for a school or district)	12	7.8%
Working with a university - teaching CS	10	6.5%
Other	3	2.0%

group we did not consider before when a user commented that "Generations of future doctoral students will be incredibly grateful for this resource."

V. Discussion

The resource center was developed in several phases and input from the users were taken into account to determine how the next phase should progress. This aligns with best practices from user-centered design software engineering.

When we look at the criterion given by Fincher (2010) and Armbruster and Romary (2012) (see Table I), we collected feedback about the considerations needed for design and addressed the issues raised [26], [25]. For the challenge of identification and deposit of data (Fincher's curation, content, contribution), our focus group first identified key elements of important data to be retained and additional results from future testing (concept, alpha, beta) seem to indicate we are collecting and depositing the data our users are looking for. In all phases (focus group to beta), there is a reiteration of the utility of the "Research Guides" and general excitement about their development and inclusion on the site. This part of the site is seen as extremely valuable to users and it is one area where we should concentrate growth in the near term.

For the challenge of access and use (Fincher's community and catalogue) [25], from the research group to the post release testing, there have been technical problems raised, issues of how something should work, or how a user expects it to work when it did not work as they expected. Each of these is an aspect of access, but more of use. One of the challenges to access is to make sure the community is aware of the site and what it offers. Based on the growth of our user base, we can see that community awareness of the site is growing and therefore it is being utilized more.

For the challenge of sustainability and preservation (Fincher's control), it is a challenge going forward for all resource centers and csedresearch.org is not immune. Keeping the data current, particularly as new articles are published every year and new instruments are developed, will be a challenge. A sustainability plan is currently in development to address both issues and to ensure that the data remains relevant, the first step of which is the inclusion of a feature of the site that allows authors to contribute their own articles to the resource center and even curate the data. In this way, the new data would only need to undergo a validation. It eliminates a discovery phase of the process if authors contribute. The ability for users to suggest content has already been implemented on the site.

This represents the next major challenge to this work and the focus of our next steps. We will focus on sustainability of the continued maintenance and upkeep of the resources even when community contribution becomes more widely adopted. In the presence or absence of funding, a team needs to be identified for ongoing maintenance. One of the current options that is being explored is through strategic partnerships with groups that have a vested interest in the resources created for and housed in the resource center. We currently have such a partnership with RPPforCS and are leveraging that community for content as well as exposure of the site to more users and contributors. The RPPforCS (https://www.csforall.org/projects_and_programs/rppforcs/) community is made up of researchers and practitioners in the K-12 computing education space that are collaborating on research projects in that domain. The resource center has been presented to this community several times through webinars and other newsletter features. We have starting working with the members of this community to understand how to continue with maintenance and growth of the sites to meet their needs.

For research limitations, in each phase, the number of participants was small. This was by design in the concept and alpha phase to solicit in-depth feedback. For beta, the response rate of approximately 10% of visitors is low and for post-launch it was 21.4%, but visiting the site and interest in the content does not necessarily equate to visitors willingness to provide feedback. Because of this, it is probable that there are opinions and feedback not being recorded in our data. However, the site offers a feedback mechanism, so additional comments, concerns, or technical difficulties can be handled by the research team as they arise.

VI. Conclusion

Csedresearch.org is a free, easily accessible, user-friendly site. The resources support CS education researchers by significantly reducing the amount of time needed to search relevant literature. It may also open up opportunities to conduct new research using resource center data or validate old research. Users have easy access to literature and reports about a variety of CS education interventions by housing a larger number of commonly-used instruments for evaluating STEM and CS education activities.

The resource center is useful for policymakers who make important decisions about computing education at the national, state, and district level by providing a way for them to find relevant studies about practices to implement and mistakes they hope to avoid. It supports primary and secondary educators and administrators, particularly those new to CS education, by helping them find promising CS education practices.

The processes involved in creating csedresearch.org and other sites that support computing education research is becoming clearer. This article describes our approach based on best practices in software development and in creating shared resource centers for computing education. The site continues to evolve and maintain its relevance as we consider not only essential resources to users, but also the underlying data and how it can be used to define promising practices in an empirical manner.

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