The Women in Computer Science Program in New Mexico Tech

Amy Knowles

I. INTRODUCTION

Although 56.86% of undergraduate enrollments are females [3], only 22.5% of bachelor’s degrees are awarded to women [1]. The situation is worse in the STEM focused universities, such as New Mexico Tech. Historically, the female enrollment in the Department of Computer Science and Engineering has been less than 15%. Therefore, three alumni from New Mexico Tech decided to support the program called Women in Computer Science (WiCS), funded since 2017, to increase the number and percentage of females both entering and graduating from the Computer Science bachelor of Science program.

This article first describes the overview of the WiCS program in Section 2. Section 3 summarizes the work we did to change the introductory programming courses. Integrating game design in the computer science course in order to engage students’ interests is illustrated in Section 4. Section 5 outlines the recruitment and retention plan we made for the program via a nonprofit organization. The future plan in the program is summarized in Section 6.

II. WiCS PROGRAM OVERVIEW

Numerous studies have described the need for integrating in courses a diverse set of applications to show possible careers in Computer Science and Information Technology. Careful analysis of best practices and evaluation of the exceptional programs visited will be used to implement changes to CSE 101 (Introduction to Computer Science and Information Technology), CSE 107 (Python Programming), CSE 113 (Introduction to Programming with C), and CSE 122 (Data Structures) courses with the intent to increase retention rates and use CSE 107 for recruiting. We have already added a python course for students who do not have the mathematical maturity to take programming in C, but will focus on promoting that course for students with limited programming experience.

The program has indicated that “boot camps” and summer “catch up” courses can be successful in bringing students up to speed for those who may, for various reasons, not be ready academically to initially be in the same classes as their peers or who fall behind. There are various solutions that will be assessed through visits to programs such as Harvey Mudd and through discussions with high school counselors. Based on these findings, a program will be designed using best practices. For example, we have scheduled the Program Lead to teach CSE 122 in the summer for students who are a semester behind; this would allow them to catch up in the summer after the first year.

While the department has had a mentoring program for a number of years, many students do not take advantage of the opportunity. In addition to assigning every new female student a mentor in our program, and a female advisor, we will build a database of mentors – including students, alumni, faculty, and others – that will facilitate matching each student’s interests with a mentor. We will arrange mentoring events (to meet and get to know each other) and provide guides to mentoring and being mentored.

For each major component of this program, an assessment process will be developed along with the component. The assessment process will allow us to evaluate the effectiveness and perceived impact of the component. Ultimately, this will allow us to improve the operation and effectiveness of the component or if it is not having a positive impact, to eliminate components or replace them with more effective approaches.

III. CHANGES TO INTRODUCTORY PROGRAMMING COURSE

Two female faculty in the program visited Harvey Mudd College (HMC) on October 29, 2019. There are two pathways to create the foundational knowledge in programming for both CS majors and non-majors at HMC: the first pathway consists of CS5 (Introduction to Computer Science), CS60 (Principles of Computer Science) and CS70 (Data Structures and Program Development); the second pathway consists of CS42 (Principles and Practice of Computer Science) and CS70 (Data Structures and Program Development). The CS5 course is separated into black and gold sections – one for students who come into computer science with experience and the other for students without any experience.

The two sections (Black and Gold) are offered at the same time to allow students to switch between the two until a certain point in the semester. This allows students progressing quickly in Gold to switch to Black and those who feel they were not as prepared as they thought to switch from Black to Gold. They chose Python as the introductory language because it is relatively simple to have beginner students creating something they think is really cool due to the large number of libraries and packages available in Python. Students in the Gold section of the course will progress at a slightly slower pace than students in the Black course, but students in both sections will complete the course knowing the basics required for CS60. Students in the Black section of the course may delve a little deeper into a more diverse range of applications across the computer science discipline, but will not be ahead of the Gold course or gain more experience/knowledge toward CS60 or CS70.

A compromise was reached with the New Mexico Tech faculty on how to implement the Harvey Mudd model at New Mexico Tech. The first programming introductory core course – CSE 113 – was split into two sections starting in Fall 2020, but it was still taught in C, as opposed to Python. One instructor taught the CSE 113 Silver section for inexperienced coders and another taught the CSE 113 Blue section for students who had coding experience before attending New Mexico Tech. Despite limitations due to Covid-19, both sections made active use of pair programming.

Over the summer, the Program Lead tested online tools to facilitate distance pair programming. Some of the tools used to do this were recommended during an online meeting with HMC faculty. The primary tools for the online pair programming activities were Visual Studio Code with MS LiveShare, which allowed students to share the same coding environment despite not being in close physical

Received December 30, 2021, Accepted January 2, 2022, Publish online January 12, 2022.

A. Knowles is with the Department of Computer Science and Engineering, New Mexico Institute of Mining and Technology, Socorro, NM 87801 USA (e-mail: amy.knowles@nmt.edu).

This work is under Creative Commons CC-BY-ND-NC 3.0 license. For more information, see https://creativecommons.org/licenses/by-nc-nd/3.0/
proximity. Discord was used for screen share and discussion during labs so that TAs could jump between groups and aid students when needed. Significant issues that were dealt with in the HMC model include: (a) Placement Test – a placement test was given to all enrolled students at the beginning of the semester. Recommendations for which section students were likely to be most successful in were based on the student performance on the test. Students who were not enrolled in the recommended course were told they should change to the recommended section; (b) Course Switch – unlike at Harvey Mudd, all but three students in the two semesters took the placement exam and followed recommendations as to which section (Blue-experienced or Silver-novice) would be the best fit; (c) Overall Student Performance Statistics for CSE 113 – data was gathered over 6 semesters to show pass/fail rates for our introductory coding course. Passing is defined as performance of a C or better and Failing is defined as performance below passing.

IV. INTEGRATING GAME DESIGN IN CS COURSES

The Program Lead developed and taught a Video Game Design course that counts as a technical elective for current CS students and as a Fine Arts credit for non-CS students. This course is designed as a recruitment tool to generate more diverse interest in the CS major at New Mexico Tech. New Mexico recently made changes in the core curriculum for all NM college students that would require 3 credit hours in Fine Arts. Since all students starting with the 2019/20 freshman will be required to take 3 credit hours in fine arts, we believe that this Video Game Design course will act as a great recruitment tool to generate more diverse interest in CS as a possible major and/or as a minor. Note that students could take this course twice, once as a fine arts course meeting the arts requirement and once as a computer science technical elective. The requirements for the two courses are substantially different, but the students in the two sections work together on projects, which gives those in the fine arts section exposure to coding and computer game development.

Despite the setbacks of COVID-19 on the Spring-2020 semester, each of the 10 teams in the “Elements of Game Design: Programming” and “Elements of Game Design: Art” courses successfully completed much of their planned games. Teams were made up of four students - two programmers and two art students. Art students were responsible for designing assets, music, and sound for the games, and the programming students were responsible for bringing the designs to life and implementing game mechanics. This course is being offered a second time in the Spring semester of 2022 with an additional instructor who will be teaching the Art and Assets section of the course.

Besides the Video Game Design course, the Game Jam – an activity that brought together the student community to work over a weekend to make video games – has been used during the past few semesters to interest a diverse group of students in pursuing computer science. In 2019, the WiCS program host the Game Jam with the Cybersecurity Education Center in New Mexico Tech. We also have outreach underway that involves video game development with the Cybersecurity Education Center.

The outcome of the 2019 cybersecurity game outreach was presented in a webinar hosted by Asia-Pacific Society for Computers in Education (ASPSC, https://apsce.net/) in December 2020. The 2020/2021 Cyber Game Jam kicked off in October of 2020 and was fully digital through Zoom due to COVID-19. Participants met bi-weekly via Zoom to discuss problems and updates, and demonstrate the current progress of their games. The winning game, which has been purchased by the Cybersecurity Centers and will be used for outreach.

V. NCWIT LEARNING CIRCLE FUNDING

The National Center for Women & Information Technology (NCWIT) is a nonprofit organization founded in 2004 which works on increasing participation of females in computing. The Extension Service Learning Circles of NCWIT assists departments in developing and implementing strategies to increase female enrollments. The WiCS program joined the Learning Circle in 2020. After 12 meetings with two other departments of computing, an Extension Service consultant, and an Extension Service staff member, the WiCS program received the 10,000 Gift Fund.

We plan to use our 10,000 Gift Fund to develop content for outreach and to bridge the knowledge gap for transfer students and incoming freshmen. Through outreach, we plan to inspire local female and underrepresented minority students not currently majoring in computer science through online exposure experiences. Once a post-COVID-19 normal has been established, we also plan to have face-to-face outreach experiences as well.

For the online exposure experience, we have a large quantity of Galileo boards (Intel Arduino boards). We plan to build kits including these Galileo units that can be mailed to workshop participants. A team of 3 undergraduate computer science students will develop the curriculum utilizing the Galileo boards. By creating fun and engaging content centered around active learning, we hope to build interest in computer science as a major and as a career. As we do have a limited number of Galileo units, we plan to shift this online experience to utilize a Galileo simulator/emulator for future workshops and events.

For in-person events, we would like to utilize Orzobots, small robots that utilize a light sensor to follow a line or path. These little robots are very flexible in their range of appropriate content across a wide range of ages. We plan to have a team of 3 undergraduate students create content for these Orzobots that can be used across a wide variety of outreach events and workshops. We first came across these little robots during a trip to New Mexico State University to learn more about their Young Women in Computer Science (YWiC) program.

In addition to the outreach content development, we plan to utilize our gift fund to build transition content for our introductory computer science courses. We teach our introductory courses in ANSI C, a language known for its hellish memory management. Although this allows us to produce high-quality computer scientists upon graduation, it is not necessarily conducive to recruitment or retention.

In New Mexico, only 44% of all public high schools teach a foundational computer science course [2]. When taught, the language for the course is generally an object-oriented language such as Java or Python. Only 371 exams were taken in AP Computer Science by high school students in New Mexico in 2020 (113 took AP CS A and 258 took AP CSP) [2]. There are fewer AP exams taken in computer science than in any other STEM subject area. This knowledge gap is one reason our introductory course retention hovers around fifty percent. We plan to hire 4 undergraduate computer science students to focus on creating high-quality videos and associated documents that would aid in bridging the content gap between incoming freshman and transfer students and the introductory courses at New Mexico Tech. We plan to make this content available on the website and our computer science community discord server. Once created, these videos and instructional materials would be maintained by current course TAs and instructors.
VI. NEXT STEPS

While we do think we are beginning to make significant progress, we have much more work to do. Here are a few of the next steps we are pursuing. Only 44% of New Mexico public schools teach computer science courses. The Randolph Program in New Mexico Tech is focusing on how to inspire New Mexican middle and high school teachers using innovative teaching methods to teach computer science in classrooms. The WiCS program will work with the Randolph Program to ensure seamless integration between WiCS educational outreach and that of the Randolph Program. On the other hand, the WiCS program formed connections with the local junior high and high school through the Socorro Educational Mentoring Alliance – a collaboration between New Mexico Tech, the Socorro Consolidated School District, and Mentoring Kids Works. We are looking forward to providing computer science related activities to local school students ranging in topics from cybersecurity to video games.

REFERENCES


Amy Knowles is a Computer Science instructor who teaches beginning to advanced topics for undergraduate students at New Mexico Tech (NMT). In addition to their teaching responsibilities, Amy is the Women in Computer Science (WiCS@nmt) Coordinator and is dedicated to encouraging young women and underrepresented minorities to pursue careers in computer science. Amy believes that computer science is more than just coding and analytics as it requires quite a bit of creativity and problem solving.