

Tapping the Rich Diversity of the Community Colleges: Akamai Summer Internship Program - An REU Model at Maui Community College

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Abstract

The program is a collaboration between the Center for Adaptive Optics (CfAO), the Maui Economic Development Board's Women in Technology Project (WIT), Maui Community College (MCC) and the Maui technology industry. CfAO is one of the NSF funded Centers supporting REU models within academic environments. WIT is a U.S. Department of Labor funded workforce development project led by industry partners to increase the number of girls/women entering STEM education and employment. CfAO and MEDB combined their resources, expertise and adapted their respective best practices to create the Akamai Summer Internship Program providing (MCC) students an opportunity to get involved in CfAO research within an industry setting.

The Akamai program model offers an intensive eight-week introduction to research method and tools with an emphasis on adaptive optics science. The interns start with a 5-day short-course in general optical principles and adaptive optics, industry protocols and cultural awareness, taught at MCC. The program then places interns at Hawaii technology sites such as Boeing, the Maui High Performance Computing Center, Trex Enterprises, Northrop Grumman, Oceanit and Akimeka. Upon completion each participant is required to give an oral presentation. Participants are invited to present their research in a student session at the AMOS Technical Conference and at the SACNAS National Student Conference. The CfAO pays interns \$2500 for an 8-week full time commitment during the summer. Additional activities provide support and opportunities to the interns during the academic year.

The Akamai Internship Program offers two-year students a unique industry-based research experience that exposes them to technology careers and gives them an opportunity to present their research results in a cutting-edge forum. The combined commitment of both CfAO and WIT to diversity is reflected in the demographics of the 2003 and 2004 intern cohorts, where women and underrepresented minorities made up a more than 70% of participants. This paper will discuss the facilitated collaboration dynamics that made this internship program possible, provide suggestions for starting an industry-based internship program for community college students, and offer strategies for attracting underrepresented students to such a program.

Introduction

It is estimated that over the next ten years, the U.S. will need an additional 1.9 million workers in science, technology, engineering, and math (STEM) (Chang, 2002). Traditionally, the STEM workforce has consisted of mostly white, non-Hispanic men, who made up 69% of the STEM workforce in 2000. In the same year, underrepresented minorities (URM) - African-Americans, Hispanics, and Asians - comprised only 28% of the STEM workforce (Babco, 2004).

This reliance on a predominately white, male workforce is troubling in the face of the changing demographics of the U.S. population. The Advisory Committee to the National Science Foundation Directorate for Education and Human Resources (1996) has expressed concern that the facts that the majority of Americans are women, and that the proportion of Americans aged 18-22 who are URM is expected to rise above 40% by the year 2015, have profound implications for STEM education. It concluded that unless STEM education becomes much more inclusive than it has been in the past, the U.S. will be denied the STEM talents of the majority of its population. In order to remain competitive, the U.S. must reinvent STEM education and employment to attract, educate and employ those who have been traditionally underrepresented in STEM.

While the 2000 Census showed that almost 25% of Americans are African American or Hispanic, only about 10% of engineers are from those ethnic backgrounds. Women constitute half the U.S. population, but are less than 10% of its engineers (American Association of Engineering Societies, 2003). Today the U.S. is the world leader in the global STEM enterprise, but other countries stand ready to challenge this economic strength. One of the main reasons is a shortage of U.S. citizens with the necessary education to fill STEM jobs in the U.S. (Babco, 2004).

The Role of Two Year Colleges

Almost 50% of all college freshmen, and an even greater percentage of women and URM, start their postsecondary education at two-year schools (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development [CAWMSET], 2000). Two-year colleges are attractive to many students because of their low cost, open admission policies, and flexible schedules. The annual average tuition and fees at a two-year college is only \$1,492, and more than 90% of the U.S. population is less than an hour's drive from a two-year college campus (Hendley, 1996). Since they have smaller class sizes and no research requirement for teachers, two-year colleges can offer students more individual attention than traditional four-year colleges (Hendley, 1996). Given the large numbers of women and URM whose first attempt at postsecondary education is at a two-year college, these colleges play a vital role in the education of potential entrants into the nation's STEM workforce (CAWMSET, 2000).

Underrepresented Student Profiles in Hawaii

The national statistics related to URM in STEM focus on African Americans, Hispanics, and American Indians. Hawaii is demographically unique. Enrollment and degree data in Hawaii

indicates that Native Hawaiians and part-Hawaiians, like other URM, are underrepresented in both higher education overall and in STEM fields in particular.

Ethnicity	Percentage in Hawaii
Non-Hispanic White	24.5%
Hispanic	7.3%
African American	1.8%
American Indian	0.1%
Asian	39.9%
Hawaiian/Pacific Islander	7.6%
Hawaiian/Part-Hawaiian	24.8%
Mixed Race	24.8%

While Hawaiians/part-Hawaiians are 24.8% of the Hawaii population overall, they continue to be underrepresented in STEM field enrollments (U.S. Census Bureau).

Fall 2002	Programs	Enrollment of Hawaiian/ Part-Hawaiian
University of Hawaii at Manoa	Information & Computer Sciences	6.7%
	Physics & Astronomy	2.6%
	Engineering	6.5%
Maui Community College	Electrical & Computer Engineering Technology Program	17.5%

Women hold commanding majority enrollments at both the 4-year university and community college levels at U.H., however STEM field enrollments are significantly below parity (see fall 2002) (U.S. Census Bureau).

Fall 2002	Programs	Enrollment of Women
University of Hawaii at Manoa	Total Enrollment including non-STEM	56.7%
	Information & Computer Sciences	31.8%
	Physics & Astronomy	31.2%
	Engineering	20.7%
Maui Community College	Total Enrollment including non-STEM	63.8%
	Career & Technical Education Programs	64.8%
	Electrical & Computer Engineering Technology Program	21.0%

Internships as a Mechanism to Engage Undergraduates in STEM

In recognition of the need to increase the number of STEM workers in the U.S., there has been much focus on educational reform to increase the participation and to decrease the attrition of undergraduates in STEM. One recommendation for reform of the undergraduate STEM curriculum focus on investigative learning, technology, laboratory experience, and collaborative work. Programs that have provided students an opportunity to engage in hands-on, real-world

projects have been successful in increasing female enrollment and retention (Chang, 2002). Establishing the relevance and social value of these fields is another effective retention strategy. Smith College, Rensselaer Polytechnic Institute, and a few other colleges are trying to make engineering relevant by engaging students in hands-on assignments and real-world projects (Chang, 2002; Farrell, 2002).

Real-world experience is key to developing working understanding of STEM. Unfortunately, the hands-on experience so vital to STEM literacy is rarely provided to undergraduates. Internship programs, such as the Akamai Internship Program, are a recommended mechanism for engaging diverse populations of students, exposing students to STEM in a real-world context, and making students aware of STEM careers. Many students are able to use internships as a stepping-stone into later employment at the host firm. The benefits of internships flow both ways; firms that host interns have an advantage in recruitment of STEM graduates (Committee for Economic Development [CED], 2003). Internships also provide an opportunity for industry and institutions of higher education to form partnerships that improve the overall quality of undergraduate education and ensure the workplace relevance of skill sets provided by STEM education (National Science Board, 2002). Targeted outreach to women and URM to participate in these experiences is a recommended mechanism for increasing the number of underrepresented undergraduates in STEM, and has been identified as having a significant impact on the retention of these groups (CED, 2003).

There have been a number of projects to increase the numbers of two-year college students going into STEM. The successes of bridge programs that facilitate the transition from two-year to four-year colleges are well documented. There is little in the literature focusing on REU or internships specifically designed for two-year college students. The remainder of this paper will discuss the collaboration between the Center for Adaptive Optics at University of California-Santa Cruz, Maui Community College, the Maui Economic Development Board, and the adaptive optics industry on Maui to provide a full-time, paid summer internship program in optic technologies targeting underrepresented two-year college students on Maui.

Building Partnerships for a Successful Internship Program in Adaptive Optics on Maui

Adaptive optics is a method for removing the blurring of images caused by changing distortions within optical systems. The use of adaptive optics allows ground-based telescopes to see as clearly as if they were in space, and these techniques, when used to look at the retina of the human eye, dramatically sharpen images of the retina. Large ground-based telescopes using adaptive optics can exceed the performance of the Hubble Space Telescope and at much lower cost.

The world has long recognized Maui, Hawaii as a top vacation destination, but few vacationers realize that Maui is also home to some of the world's most sophisticated adaptive optics technologies. The Air Force Maui Optical & Supercomputing Site (AMOS) is a Center of Excellence in electro-optical space surveillance and high performance computing. The Maui Space Surveillance System (MSSS) houses the nation's largest optical telescope designed for tracking satellites. It is equipped with an adaptive optics system than can change its shape to

remove the atmosphere's distorting effects. Activities at the MSSS include space surveillance, data acquisition for NASA, satellite tracking, and study of the geometry of the Universe. The Maui High Performance Computing Center (MHPCC) supports Department of Defense, government, private industry, and academia with state-of-the-art scalable computing and applications. MHPCC specializes in image and signal processing of data from telescopes, satellites, radar, and other sensors, as well as modeling and simulation of environmental and battlefield scenarios. The technical and administrative facilities of AMOS are located at the Maui Research and Technology Park. The Air Force Research Laboratory, Boeing (prime contractor), Textron, Trex Enterprises, and Oceanit (subcontractors) and the Maui Research and Technology Center are all based at the Park.

The Center for Adaptive Optics is a National Science Foundation-funded Science and Technology Center (STC) headquartered at the University of California, Santa Cruz. The STC Program funds eleven Centers in a variety of disciplines to conduct important basic research and education activities and to encourage technology transfer and innovative approaches to interdisciplinary activities. One goal of STCs is to explore better and more effective ways to educate students in STEM. NSF support as an STC enables academic research teams to involve students, research scientists, and engineers from academic, industry, non-profit organizations, and federal laboratories in partnerships to enhance STEM education and training. STCs receive long-term, stable funding at a level that encourages risk-taking and ensures a solid foundation for attracting quality undergraduate and graduate students into STEM careers, with special emphasis on women and URM.

Maui Community College (MCC) is one of seven community colleges that make up the University of Hawaii Community College system. MCC is recognized by the U.S. Department of Education as an Accredited Postsecondary Minority Institution (66.29% minority enrollment) and as a Native Hawaiian Serving Institution (21.5% Hawaiian/Part-Hawaiian enrollment). MCC received two Advanced Technological Education grants from the NSF to create the Electronic and Computer Engineering Technology (ECET) Program. The ECET Program leads students to a Certificate of Achievement in Electronic Engineering Technology or to an Associate in Science degree in either Computer Engineering Technology or in Electronic Engineering Technology.

The Maui Economic Development Board, Inc. (MEDB) is a nonprofit corporation chartered to strengthen and diversify Maui County's economy, with a focus on the development of high tech activity. In 2000, MEDB launched the Women in Technology (WIT) Project, a workforce development project funded through a grant from the U.S. Department of Labor. WIT is a pilot and demonstration project to build a highly qualified and well-diversified resident STEM workforce in Hawaii. The primary goal of WIT is to increase the number of women and URM working in emerging technology fields. The WIT Project mission is three-fold: to partner with educators and industry to create a pipeline from education to employment in STEM; to improve the economic quality of life for women by facilitating their success in higher paying technology careers; and to promote the overall economic development of Hawaii's technology industry by building a skilled workforce. WIT Project collaborations with educators and industry have resulted in an increase in the representation of women in the technical workforce at the Maui Research and Technology Park from less than 13% in 1999 to more than 23% in 2004.

Several factors facilitated the collaboration between the CfAO, MCC, WIT and the Maui adaptive optics community that resulted in the Akamai Summer Internship Program. Hawaii is home to two extremely important astronomical sites and has undergraduate institutions with specialized programs that provide the technical skills required by these astronomical sites. Maui plays an important role as a center for adaptive optics facilities and research and is the location of the nationally recognized WIT Project to increase the representation of women and URM in STEM.

CfAO Akamai Summer Internship Program Model

The CfAO Akamai Summer Internship Program is part of the Science, Engineering Technology Training (SETT) project at the CfAO. The mission of SETT is to increase the number of underrepresented undergraduates in STEM fields, through technical training, professional opportunities, and mentoring, in the context of the interdisciplinary, national center. A major educational goal of SETT is to significantly increase the retention and graduation rates of participants in STEM programs, relative to reported rates for students with similar backgrounds.

The internships required a full-time eight-week commitment, for which the students were paid \$2,500 by the CfAO, with the possibility of an additional \$500 supplement during the academic year. Transportation and other support services were also made available. The CfAO Program Coordinator for the program kept in contact with both the interns and the employers to ensure that each got what they expected from the internship experience. The CfAO, in collaboration with MEDB and MCC, followed the CfAO SETT internship model for the Akamai Internship Program. This model includes recruitment and selection, preparation, research experience, and communication.

Recruitment and Selection

The Akamai Internship Program was designed for students interested in pursuing a career in STEM fields who may have overcome barriers to achieve their educational and/or career goals. WIT worked with MCC to recruit students for the internship with a strong focus on attracting women, Hawaiians/part-Hawaiians, and students who were first-to-college. This recruitment included targeted outreach to women and URM by MCC staff and faculty that had previously participated in WIT trainings on strategies to recruit and retain women and URM into STEM. A selection committee was established comprised of MCC faculty, WIT staff, CfAO members and staff, and an AMOS representative. Students were evaluated based on their interest in science, reference reports, recommendations, transcripts and personal statements. As initially mentioned, particular consideration was given to students who had overcome specific barriers to achieve their educational and/or career goals.

Internship cohort 2003: 55% of the eleven interns selected were URM, and 36% of the interns were women. Nine of the students were MCC students, three of the students were pursuing bachelor degrees through distance education at the UH Center, Maui, and one of the students was preparing to pursue a master's degree via distance education at the UH Center Maui. Four of the interns had children and six were the first in their family to attend college.

Internship cohort 2004: 73% of the eleven interns selected were URM, and 36% of the interns were women. Seven of the students were MCC students, one from Kauai Community College, one student was pursuing a master's degree via distance education at the UH Center Maui, and two were Hawaii URM students at mainland universities. Five of the students were first in their family to attend college. Because of the disparate educational and experience levels, an important element to the selection process included proper internship placement. The selection committee worked hard to assess the needs of the host sites and to match students appropriately, based on their interests, varying academic backgrounds, previous skills and maturity. In addition, it was important to know which students would be able (physically and/or logistically) to work on the 10,000 foot summit of Haleakala.

Preparation

Preparation for interns' research experience was provided through a five-day intensive Optics Short Course held at MCC the week preceding the 8-week industry experience. Andy Sheinis, a CfAO Research Fellow at University of California, Santa Cruz was the lead instructor and developer of the course. Mark Hoffman, a MCC faculty member, Jenny Patience, a Postdoc at Cal Tech, and Fernando Romero, a Postdoc at the University of Houston, were all involved in the instruction and/or the development of the Short Course. Consistent with known strategies for successfully advancing underrepresented students (Gandara & Maxwell-Jolly, 1999), this course provided the interns with an intensive introduction to the basic optics principles. Topics covered by the short course included: optics, electronics, computer control, detectors, and preparation for the industry environment utilizing inquiry-led pedagogy in the lab experience. In addition, representatives from organizations who were to host interns were invited to give brief presentations about their company as well as intern projects. The interns completed their short course with a tour of the AMOS facilities on the summit of Haleakala.

Since the interns had varied educational backgrounds and attainment, the short course played a vital role in the overall success of the internship program by providing all of the interns with an understanding of adaptive optics appropriate for the scope of their internship projects and sufficient enough for them to develop a certain degree of confidence and camaraderie before entering their respective workplaces.

Research

Students were placed with one of the following organizations for approximately 40-hours per week, for 8 consecutive weeks and were engaged in projects that furthered the work of the host company and exposed the students to STEM jobs in their community. Akimeka, LLC, an information management/information technologies solution provider focused on the Federal IT market in Hawaii and the Pacific Rim, hosted two interns. W. M. Keck Observatories, located on the summit of Mauna Kea on the big island of Hawaii, hosted a Native-Hawaiian woman with a strong interest in astronomy. Travel and housing expenses for the intern were provided by the CfAO. The Boeing Company, prime contractor for the Maui Space Surveillance System (MSSS), hosted five of the interns, who were placed at either the Boeing administrative facility in the Maui Research and Technology Park or at the MSSS facilities at the summit of Haleakala at an altitude of 10,000 ft. Textron Systems, a defense contractor participating as a subcontractor

for the MSSS facilities joined the industry hosts accommodating one intern in cohort 2004. The Maui High Performance Computing Center hosted two interns at its supercomputing facility. Trex Enterprises, a high tech company specializing in government and commercial R&D in the field of applied physics, hosted one intern. Oceanit Laboratories, a diverse research company hosted two interns in its adaptive optics division. The University of Hawaii, Institute for Astronomy (IFA), hosted one intern. The IFA is responsible for research and education in astronomy and for management of the Mauna Kea Science Reserve and the Haleakala High Altitude Observatory Site.

The students met as a group weekly by videoconference with the education staff at the CfAO headquarters at UCSC. Weekly meetings included such topics as how to write an abstract, an oral presentation workshop, and general sharing out about issues that come up in an internship position. Students were consistently reminded of the final expectation from them to produce a clear and concise final presentation on their research.

Student Presentations

Employers have stressed that undergraduate education must provide STEM graduates communication and teamwork skills (Reichert & Absher,1997). The internships provided the participants the opportunity to work in project teams with researchers and engineers utilizing some of the world's most advanced computer and optics technologies. The internship experience itself proved an exercise in teamwork, leadership and communication. Each participant was required to give an oral presentation reporting on the research they did during their internships. To prepare them for the presentations, the interns attended a workshop on oral presentation skills provided by the CfAO. Several interns were invited to present their research in a student session at the AMOS Technical Conference. The annual AMOS Technical Conference brings individual researchers and research teams from around the world to present application briefs representing selected cutting edge research efforts utilizing the assets of the Maui High Performance Computing Center during the prior year. The student presentations were attended not only by supercomputing end-users, but several 4-star generals! Select Akamai Summer Interns were also invited to participate in the Society for the Advancement of Chicanos and Native Americans in Science National Student Conferences in October 2003 and 2004.

Program Results

The CfAO Akamai Summer Internship Program is an excellent example of the kinds of successes two-year students are capable of when presented opportunities to engage in the STEM workplace and to present STEM research to a sophisticated audience. The Program also demonstrates what is possible when academia, industry, community organizations and two-year colleges collaborate to leverage funding from the NSF to provide research experiences to two-year students. The internship program has helped to form a core group of stakeholders from MCC, industry, and academia that collaborate on workforce development issues. Such collaboration has facilitated the entry of two-year college technical graduates into industry by demonstrating their value-add to the workplace, has helped to shape curriculum development at MCC to be responsive to employer needs, and has encouraged participating interns to continue their education at the next level by showing them the relevance of advanced education to their

career and personal goals. Eighty percent of both intern cohorts are currently continuing their STEM education; the program suffered attrition of only one student each summer. Of the 2003 cohort, one is currently employed by his host company and another has developed a long-term relationship with the Keck Observatories while pursuing her baccalaureate astronomy degree at UH, Hilo. One was awarded a traineeship supported by CfAO at Lawrence Livermore Laboratories and a fourth has been retained by Boeing Maui in a technician level position. In the 2004 cohort, two females were given extended internship opportunities for Fall semester 2004 at Akimeka and one accepted full-time employment at his host company, Textron. Another who completed his Associate Degree in December 2004 was hired full time by the local cable company as a result of contact made at Maui High Tech Holiday Job Fair.

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