

Understanding Institutional Factors to Broaden Participation in Computing

Heather M. Wright

Center for Evaluating the Research Pipeline *Center for Evaluating the Research Pipeline* *Department of Computer Science*
Computing Research Association Computing Research Association Harvey Mudd College
Washington, DC, USA Washington, DC, USA Claremont, CA, USA
heather@cra.org burcin@cra.org lewis@cs.hmc.edu

Abstract—This work aims to introduce a new line of research, lead by the Computing Research Association’s Center for Evaluating the Research Pipeline and Harvey Mudd College, to stakeholders at the RESPECT 2019 conference. It is well known that the field of computing lacks diversity, and more qualified researchers are needed to meet the demands of the computing labor force. Further, while researchers and practitioners have recommendations for improving department culture to broaden participation in the field, we do not know which practices have the most impact on these goals. Through the analysis of national data collected from students, faculty, and institutions; our research will contribute to the understanding of institutional-level factors that help shape students’ experiences, interests, and sense of belonging in the field of computing. In doing so, this project aims to identify evidence-based best practices that can be adopted by the broader academic community to increase diversity in computing and STEM.

Index Terms—research initiatives, computer science education, evidence-based best practices, diversity, broadening participation in computing

I. INTRODUCTION

The U.S. Bureau of Labor Statistics projects a 19% job growth for Computer and Information Research Scientists between 2016 and 2026. While they estimate that at least a Master’s degree is necessary for these entry-level research positions [1], 21% of Master’s degrees and 12% of doctoral degrees were awarded to students from racial or ethnic groups underrepresented in computing (e.g., those from American Indian/Alaska Native, African American/Black, Hispanic/Latino/a, or Native Hawaiian/Pacific Islander backgrounds) [2]. Studies have shown these students are less likely to persist in their degree program beyond the first year of college [3]; this finding also holds true among students of color who enter college with the intentions to major in science fields [4]. As such, it is crucial to make strides to improve the factors that contribute to student attrition in the field as an effort to retain a diverse workforce required to meet the growing needs of the nation.

Researchers and practitioners have been examining and building interventions and pedagogies to broaden participation in computing (BPC) and retain students in the field [5], [6].

Social science literature on students’ academic experiences and levels of success has identified several factors at the individual and institutional levels that influence field interest and persistence. For example, studies point to students’ self-confidence [7], sense of belonging to their field [8], and levels of social support [9] as important contributors to academic success and retention. These factors have been found as interdependent with institutional environments; scholars have highlighted that institutional culture and climate play an important role in influencing students’ academic achievement and persistence [10]. At the department level, characteristics such as faculty engagement in diversity programs and the degree to which departments place importance on various academic programs, have also been found as potential indicators of students’ entry and persistence in STEM fields [10], [11].

Taking what is known from the literature and expanding on current BPC efforts, Computing Research Association’s (CRA) Center for Evaluating the Research Pipeline (CERP) has partnered with Harvey Mudd College in a project that will collect and analyze survey, interview, and website data; and host intervention-style workshops and meetings with U.S. based academic departments. Evidence-based best practices will also be shared with the broader community through publications and conference presentations. Ultimately, this project aims to improve all students’ experiences in computing degree programs by guiding positive culture change based on rigorous evidence-based best practices, with the intention of retaining a diverse pool of students.

II. METHODOLOGY

In this project, we will (a) collect and analyze national data to generate insights and (b) engage with the departments to enable dissemination of these insights to the departments.

A. Data Collection and Analysis

Data collection in this project will be multifaceted, utilizing several research methods to collect data about individuals (e.g. students and faculty) as well as about departments. Data collected at the individual level will include survey data from undergraduate and graduate students in computing degree programs across the U.S. and Canada. CERP has been

collecting this type of data through their Data Buddies Survey (DBS)¹ since 2011.

Since then, CERP's data have been used to understand the mechanisms that may influence students' experiences in their degree programs at the individual level². Between 2013 and 2017, CERP collected more than 40,000 undergraduate and 14,000 graduate student responses nationwide. Further, samples of survey respondents are tracked each year, allowing for longitudinal data analysis. Departments who volunteer for the project receive a report that summarizes their students' responses and compares them to a national sample of similar students. For this project, the department report will serve as an important tool for disseminating best practices during this project.

Another method of data collection for this project includes surveys and interviews with faculty and department chairs. These data will include information on respondents' perceptions of their department's climate, policies and procedures related to BPC efforts, and the steps that the faculty and/or departments have taken to increase diversity.

Additional institutional level data will be collected from departmental and institutional websites to gauge their outward-facing representation, faculty composition, and accessibility. Resources from CRA Taulbee Survey and the U.S. Department of Education will also be utilized. Alongside individual data, these institutional level data will be used to form a clearer picture for data analysis.

B. Community Engagement and Research Dissemination

Community engagement is a central feature of this project; in tandem with data analysis, we will seek to engage with the broader CS community in several ways. First, we will hold workshops and one-on-one meetings with faculty and department chairs. These workshops and meetings will serve as interventions, providing departments with actionable items based on research findings while also engaging them in conversations related to BPC efforts. The goals of these conversations will be to better understand departmental practices, identify the challenges faced by the departments, and understand their goals for broadening participation and increasing student retention. As CERP collects longitudinal data throughout the duration of the project, we hope to observe impacts of these interventions in the data overtime and determine which practices may be most impactful for BPC efforts.

Alongside workshops, we will also engage in conversations with community members at conferences like RESPECT and SIGCSE to reach broader audiences. These conversations will aim to gauge stakeholder perspectives on project goals and emergent research findings. Further, we will utilize CSTeachingTips as a driving force for the dissemination of best practices generated from research findings. Tip sheets will be distributed online and at these conferences and meetings. Best

¹More information about DBS can be found at <http://www.cra.org/cerp/data-buddies/>

²CERP publications produced using DBS data can be found at <https://cra.org/cerp/research-findings/>

practices will also be disseminated through research presentations, publications, and online sources such as Computing Research News.

III. IMPLICATIONS

This initiative will not only contribute to research on BPC efforts, but it also aims to create an interactive relationship between researchers and computing departments to promote positive culture change. The project team will actively work to deliver results in the form of actionable insights while at the same time, learning from the community to inform the research. This approach will also allow us to understand current BPC practices and recommendations and refine them into evidence-based best practices for adoption by the broader community.

Beyond impacting efforts for BPC in higher education, the research results can be transferable to other STEM fields that also suffer from low diversity. Further, any positive change influenced by this project will not be limited to the higher education sphere; there is the potential to influence the strength of the nation's computing workforce as whole for future generations.

ACKNOWLEDGMENT

The current work is supported by National Science Foundation grant DUE-1821136, awarded to the Computing Research Association. The authors would like to thank Dr. Jane Stout for her contributions developing this initiative and previously serving as PI on the award.

REFERENCES

- [1] Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, Computer and Information Technology Occupations, 2018.
- [2] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS): Completions Survey, 2015.
- [3] National Student Clearinghouse Research Center, "Snapshot Report: First-year Persistence and Retention," Herndon, VA, 2017.
- [4] E. A. Rogers, C. Strenta, R. Adair, M. Matier, and J. Scott, "The role of ethnicity in choosing and leaving science in highly selective institutions," *Research in Higher Education*, vol. 37, no. 6, pp. 681-709, 1996.
- [5] C. Stephenson, A. Derbenwick Miller, C. Alvarado, L. Barker, V. Barr, T. Camp, C. Frieze, C. Lewis, E. Cannon Mindell, L. Limbird, D. Richardson, M. Sahami, E. Villa, H. Walker, and S. Zweben, "Retention in Computer Science Undergraduate Programs in the U.S.: Data Challenges and Promising Interventions," New York, NY: ACM, 2018.
- [6] C. Lewis, "Twelve Tips for Creating a Culture that Supports All Students in Computing," *ACM Inroads*, vol. 8, no. 4, pp. 17-20, 2018.
- [7] R. W. Lent, S. D. Brown, and K. C. Larkin, "Self-efficacy in the prediction of academic performance and perceived career options," *Journal of Counseling Psychology*, vol. 33, pp. 265-269, 1986.
- [8] C. Good, A. Rattan, C. S. Dweck, "Why do women opt out? Sense of belonging and women's representation in mathematics," *Journal of Personality and Social Psychology*, vol. 102, pp. 700-717, 2012.
- [9] H. R. Tenenbaum, F. J. Crosby, and M. D. Gliner, "Mentoring relationships in graduate school," *Journal of Vocational Behavior*, vol. 59, pp. 326-341, 2001.
- [10] A. A. Stacy, R. Allen, and Campbell A. G., "Reimagining the Pipeline: Advancing STEM Diversity, Persistence, and Success," *BioScience*, vol. 64, July 2014.
- [11] T. S. Ransom, "When Do Faculty Inputs Matter? A Panel Study of Racial/Ethnic Differences in Engineering Bachelor's Degree Production," Publicly Accessible Penn Dissertations, Paper 790, 2013.