A. State of Computing Education Research Literature

Over the past year, the Science and Technology Policy Institute (STPI) sought to evaluate the current state of knowledge within the field of computing education research. We were seeking to understand the epistemological commitments of computing education researchers and to identify what advances have been over the past 30 years.

We found that many published computing education papers and articles are not education research papers, per se: they lack explicit appeals to existing or proposed learning theories, clearly defined intended learning outcomes, or validated measures of the degree of student attainment of intended learning outcomes. Instead, computing education papers typically rely on unvalidated instruments, if any, to assess student attitudes toward computing or toward a particular class or tool and, as such, offer little to no generalizability.

We were not able to identify a literature that indicated shared methodologies for CER. Nor was there clear evidence that a robust discussion about researchers’ epistemological commitments existed, resulting in confusion over what constituted research. Without shared methods or a common understanding of what constitutes valid ways of knowing within CER, researchers are limited in what they can extrapolate from or contribute to a core CER literature. The lack of empirical research on best practices in computer science education has led researchers to repeatedly ask the same basic questions without clear progress toward answering them, although recent practical successes show promise (Porter, 2013; Kaufman, 2013). Our analysis indicates that the disparate and disjointed nature of computing education research that has complicated our analyses may also contribute to larger inefficiencies in achieving meaningful growth toward improving computing education.

STPI also conducted research interviews at the Association for Computing Machinery’s (ACM) annual meeting of the Special Interest Group in Computer Science Education (SIGCSE) in March 2013. These semi-structured interviews sought to gather information from interviewees’ regarding their professional background, the capacity of CS researchers to conduct CER, sources of information they rely upon for computing education information, their desired direction for the CER community, and potential NSF actions to strengthen the CER community.

Experts identified a lack of training in educational research and a lack of shared methodologies within the field as barriers to improved research. Additionally, interviewees noted the focuses of SIGCSE conference sessions are overwhelmingly (a) large university contexts and (b) demonstrating their own teaching practices and tools, which offer insight into only a small portion of computing education and do not speak to the realities faced in smaller colleges. This
manifests as inconsistent feedback from reviewers, who sometimes define research narrowly as quantitative studies showing statistical significance regardless— or in spite of— the soundness of the underlying educational research methods.

B. Defining a Corpus of Literature

The Scopus abstract and citations database was used to assess the CER literature. Scopus indexes a large number of conference proceedings in addition to publications making it the database of choice for this exercise. The terms “computer science education” or “computing education” were used and resulted in 2,783 documents (excluding Chinese documents) that appeared to be CER-related. A majority (82%) of these papers were presented at conferences, consistent with Sheard et al. (2009) who indicated that between 2005 and 2008 alone there were 979 refereed papers in CER-related conferences.

Computer Science Education Research (Fincher & Petre 2005) provides an introduction to computing education research and describes the scope of CER, a range of research methods that can be used to conduct CER, and a classification system for CER based upon the authors’ observations. They offer 10 categories of CER including (1) student understanding; (2) animation, visualization and simulation; (3) teaching methods; (4) assessment; (5) educational technology; (6) transferring professional practice into the classroom; (7) incorporating new developments and new technologies; (8) transferring from campus-based teaching to distance education; (9) recruitment and retention; and (10) construction of the discipline.

Using Google Scholar, we identified articles that cited Fincher & Petre. Many of these articles discussed methods for categorizing the field of CER. Using this initial set of citing articles and a snowball sample of other classification articles references in the initial set, we found a total of 22 articles discussing methods to classify CER publications. The authors typically defined their corpus using a specific conference or set of conferences. For the majority of papers, multiple researchers participated in the development and validation of the classifications. The classifications primarily focused on the methods used to compile the classification schema, rather than the phenomenon of interest in the research articles. The classification papers helped us better understand the methods used in CER but did not provide a robust list of topics within CER as initially hoped. Sheard et al. offered a categorization schema that included (in order of prevalence):

- Ability/aptitude/understanding
- Teaching/learning/assessment techniques
- Teaching/learning/assessment tools
- Teaching/learning theories & models
- Curriculum
- Gender issues
- Educational technology
- Recruitment, progression, pathways
- Cheating & plagiarism
- Research
- Accessibility
While this schema and others offered are useful starting points, it appears that there is no consensus or even discussion of what the research foundations of CER are. IEEE has issued a call for a special issue of IEEE Transactions on Education to appear in 2015 that will address computer science education issues using a systematic literature review process to explore the CER literature in greater depth. Systematic literature review is a methodology that has emerged in an effort to find meaning in diverse bodies of research literature. Interdisciplinary teams use large journal databases to systematically identify a question of interest to the field, explore the existing literature, and synthesize their findings using an iterative, reproducible, justifiable protocol.

C. Evaluating Computing Education Research

While Fincher & Petre and Sheard suggest areas of CER research, there also needs to be a conscious consideration of the shared research practices that might define the CER community. A recent joint report from the NSF and DOEd (2013) outlines Common Guidelines for Educational Research and Development, which emphasizes the need for education research to be theory-based and justified by appropriate methods—both quantitative and qualitative; from small-n case studies to large-n studies. Education research should offer an explicit chain of reasoning explaining how inputs and activities could lead to desired outcomes. Elliott Tew & Dorn (2013) call for CER researchers to develop and use validated assessment instruments to improve the reproducibility and generalizability of studies. CER can be constructive—building upon earlier work and embracing a range of epistemological commitments and methodologies. Such shared values can serve to foster a vibrant and connected CER community.

References List


