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Board 61: Work in Progress: Applied Programming Experiences (APEX) for Community College Students

Dr. Valerie A. Carr, San Jose State University

Dr. Valerie Carr earned her PhD in Neuroscience and completed a postdoctoral fellowship in Cognitive Neuroscience before joining the Department of Psychology at San Jose State University, where she is now an Associate Professor. She conducts research regarding learning and memory across the lifespan and teaches courses relating to memory, neuroscience, and interdisciplinary computing. She actively collaborates with faculty across several departments on SJSU's minor in Applied Computing for Behavioral and Social Sciences (ACBSS), and is a co-advisor for the minor. Additionally, she teaches the first course in the minor series, which covers the application of Python to current social science topics, as well as the use of programming in careers such as data analysis, user experience research, and econometrics.

Jennifer Avena, San Jose State University
David Schuster, San Jose State University
Wendy Lee, San Jose State University
Dr. Belle Wei, San Jose State University

Belle Wei is Carolyn Guidry Chair in Engineering Education and Innovative Learning at San JosÃ© State University (SJSU). Previous roles include: Provost and Vice President for Academic Affairs at California State University, Chico; a decade of service as

Work in Progress: Applied Programming Experiences (APEX) for Community College Students

Abstract

The nation's expanding digital workplace requires more computing professionals as well as workers with both domain and computing skills. Several universities have developed new interdisciplinary computing programs to meet these demands, but many lower-division students, especially those at community colleges, are not aware of these programs. Moreover, many students may not encounter learning experiences that foster their self-efficacy in pursuing these programs, creating an inequitable lack of opportunity for students at two-year institutions. In this paper we describe our approach to addressing these issues: the Applied Programming Experiences (APEX) program, which embeds computing modules into existing introductory statistics and biology courses. These modules use Python and are accessed via Google Colab, a free, web-based version of Jupyter Notebook. Critically, the success of the program requires instructors who feel comfortable teaching APEX content, particularly when they have little or no prior experience with computer programming. To this end, we created two Canvas courses, the first of which introduces faculty to Colab and Python, and the second of which contains APEX statistics and biology modules plus instructor solutions. We also piloted a faculty learning community (FLC) with a local two-year institution to foster a collaborative community and support faculty in adopting APEX materials, which included helping them to consider, plan, apply, and reflect on effective practices for integrating computing into their courses. Building upon these pilot efforts, we are actively expanding adoption of the APEX program in several ways. First, we have begun holding summer and winter training workshops for faculty at several additional community colleges. Second, we are refining and improving the FLC experience as we initiate new FLCs with these institutional partners. Finally, we will continue to assess the program's efficacy through a research plan that evaluates student and faculty experiences, allowing us to optimize the program and encourage faculty across the country to adopt our model of embedding computing experiences in lower division courses.

Introduction

Advancements in digital technology have radically changed our daily lives and routines, from the way we educate students and navigate traffic to how we treat patients and collaborate with coworkers. This infusion of technology brings with it an increased need for interdisciplinary professionals with both domain knowledge and computing skills. Including more women and individuals from historically marginalized communities will further diversify and grow the digital workforce to meet this increased need. As interdisciplinary computing jobs command an average 14% salary premium [1], an increasingly diverse, computing-capable workplace will generate broader prosperity and reduce income inequality [2][3].

To meet this growing need, several California State University (CSU) and University of California (UC) campuses have recently developed new interdisciplinary computing minor and major degree programs. Examples are the Bioinformatics minor, Applied Computing for Behavioral and Social Sciences (ACBSS) minor, and Data Science major at San José State University (SJSU), the Computing Applications minor for Biology majors at San Francisco State University (SFSU), and the Data Science major and minor at UC Berkeley.

Unfortunately, lower-division non-STEM students, especially those at community colleges, are often not aware of these new interdisciplinary computing programs or only learn about them too late in their college studies to complete the program. Moreover, many lack learning experiences that foster their self-efficacy [4] in pursuing these opportunities. As a result, their career choices in the digital workplace are limited [5] - [7]. This opportunity-loss particularly impacts students from historically marginalized communities, who are shown to disproportionately attend 2-year institutions [8]. In line with national trends, California community colleges enroll a higher percentage of such students (51%) than UCs (29%) and CSUs (49%), as well as a higher percentage of first-generation students (49%) than UCs (40%) and CSUs (32%) [9] - [11].

To address these issues, we developed the Applied Programming Experiences (APEX) program, which embeds new computing modules into existing lower-division courses at a large public university and several nearby community colleges. The APEX program specifically targets introductory statistics and biology courses, which are prerequisites to several of the abovementioned degree programs and are articulated with four-year-university-equivalent courses at many California community colleges. The outreach and engagement of these students provides us a platform to motivate and inform them of new interdisciplinary educational and career opportunities, helping them plan during a critical stage of their college studies [5].

APEX Program

Curricular Materials

Broad adoption of APEX computing modules requires an accessible, economical technology platform as well as effective curricular designs. To this end, APEX modules are taught using Python and Google Colaboratory (Colab). Python is a free, open-source, and general-purpose language. Google Colab is a free, web-based Python environment based on Jupyter Notebook that has the added benefit of being more accessible for visually impaired students than Jupyter.

APEX modules include one or more learning objectives, instructions to students, datasets, interactive programming exercises, spaces for students to respond to prompts, and (for instructors) exercise solutions. Instructors can modify all APEX modules to meet their students' needs given that the modules use Creative Commons licensing to allow broad adoption and adaptation of our materials.

With respect to domain-specific content, APEX statistics modules include demonstrations of statistical methods and associated student exercises. Statistical datasets are chosen to have broad appeal and cover topics such as the economy, public policy, consumer behaviors, and health. Such authentic content is critical to stimulating the interests of diverse students and motivating their learning [12], [13]. APEX biology modules allow students to gain hands-on experience with bioinformatics, an interdisciplinary field that utilizes computing to analyze biological data such as gene sequences. The modules are designed to encourage student interest in developing computing skills that are in high demand by life sciences and biopharma companies [14], [15].

An important benefit of APEX curricular materials is that they are easily scalable and sustainable. They supplement or replace technology used in existing introductory statistics and biology courses, and their adoption requires neither significant curricula redesign nor multiple levels of approval by college curricular committees. They are freely available via Canvas courses and can be accessed by contacting the corresponding author of this paper (Valerie Carr). Additionally, many of our materials can be accessed directly via GitHub: APEX: Python Training for Faculty, APEX: Statistics Modules

Faculty Materials and Learning Communities

Critical to the success of the APEX program are instructors who feel comfortable and confident teaching APEX content, particularly when they have little or no prior experience with computer programming. To support and incentivize faculty in incorporating APEX content into their courses, we have taken a three-pronged approach. First, we offer APEX summer and winter workshops that include sessions on introductory computer programming and guided walkthroughs of sample APEX statistics and biology modules. Second, we created a Canvas course with asynchronous modules designed to introduce faculty to Google Colab and the basics of Python programming. Interested faculty can work through these materials independently, at their own pace. However, we believe that a community of faculty working through these materials together, while also learning about evidence-based and inclusive approaches to teaching programming, will ultimately lead to greater comfort with APEX materials and increased likelihood of adopting the program. To this end, as the third component to our approach, we have begun working with faculty at local community colleges to co-host Faculty Learning Communities (FLCs), described in greater detail below.

Progress to Date

After developing an initial set of Python training materials, APEX statistics modules, and APEX biology modules and making them available as Canvas courses, we launched a pilot FLC with Las Positas College, a local two-year institution. The FLC was designed to foster a collaborative community and support faculty in adopting APEX materials, which included helping them to consider, plan, apply, and reflect on effective practices for integrating computing into their courses. Two of the FLC participants tested an APEX module in their biology course, and both agreed that the module was appropriate for students with no prior programming experience. They also solicited student opinions regarding the module, and across 31 students surveyed, a majority recommended that their instructors use the APEX module again (68%) and further indicated interest in learning more about bioinformatics (52%).

Building upon these pilot efforts, we are actively expanding adoption of the APEX program in several ways. First, we continue to form new partnerships with community colleges and offer training workshops for interested faculty. Second, we are refining and improving the FLC experience as we initiate new FLCs with these institutional partners. Finally, we will continue to assess the program's efficacy through a research plan that evaluates student and faculty experiences, allowing us to optimize the program while encouraging faculty across the country to adopt our model of embedding computing experiences in lower division courses.

As we continue to expand the APEX program, we are working to broaden career participation and achievement in computing by delivering computing education to a diverse community of learners. The resulting computing-capable graduates will be better prepared to apply emerging information technology across disciplinary boundaries. This is especially strong preparation for highly interdisciplinary fields such as bioinformatics and human-computer interaction. Computing-capable graduates will help advance the nation's economic competitiveness while fostering a broader-based prosperity.

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