

Robotics Programs Stimulate Hawaii County Girls' Interest in Engineering

Shawna Sodersten, Leslie Wilkins

Maui Economic Development Board/Women in Technology Project

Abstract--Women in Technology (WIT) would share its experience with robotics programs in the State of Hawaii. In March 2004, WIT and subcontractor Hawaii Educational Development Board (HIEDB) provided support for eight Big Island teams to participate in Hawaii's first Botball Robotics Tournament in Honolulu. Since 2002, WIT has also provided support for the participation of students at Waiakea High School in FIRST (For Inspiration and Recognition of Science and Technology) Robotics competitions. WIT's goal in funding these activities is to inspire interest in science, technology, engineering and math (STEM) among Hawaii's girls. Once such interest is sparked, some girls who might not otherwise have considered such paths may consider pursuing STEM education and careers.

The Botball program provides hands-on learning in science, math and technology in a sporting venue where autonomous, programmed robots are the players. WIT's initial support (including gender equity recruitment and training) was later joined by private donations and grants helping to fund the Big Islands Botball program and launch a much-publicized Botball Tournament that eventually drew 23 middle and high school teams from across the state. Then, a week-long RoboTech Exploration pilot program was tested with six female instructors and 72 participants (25% were female) at the U.H.-Hilo. Three female middle school students received full scholarships from the Zonta Club of Hilo.

WIT technical assistance promises expanded activities for 2005. A similar program will be established in Maui for summer 2005. A 2005 Botball regional tournament is confirmed for the Hawaii Convention Center. Sponsors will be Hawaii Space Grant Consortium, the UH College of Engineering, and the Hawaii Convention Center. Waiakea Intermediate and Waimea Middle Schools are introducing new courses in robotics as a direct result of their participation in the Botball program. Waiakea High School has received private and grant funds to initiate an Engineering Academy in fall 2005. This funding is due largely to student participation in the FIRST (For Inspiration and Recognition of Science and Technology) Robotics competitions.

Introduction

The Women in Technology Project (WIT), launched in fall 1999, encourages women and girls in the rural counties of Maui, Hawaii and Kauai, also including the city and county of Honolulu, in the state of Hawaii – to pursue science, technology, education and math (STEM) careers. WIT actively reviews best practices and model programs designed to address the under representation of girls and women in STEM. Hands-on activities and cooperative learning have been found to stimulate interest in STEM for all students, especially girls (Land of Plenty, 2000).

Hands-on robotics projects have proven especially effective as an introduction to engineering education and careers (The Birth of Best, 2005). Students enjoy the projects immensely and acquire basic engineering knowledge as well as experience in teamwork, self-directed learning, technical invention, and research (Verner, Ahlgren, 2004). Experiences with robotics in middle school may inspire girls to take more science and math courses in high school (Saviano, 1999). WIT has therefore devoted some of its resources to funding robotics education programs in Hawaii, with the goal of increasing girls' interest in STEM education and careers.

One of the programs that drew WIT's attention was the Robotics Education Program (REP) of the National Aeronautics and Space Administration (NASA). REP provides educators prepared robotics curricula online: from full courses to single lesson plans. WIT helped sponsor teams in the inaugural year (2003) of Hawaii schools' participation in REP's Botball Educational Robotics Program regional competition.

Each registered team receives a kit of robotics equipment. The kits include sensors, motors, customized robot computers, selected LEGO Technic pieces, software, and documentation. The annual competition begins with a workshop where the adult team leaders are educated about basic concepts in current robotics technology. The team leaders are also coached through hands-on designing, building and programming an actual working robot. After the workshop the leader returns to the students with that year's kit. The students then begin working against a deadline (six-seven weeks) to create a team of robots and a weblog documenting their progress. Finally, the students put their robots to the test in competition against other teams. The robots must turn themselves on and off, perform programmed tasks, and utilize no assistance from humans or a remote control during the competition. No combat or military-like exercises are used in the program model or the competition arena.

Botball teaches science (including physics), technology, engineering, math, computer programming (in the C language), internet research, website design, creative problem solving, and teamwork. The National Botball program is not focused on directly addressing the under-representation of girls and women in STEM. However, the skills imparted and the hands-on nature of the Botball team experience appealed to WIT as a potentially successful portal for girls into the world of STEM. WIT decided to sponsor four Hawaii county teams, starting with the 2003 competition.

According to the KISS Institute for Practical Robotics, the national average representation of females on Botball teams is 30%. Hawaii's Department of Education reports that the 30% average is also typical of Hawaii's teams. The WIT-sponsored teams were charged with

engaging in specific recruiting of girls with a goal having girls comprise 50% of the participants. WIT has also mandated gender equity training for the adult facilitators involved in the program. NASA is currently working on a “best practices” protocol for increasing the numbers of girls participating in robotics learning. The effort has been dubbed REP GIRL (Girls Involved in Robotics Learning) and WIT will encourage the teams it sponsors to follow these protocols once they are released.

In addition to Botball, WIT also took note of the FIRST (for Inspiration and Recognition of Science and Technology) Robotics Competition. This Competition teams professionals and students to solve an engineering design problem. The professionals are reminded of what led them to choose engineering as a career and the students are exposed to the opportunities available in technological fields. The practical applications make the basic concepts of science, math, engineering and invention exciting. The competitions themselves are high-tech spectator sporting events. They engage the students and their families and friends in the results of focused brainstorming, real-world teamwork, and dedicated mentoring.

The FIRST Robotics Competition challenges teams of students and their mentors to solve a specific problem in a six-week timeframe using a standard "kit of parts" and a common set of rules. The robots' raw performance (scoring the most points) is a secondary goal. Awards focus instead on excellence in design, demonstrated team spirit, gracious professionalism and maturity, and an ability to overcome obstacles. WIT has funded air travel expenses for female students who were part of the Waiakea High School Robotics Club and Hilo High School teams participating in regional FIRST Robotics Competitions.

The WIT-sponsored Botball Teams

WIT communicated the opportunity for grant funding to all public middle and high schools in Hawaii County through email to principals and complex coordinators. WIT sponsored 4 teams in the 2003 and 2004 competitions. In 2005, WIT is continuing to help sponsor 4 teams, including an all-girl team from Waiakea High School.

Recruitment of female students is accomplished primarily by teachers approaching female students directly to encourage their participation. This is resulting in a higher rate of female participation than is experienced at schools where students “self-select” for the robotics activity. In addition, the NASA Explorer Team visited an assembly at Waimea Middle School and distributed a flyer with particular emphasis on encouraging females to participate.

In the 2003 competition, the four WIT-sponsored Botball teams together had seven female (77%) and two male adult facilitators. The overall teams were comprised of 24 female (38%) and 40 male students. Although the goal of 50% representation was not met, the teams did beat the national and state average of 30%.

Female participation increased slightly for the 2004 competition, in which the four WIT-sponsored Botball teams together had nine female (81%) and two male adult facilitators. The overall teams were comprised of 22 (39%) female and 34 male students.

Since participating in the 2003 Botball competition, two of the involved schools, Waiakea Middle School and Waiakea Intermediate School, have started offering robotics classes within their curriculum in addition to having after-school robotics clubs which participate in Botball.

Other Impacts of Botball in Hawaii

Botball is becoming a high-profile competition in Hawaii. The 2004 Botball tournament received statewide news coverage via reporting by all three major local television stations' newscasts the evening of the tournament and an article in the Honolulu Star Bulletin. In addition, the Hawaii State Senate passed a concurrent resolution requesting the Hawaii State Department of Education to coordinate and support robotics education in Hawaii.

There is not yet sufficient data to establish that participation in Botball has led to an increase in interest in STEM in the girls that participate. After the 2005 competition, all students at WIT-sponsored schools will complete surveys designed to begin to measure the impact of participation on interest in STEM education and careers.

FIRST Robotics

Students at Waiakea High School participate in the FIRST Robotics Competition through the WHS Robotics Club. During the 2002-2003 school year, WIT funded practice robotics kits for the WHS Robotics Club. It also paid the air fare of seven female members of the WHS Robotics Club team participating in the regional FIRST Robotics Competition in Seattle, Washington. A local cable television show tracked the students' progress with nightly segments over the month leading up to the competition.

During this school year the club was comprised of 40 students (20 of them female). The FIRST Robotics Competition was limited to 17 students, of which nine were female. All of the club's officers as well as all the primary robot drivers in the competition were female. Of these nine, five were seniors, three of whom went on to study engineering at college. All four female underclassmen returned to the club the following school year and took leadership roles.

A pre-activity survey of all club members was conducted at the start of the 2003-2004 school year. The students rated their interest in science and technology and their abilities in engineering and technology (use of tools, including computers) on a scale from one to ten. The largest difference between the responses of the females and males was in their view of their abilities in engineering (female average 5.8, male 7). However, there were also notable disparities in the rating of interest in technology (female average 7.9 compared to male 8.6) and self-assessment of technological abilities (6.9 compared to 7.6).

During that school year, the students worked on three different robotics projects, including the FIRST Robotics Competition. The 17 students (seven female, ten male) who traveled to Portland, Oregon to compete in the Pacific Northwest Regional of the FIRST Robotics Competition were re-surveyed at the end of the school year. The students raised their self-ratings in every category, but the largest difference was between the pre- and post-activity responses of females in their view of their own abilities in engineering. Their average rating climbed from 5.8

at the beginning of the school year to 7.6. They also closed the gap between their self-rating and that of the males (post-survey females average 7.6 compared to males 7.8).

During this same school year, students from the WHS Robotics Club mentored students from Hilo High School who were entering the FIRST robotics program for the first time. WIT provided funding for practice robotics kits for Hilo High School as well. The two schools held joint meetings and activities in order to support each other with their goal of competing in Portland. At Hilo High School, females comprised 40% of the robotics club and 33% of the competing team. The Hilo team placed tenth after the qualification rounds and seventh in the final competition.

The Club's teacher-advisor reports that when recruiting females, he is often met with the response that "it sounds fun, but I don't know anything about robotics." Once involved, female students find both that they had underestimated their own knowledge and abilities and overestimated what others know about the subject. As they work on the robotics projects, their confidence grows. Thirteen of the seventeen students filling out the post-activity survey listed engineering/technology as a career goal. The teacher-advisor was recently visited by six of these students (five female) who are all succeeding as electrical or mechanical engineering majors in college.

Waiakea High School has now received private and grant funds to initiate an Engineering Academy in fall 2005. This is due largely to the leadership of the WHS Robotics Club teacher-advisor and the high-profile student participation in the FIRST Robotics competitions.

Conclusion

Robotics is a viable portal for the entry of Hawaii County girls into the world of STEM. The hands-on nature of robotics projects and the high-profile nature of the competitions provide excitement and make basic engineering and technology concepts interesting and engaging. Botball presents a promising introduction to engineering for seventh and eighth graders. The FIRST Robotics Competition for high school students is promising particularly for its potential impact on the view that female students hold of their own engineering abilities.

WIT plans to continue its focus on robotics as one of the ways to increase representation of women and girls in STEM. WIT will encourage broader participation in the FIRST Robotics Competition, and will work with its sponsored Botball programs to further document the impact of Botball on the girls they recruit to participate.

Acknowledgements

The Women in Technology Project, funded in part by the U.S. Department of Labor, a project of Maui Economic Development Board, Inc. in partnership with Hawaii Island Economic Development Board, Inc.
Art Kimura, Hawaii Space Grant Consortium
Dale Olive, Waiakea High School, Hilo, Hawaii

References Cited

The Birth of Best (2005, Dec./Jan.). *Technology Teacher*, Vol. 64, Issue 4, p. 22.

Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology (2000, Sept.). *Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development (CAWMSET)*, p. 22.

Saviano, M.J. (1999, Fall). Teaching About Robotics. *Childhood Education*, Vol. 76, No. 1, p.32-C.

Verner, I.M., Ahlgren, D.J. (2004, July). Conceptualising Educational Approaches in Introductory Robotics. *International Journal of Electrical Engineering Education*, Vol. 41, Issue 3, p. 183.

Web Resources

FIRST Robotics, www.usfirst.org/robotics

KISS Institute for Practical Robotics (Botball), www.kipr.org

NASA Robotics Education Project (FIRST, Botball, and REP GIRL), <http://robotics.nasa.gov>

Contact Information

SHAWNA SODERSTEN, J.D., Southstone7@yahoo.com

LESLIE WILKINS, leslie@medb.org.