Lowering the Barrier for Undergraduates to Learn about Computational Research through a Course-Based Conference Experience

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***Abstract*—Computer science research is largely communicated through conferences, and these in-person meetings offer a potentially powerful means to engage undergraduates in cutting-edge research. However, attending a conference as an undergraduate is an opportunity reserved for very few students, typically those who are doing relevant research with a faculty member at the time of the meeting. In an effort to give a broader set of students access to a scientific meeting, we describe a pilot study where thirteen students attended an ACM conference as part of an interdisciplinary course. While these numbers are admittedly small, students reported larger average gains in learning about oral and poster presentations compared to a large background population of students who participated in course-based research. In a follow-up survey two and a half years later, the cohort reported that they learned more on average about scientific careers and professional networking compared to other students whose conference attendance was not linked to a course. We find that conference attendance is a promising way to engage a broader swath of students in computer science and interdisciplinary topics.**

***Keywords*—undergraduate education, conferences, interdisciplinary courses, broadening STEM participation**

I. Introduction

Conferences and workshops are the cornerstone of computer science research dissemination, and undergraduate students have the potential to benefit from conference attendance in numerous ways. Students may gain a broad sense of active research areas in computing, observe how real research is communicated, and have a chance to meet researchers at all career stages (from graduate students to leaders in the field to industry representatives). Undergraduates who have attended scientific conferences have reported increased confidence and an increased sense of belonging [1]–[5]. Further, students gain a better understanding of research and the profession [2]–[4]. Research has shown that technical conference attendance can be beneficial even for early-career computer science undergraduates [2].

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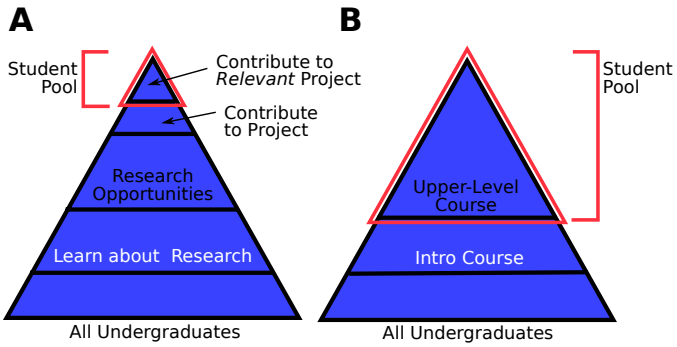

Fig. 1. Paths to undergraduate conference attendance. **(A)** This opportunity is typically reserved for students who have conducted research. **(B)** This report proposes course-based participation.

Despite the large gains that can come with conference attendance, only a handful of undergraduates ever get this opportunity. Undergraduates who attend conferences typically have worked on research projects that are presented at the venue, and presenting work has been shown to be valuable for undergraduates [4]–[6]. However, there are numerous barriers to engaging undergraduates in research [7], [8]. Many undergraduates are unaware that academic research is a possibility, and may not think to ask for opportunities. While funded research opportunities exist, they are often competitive, and students may not be able to participate due to financial or family obligations. Of the students that find research opportunities, they usually need to meaningfully contribute to a project that is relevant to a scientific meeting. Finally, the timing of conferences can make undergraduate attendance difficult. As a result, only a small number of the students who navigate this process end up attending conferences (Figure 1A).

Researchers in science education have acknowledged the barriers that students face in securing research opportunities [7], [8], which are closely tied to barriers for students attending conferences. In an effort to broaden participation in undergraduate research, Classroom-Based Undergraduate Research Experiences (CUREs) bring research opportunities into undergraduate courses [9]. The Genomics Education Part-

nership (GEP) is a multi-institutional example from biology where undergraduates help annotate fly and other eukaryote chromosomes [8]. GEP students reported learning and professional gains similar to those reports by summer undergraduate researchers [8].

Classroom-based opportunities have reduced the barrier to learning about scientific research, and we wanted to similarly reduce the barrier for conference attendance by integrating it into a course. Inspired by the benefits of CUREs, we have integrated conference attendance as a component of an upper-level course at a primarily undergraduate institution. In 2016, Dr. Ritz conducted a pilot study to bring thirteen undergraduates to an ACM conference in Seattle, WA, USA. The study was designed to assess how conference attendance affected student perceptions about scientific research compared to other student experiences that (a) did not involve conference attendance and (b) were not part of a course. While the numbers from student surveys are not large enough to make concrete claims, this experience report describes the assessments and trends that we have observed thus far.

II. Methods & Implementation

Reed College is a private primarily undergraduate institution serving about 1,400 students in Portland, Oregon, USA. Dr. Ritz, a computer scientist by training, teaches computational biology courses within Reed's Biology Department.

A. Course, Conference, & Assignments

Dr. Ritz integrated conference travel into an upper-level elective *Computational Systems Biology* course (Bio331), where students learn about biological networks and the graph algorithms that elucidate network features to address open biological questions. This course requires one semester of an introductory Biology course and one of two other prerequisite courses: either a programming-heavy *Introduction to Computational Biology* course or *Introduction to Computer Science*.

The 2016 pilot study was conducted in the first offering of Bio331, so the course was designed from the start with a conference experience in mind. Bio331 students attended the Association for Computing Machinery's Conference on Bioinformatics, Computational Biology, and Health Informatics (ACM-BCB [10]). ACM-BCB presents computer science contributions to biology/biomedical fields, and its breadth in application is of interest for students from a variety of STEM majors. ACM-BCB was held in Seattle, Washington, USA in 2016, a 3.5-hour drive from Reed College.

The Bio331 assignments that pertained to ACM-BCB travel were staggered over three weeks, and the students conducted a multi-week independent project on a topic of their choice at the end of the semester (Table I). Importantly, students were given complete choice regarding the talks they attended at the conference, allowing them to explore topics that were not necessarily related to Bio331. Example assignments are freely available at https://www.reed.edu/biology/courses/bio331/conference-resources.html.

TABLE I
Example Assignments Related to Conference Attendance

Before the Conference	Complete pre-course survey Read abstracts for relevant tracks Conference attendance logistics Prepare to field questions from attendees
During the Conference	Write short summaries of 3 talks Write short summaries of 2 posters
After the Conference	Complete post-course survey Write a detailed summary of one paper Write a reflection essay
Independent Project	Give an oral presentation Write a mini-paper in conference template

B. Assessment

1) Pre- and post-course surveys: We assessed the conference experience using the Classroom Undergraduate Research Experience (CURE) survey[1] [11]. The pre-course survey determines student demographics, attitudes about science, and experience with course elements, and the post-course survey estimates student learning gains in course elements and changes in attitudes about science. Student responses are compared to a much larger background dataset of student responses from other CUREs. We administered the pre-course survey a few days before the conference and the post-course survey upon returning from the conference to evaluate the impact of conference attendance rather than the impact of the entire course (Table I).

2) Long-term surveys: In May of 2019, we followed up with any student who had traveled to a conference that was supported by Dr. Ritz. The 2019 survey covered demographic information, perceived learning gains, influence of the conference on career choice, and barriers for attending. This survey is freely available at https://www.reed.edu/biology/courses/bio331/conference-resources.html.

III. Results and Discussion

Seven students were enrolled in Bio331 in the fall of 2016. Dr. Ritz recruited six more Reed students who had previously taken *Introduction to Computational Biology* to participate in the conference. We consider this group of thirteen students to be the **BCB Cohort**, which included two sophomores, two juniors, seven seniors, and two recent graduates. Five (38%) of the BCB Cohort were women and five (38%) were members of an underrepresented group. Strikingly, over 50% of the BCB Cohort were interdisciplinary majors with Biology and over 20% were computer science or mathematics majors. All registered Bio331 students completed the course after returning from the conference.

A. CURE Survey Assessments

The CURE pre-course and post-course surveys were administered by an independent survey system, and we received an analysis of results [11]. Eleven students in the BCB

[1]The CURE and other surveys were conducted with IRB approval by Reed College (#2016-S26, #2017-S23 & #2018-S24).

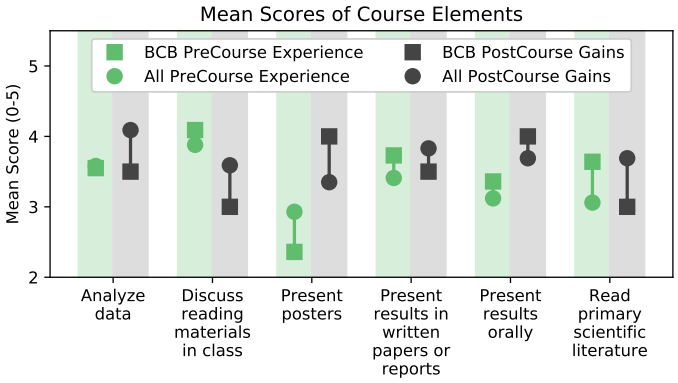

Fig. 2. Perceived experience and learning gains of BCB Cohort compared to CURE survey background population. Score elements for BCB Cohort (squares) compared to background (circles). Green: student experience from pre-course survey (Reed $n=11$; All $n=6,195$). Gray: perceived gains from post-course survey (Reed $n=5$, All $n=4,876$).

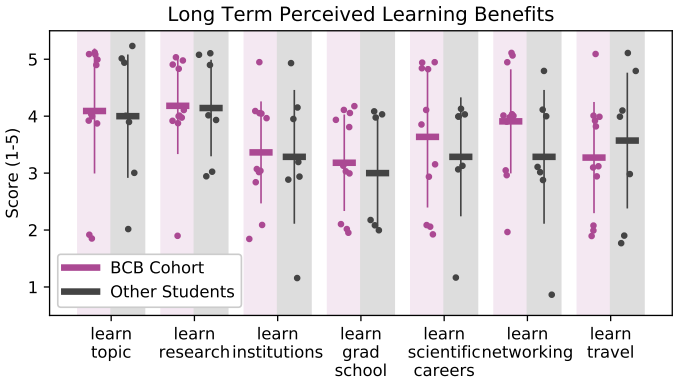

Fig. 3. Perceived learning benefits for the BCB Cohort (magenta, $n=11$) vs. other students who attended conferences (gray, $n=7$) evaluated two and a half years after ACM-BCB '16. Mean and standard deviation shown on a scale from 1-5; a randomized jitter was applied to the points for visibility.

Cohort took the pre-course survey, and only five students took the post-course survey. We do not aim to find significant correlations in our data due to this pilot study's small numbers, though the survey analysis compared to a much larger background of students who participated in CUREs.

We considered six elements from the CURE surveys that were related to the conference experience. On average, the BCB Cohort reported less experience in preparing posters but more experience in reading primary literature compared to the background population (Figure 2 green). In the post-course survey, the BCB Cohort reported a larger average score for presenting posters and oral results and a smaller average score for the other elements (Figure 2 gray). The pre-course experience and post-course gains are dependent, since students who had experience reading literature may report smaller gains in that element compared to students who had no experience reading literature. Given this consideration, the largest gains in the BCB Cohort compared to the background population were related to presenting work.

B. Long-Term Survey

In May of 2019, we followed up with the thirteen students from the BCB Cohort and twelve other undergraduates who had attended a conference as part of Dr. Ritz's research. This background set of students was more representative than the CURE survey students, since here all students attended a conference, and all but one student was a Reed undergraduate. Most students in the background population attended computational biology conferences such as ACM-BCB, but a few also also attended cryptography and cell biology meetings. Seven students in the background population (58%) were women. We note that all students in the background set had conducted research that was presented by themselves or others at the conferences; thus they may have even larger perceived benefits according to previous studies [4], [6].

Eleven students from the BCB Cohort and seven students from the background population responded to the 2019 survey. Students in the BCB Cohort felt, on average, less prepared to attend a conference than the background population[2] (3.18 ± 0.72 vs. 3.42 ± 1.18). This is not surprising, since all of the students in the background population were presenting research. The BCB Cohort had increased confidence in preparation for attending a future conference (4.09 ± 0.66), but the average score was still lower than the background population (4.43 ± 0.49). Interestingly, six BCB Cohort students (54.5%) reported that they became *more interested* in the conference topic and career opportunities (the other students reported that the experience *did not change* their future interests). In the background population, only three of the seven students (42.8%) became *more interested* in the conference topic and career opportunities. This hints that conference attendance in a course may help students clarify their career paths more than students presenting work at the meeting, since those presenting research are already engaged in the field.

We compared the BCB Cohort to the background in their response to seven learning benefits related to the original goals of the study: *How much did you feel you learned about...*

1) The conference topic?
2) Academic research?
3) Other types of institutions?
4) Graduate school?
5) Scientific careers?
6) Professional networking?
7) Professional travel?

Small numbers prohibit a statistical analysis of responses, but there is a slight increase in average BCB Cohort score in learning about scientific careers and learning about professional networking (Figure 3).

We also surveyed the hardships that students encountered during the conference: five BCB Cohort students and three background population students reported hardships such as missed classes, bad timing with other events, and difficulty working out logistics. On average, these hardships did not have a large impact on either group (BCB Cohort 1.55 ± 0.68 and background 1.6 ± 0.80). All participants who responded to the survey found the conference topic interesting and stated that they would attend another conference if they had the opportunity.

[2]Values in this subsection are reported as (mean $\pm$ s.d.) on a 1-5 scale.

IV. Discussion

We have described our first steps towards assessing the influence of a course-based conference experience to help broaden engagement of undergraduates in STEM disciplines. Classroom-based experiences have the benefit of engaging a larger set of students, and integrating conference attendance into a course is a clear way to provide the experience for more students in an unbiased manner. Since our pilot study, others have written about how to support undergraduates at conferences [12]. A recent study found that formally preparing for a biology conference helped students reduce anxiety about professional interactions as well as gain a sense of belonging [3].

We focused on a technical conference at the intersection of computer science and biology/biomedicine. Many computing conferences encourage undergraduate attendance, including SIGCSE, the Grace Hopper Celebration of Women in Computing, and the Richard Tapia Celebration of Diversity in Computing. These meetings, while beneficial for students, do not serve the same audience as technical conferences. We encourage faculty to consider bringing students to conferences in their area of expertise - while many of the topics may be beyond the students' knowledge, they will gain a broader sense of the faculty's research area. Further, conferences that span interdisciplinary topics may expose undergraduates to different fields of STEM, potentially broadening participation in certain subfields such as computational biology.

There are substantial costs for integrating a conference into a course, especially if the conference is not located in the same city as the institution. The 2016 pilot study was supported by an NSF grant for undergraduate conference travel (#1643361). Students who presented research at conferences were able to apply for college and department funding, and were supported by other grant mechanisms. In our experience, conference organizers are excited to have undergraduates attend and have offered discounts for conference registration. In order to make this a sustainable activity, we are considering less-expensive venues where students can still see technical research, meet graduate students and faculty, and learn about professional travel and networking. Some options may be attending smaller workshops and symposia run by graduate students, or traveling to a nearby research institution for part of their seminar series. Biology courses often have labs with substantial reagent or field trip costs; if conference attendance was considered similar to these activities, faculty may be able to receive departmental support.

While the CURE surveys were useful to establish initial assessments in the pilot study, many of the elements from the CURE survey were not relevant to a conference experience, but rather reflected an overall course experience. For example, course elements and learning gains related to assignments, tests, group work, and labs were not relevant for conference attendance. Reed students also have research experiences as part of courses (including a required year-long senior thesis), which conflates the CURE surveys. Further, as of 2018, the independent survey system is no longer available for collating and analyzing the results [11]. We continue to refine a survey that aims to assess conference activities within a course.

While our initial results show promising trends, further assessments with more students are required to draw conclusions about course-based conference attendance. We are continuing to integrate the conference experience in Bio331, and ten students from the Fall 2019 class attended IEEE BIBM in San Diego, CA. We plan to continue the longitudinal study for this and future cohorts of Bio331 students. Recent NSF funding has also helped establish an ACM-BCB travel award for undergraduates from different schools, and the first cohort of eight students attended the 2019 conference in Niagara Falls, NY. This effort will help shed light on the impact of conference attendance through course participation compared to a travel award.

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References

[1] J. M. Francioni, "A conference's impact on undergraduate female students," *ACM SIGCSE Bulletin*, vol. 34, no. 2, pp. 66–69, 2002.

[2] H. M. Wright and N. B. Tamer, "Can sending first and second year computing students to technical conferences help retention?" in *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*. ACM, 2019, pp. 56–62.

[3] E. A. Flaherty, R. E. Urbanek, D. M. Wood *et al.*, "A framework for mentoring students attending their first professional conference," *Natural Sciences Education*, vol. 47, no. 1, 2018.

[4] H. W. Helm and K. G. Bailey, "Perceived benefits of presenting undergraduate research at a professional conference." *North American Journal of Psychology*, vol. 15, no. 3, 2013.

[5] A.-B. Hunter, S. L. Laursen, and E. Seymour, "Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development," *Science education*, vol. 91, no. 1, pp. 36–74, 2007.

[6] P. A. Mabrouk, "Survey study investigating the significance of conference participation to undergraduate research students," *Journal of Chemical Education*, vol. 86, no. 11, p. 1335, 2009.

[7] E. Seymour, A.-B. Hunter, S. L. Laursen, and T. DeAntoni, "Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study," *Science education*, vol. 88, no. 4, pp. 493–534, 2004.

[8] D. Lopatto, C. Alvarez, D. Barnard *et al.*, "Genomics education partnership," *Science*, vol. 322, no. 5902, pp. 684–685, 2008.

[9] L. C. Auchincloss, S. L. Laursen, J. L. Branchaw *et al.*, "Assessment of course-based undergraduate research experiences: a meeting report," *CBE Life Sci Educ*, vol. 13, no. 1, pp. 29–40, 2014.

[10] "ACM Conference on Bioinformatics, Computational Biology, and Health Informatics (ACM-BCB)," http://acm-bcb.org/index.php, [Online; accessed 1-October-2019].

[11] "Classroom Undergraduate Research Experiences (CURE) Survey," https://www.grinnell.edu/academics/resources/ctla/assessment/cure-survey, [Online; accessed 1-October-2019].

[12] J. Davis and C. Alvarado, "Supporting undergraduates to make the most of conferences," *ACM Inroads*, vol. 8, no. 3, pp. 32–35, 2017.