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Panel: Teaching To Increase Diversity and Equity in STEM

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Panel: Teaching To Increase Diversity and Equity in STEM

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1. SUMMARY

TIDES (Teaching to Increase Diversity and Equity in STEM) is a three-year initiative to transform colleges and universities by changing what STEM faculty, especially CS instructors, are doing in the classroom to encourage the success of their students, particularly those that have been traditionally underrepresented in computer science.

Each of the twenty projects selected proposed new interdisciplinary curricula and adopted culturally sensitive pedagogies, with an eye towards departmental and institutional change. The four panelists will each speak about their TIDES projects, which all involved educating faculty about cultural competency. Three of the panelists infused introductory CS courses with applications from other disciplines, while one of the projects taught computational skills in natural science courses.

2. OBJECTIVE

The continued failure of computer science departments to match the diversity of the students in their institutions is an indication of the importance of exploring issues of multicultural education and implications for CS. To address this issue, the Association of American Colleges & Universities launched a three-year initiative in 2014 to support and mentor faculty teams at twenty institutions as they developed new curriculum and/or adopted culturally sensitive pedagogies to better support the learning and retention of all students, especially female students and students traditionally underrepresented in computing. Approximately half the projects modified or created new computer science courses which met a departmental or college requirement. The other projects injected computer science concepts into courses from other disciplines.

Faculty and administrators from all the TIDES projects attended a one week-long TIDES Institute, where they learned about acknowledging and addressing implicit bias [3], ways of incorporating student interests and cultural perspectives into courses to improve student success and retention, Banks' model of five dimensions of multiculturalism [1], overcoming stereotype threat, recognizing the importance of social capital and attribution theory [11], helping students develop growth mindsets [2], and meaningful ways of measuring change. (Several of these presentations are available at the TIDES website: http://www.aacu.org/tides/cultural-competency.) Experts in cultural competence and institutional change served as coaches to each project, providing individualized guidance on how to overcome challenges and how to assess the projects so they might serve as models for other institutions. Several aspects of the TIDES Initiative could be replicated by faculty interested in institutional change: an interdisciplinary team with administrative support, a supportive community beyond the institution to exchange ideas as the projects ran into resistance, and expert advice on cultural competence, effective evaluation measures, and institutional change.

2.1 Helen Hu

The Westminster College TIDES project developed a set of CS 0 POGIL activities with cultural relevance in mind, which were first adopted at Westminster as part of a first-year interdisciplinary learning community, before being adopted by four CS instructors from four other institutions. All instructors from multiple disciplines attended three-day workshops on POGIL (Process Oriented Guided Inquiry Learning), a student-centered pedagogy that emphasizes collaborative, inquiry-based learning [6]. Students from all five institutions took pre/post student surveys and were found to be significantly more comfortable and less uneasy with computers and technology, with female students increasing significantly more than male students. For the two institutions where there was comparison data with non-POGIL students, the students in the POGIL courses became significantly more comfortable and less uneasy with computers and technology than did the non-POGIL students [5].

In addition to running several workshops on teaching to *all* students, the Westminster TIDES project developed a rubric

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for culturally responsive assignments [4] and a framework for evaluating student engagement in terms of student participation and context [5]. Preliminary results from the multiple institutions demonstrated the importance of convincing POGIL instructors about the importance of connecting the CS content to students' interests and culture [5]. The CS 0 POGIL activities, workshop materials, rubric and framework are available at http://www.westminstercollege.edu/tides/.

2.2 Douglas Blank

Bryn Mawr College's TIDES project focused on introducing culturally relevant materials into the Physics computational curriculum for all of their courses. Because the Physics department had little computation in any course, we were able to design the entire curriculum from scratch. Our goal was to create a consistent set of self-paced modules that captured the best practices of computing and inclusive teaching for use in any Physics course. Although Bryn Mawr College is a women's college, undergraduate Physics courses often have students from Haverford College (a coeducational institution), as well.

We were able to meet our goals, in part, by using Python in a browser through Jupyter notebooks [8, 7]. Jupyter notebooks allow us to focus on the *narrative form* throughout the developed materials, including lectures, background reading, student-written profiles on significant scientists, POGIL-like activities, assignments given and turned-in, and reflections made by the students. The notebook form allowed instructor and students to weave computation, equations, multimedia, and text into relevant stories.

Specifically, we focused on *personal* stories. Using this technique, we encouraged students to develop metacognitive skills, identify their own values, and make connections between the material and their own lives. Students ended up with a collection of notebooks that could be included in an eportfolio of their work. All of the materials we developed for this project are available at https://github.com/BrynMawrCollege/TIDES.

2.3 Albert Chan

The TIDES project implemented in Fayetteville University focused on introducing into Computer Science and Mathematics courses cultural elements that are familiar to students. This can serve two purposes — to motivate students to study the subject matter, and to demonstrate that the skills they have learnt in these math and CS classes can have real life application.

We use multimedia (mainly music) as the cultural elements. We redeveloped an entry level CS course completely using musical elements (based on EarSketch), and included in a sophomore level course an assignment with musical elements (based on Jython Music). In mathematics courses, we developed modules to incorporate cultural elements with using graphics calculators, and other mathematical tools.

2.4 Travis Doom

The Wright State University (WSU) TIDES project redesigns the five courses that form the foundational core for WSU Computer Science and Computer Engineering majors (CS I, CS II, Computer Organization, Data Structures, Digital Systems). The modifications include in-class interventions to address and measure the impact on specific impediments to STEM success, particularly those affecting underrepresented students.

Each course implements at least two interventions to address one of five barriers (Academic Preparation, Motivation/Interest, Psycho-social skills, Opportunity, and Cognitive Skills). This results in a minimum of fifty in-class intervention activities for students completing the standard two-year freshmen CS core. Initial results[10, 9] show an change in progression rate (Grade of C or above) from 53% to 75% ($p = 0.016$) in CS I and corresponding increases in measures of student attitude, particularly on attitudes regarding comfort levels with asking questions, confidence in ability to deal with projects involving STEM concepts, and ability to overcome potential challenges to STEM success.

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