

## **AC 2007-2437: ALIGNING INDIGENOUS CULTURE WITH SCIENCE**

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# Aligning Indigenous Culture with Science

## Abstract

“Excite Camp” now in its sixth year is premised upon the engaging curriculum marriage of culture and science. The program creates interest in Native Hawaiian girls for math and science just prior to entering high school, by exposing them to math and science applications in their community—in tandem with the sophisticated science of their native culture and history. Program development for Excite Camp is provided by the Women in Technology Project (WIT) of the Maui Economic Development Board, Inc. (Maui, Hawaii) and is funded in part by the Department of Labor as a workforce development project. Research indicates that the transition from middle school to high school is a critical time when girls often lose interest in math and science. They view these career fields as boring, not relevant to their lives, and Caucasian male-dominated—thus they do not pursue them. WIT has worked with Native Hawaiian cultural advisors and *Kupuna* (native teachers) in conjunction to the U.S. Air Force Research Laboratory (which has oversight of the Maui astronomical assets) to address the dual barriers of gender and ethnicity facing Native Hawaiian girls by exposing them at this pivotal point in their lives to technology in the context of their community and their native culture.

The WIT project enlists female scientists of Native Hawaiian ancestry who are involved in math and science-based careers to participate in the camp and to provide mentoring for the student participants. WIT also employs a team-based, instead of the individual or competition-based, paradigm which has been proven to be more effective for girls’ education. The paper will also discuss methodology for building self-efficacy through highlighting astronomical navigational science of ancient Hawaiians juxtaposed with current day science, engineering and astronomy careers atop sacred Mount Haleakala. This paper will present survey results, anecdotal evidence, multi-year tracking and improvements/revisions to the program as it progressed through its fifth year. Its importance to this conference is demonstrating how WIT analyzed available research and developed community-based, culturally appropriate and cost-effective programming that, as it is implemented, will provide on-going validation for the need to effect policy changes to provide funding for programs like Excite Camp that can have positive career choice implications for indigenous populations of girls. It will further discuss the broader community impacts of building awareness and respect of Native Hawaiian culture within Hawaii’s scientific and technology community. Training and education protocols used in Excite Camp have become a catalyst to build cultural training protocols within the U.S. Air Force and its civilian Department of Defense contractors, helping to mitigate sometimes contentious relationships.

## Background

Launched in 1999, the Maui-based Women in Technology Project (WIT) is funded in part by the U.S. Departments of Labor, Agriculture, Education and the County of Maui as a workforce development project. Its mission is to encourage women, girls, and under represented groups to pursue education and careers in science, technology, engineering and math (STEM) in the state of Hawaii. WIT has been successful at creating systemic change by working directly with

educators and employers to make them aware of the return on investment of recruiting and retaining a diverse and inclusive skilled technical workforce.

In 2001, WIT approached the U.S. Air Force on Maui to allow student access to its classified asset the Maui Space Surveillance Complex and to partner in an educational outreach program designed to engage Native Hawaiian middle school girls in STEM education and careers on Maui. The partnership also involved Kamehameha Schools, a private school funded by the Estate of Princess Bernice Pauahi Bishop to fulfill her desire to create educational opportunities in perpetuity to improve the capability and well being of people of Hawaiian ancestry. Schools provided some seed funding for the project, WIT led the program development including gender equity principles and minority outreach, and the U.S. Air Force offered students the opportunity to visit the Maui Space Surveillance Complex, as well as technical and program development assistance.

The first Excite Camp was held August 1-3, 2001. The three-day event was designed to serve as a model for integrating the scientific traditions of indigenous peoples into current science education. The goals were:

- To provide a venue for WIT to reach middle school girls of Native Hawaiian ancestry and other ethnic minorities in Hawaii
- To develop a model workshop/curricular program integrating hands-on math and science learning with exposure to science and technology positions on Maui that will “excite” middle school girls into pursuing careers in these fields
- To provide an opportunity for the U.S. Air Force and growing Maui-based technology companies to share their technology and research with Maui students as part of an integrated education program that demonstrates the relevance of science and technology in the community
- To maximize the impact of this program initiative while achieving cost and time effectiveness for the various partners

The initial Excite Camp was based loosely upon the following model programs.

- Attracting Women into Engineering Summer Workshop, Rowan University College of Engineering <sup>1</sup>
- Outreach Activities by Benet Laboratories, U.S. Army Armament Research, Development and Engineering Center, Watervliet, New York <sup>2</sup>
- IBM Excite Camp at Purdue University <sup>3</sup>

Since then, the program has steadily grown in recognition among middle school girls and high tech employers, successfully broadening its reach to Native Hawaiian and ethnic minority applicants each year, as well as improving the educational value and cultural integration of its program activities and mentor presentations.

## **Program Approach**

Hawaii public schools traditionally rank poorly in math and science compared to the rest of the nation. According to year 2003 findings from the National Assessment of Educational Progress, Hawaii 8<sup>th</sup> graders rank lower than 31 other jurisdictions in math <sup>4</sup>, and rank lower than 36 other

jurisdictions in science <sup>5</sup>. Per the Maui District DOE Standardized Test Scores for School Year 2002-2003, 35% of Maui's Native Hawaiian 8<sup>th</sup> graders scored below average on their Math SAT and 44% below the HCPS-II Math standards <sup>6</sup>.

A best practices review was made of model programs nationwide designed to encourage middle school girls of under-represented race/ethnic ancestry in STEM. The existing research suggests that girls experience a precipitous decline in interest in math and science beginning with the middle school years, the main barriers being the perception of these subjects as boring, a disconnect with the relevance of these fields, and a sudden decline in confidence in these subjects <sup>7</sup>.

Native Hawaiian/Pacific Islanders have been identified as an under-represented race/ethnic group in STEM. Barriers for under-represented race/ethnic groups, according to the research, are focused mostly on lack of equal opportunity to educational opportunities and the resulting lack of academic preparation in math and science <sup>8</sup>. For example, students of under-represented race/ethnicity are more likely to attend schools with teachers not properly trained or certified to teach math and science, and to attend schools where math and science performance is below the national average.

Based on a 2000 Native Hawaiian Educational Attainment Survey, only 9% of Native Hawaiians (NH) living on the island of Maui obtained Bachelor's degree or higher, statewide only 12% <sup>6</sup>. Per the 2003 Educational Attainment of Individuals 18 years and Older: Hawaii Health Survey, Maui County is home to about 11% of the state's Native Hawaiian population. Nearly 20% of Maui's Native Hawaiian population did not graduate from high school or obtain a GED. Economic hardships may be a factor for the high percentage of non-high school graduates with a telling statistic 47% of state's NH school population is dependant on free or reduced lunch <sup>6</sup>.

As a means of addressing the dual barriers for Native Hawaiian girls, the program goal was to provide the girls with confidence-building exercises in math and science using models that have had demonstrated success, as well as providing the girls exposure to educational opportunities in math and science in which they might not otherwise have the opportunity to participate. There was no cost to the child or parent for their daughter's participation.

After five years of continual refining, the following strategies have been identified as crucial elements of any STEM program aimed at Native Hawaiian and other ethnic minority middle school girls.

- *Hands-on activities* demonstrating math and science principles in a context that made them relevant for the girls.
- *Team-based atmosphere*, as opposed to individual or competition based. Team-based learning has shown to be a more effective catalyst for girls' education.
- *Mentoring opportunities*. Each student team had a woman mentor who was raised on Maui and was either enrolled in higher education or employed in science and technology. Mentoring has proven to be one of the most successful mechanisms for encouraging girls into these fields.

- *Exposure to science and technology in their communities.* The need for relevance has been identified as crucial for girls to make the connection between math and science as academic pursuits, and math and science as meaningful careers. In order to accomplish this, it was imperative for the girls to see how people working in their community use math, science and technology.
- *Connection of culture and science.* Native Hawaiian girls are exposed to math and science applications in their community illustrating relational examples from their native culture and history.

Program development for Excite Camp 2006 reflected the incorporation of program model elements based on the research, evaluation and success from the past five camps, 2001 through 2005. A Native Hawaiian consultant was retained to infuse Hawaiian history and culture into the activities. The anticipated outcome was to align science, host culture and community.

In addition to, a review of other model programs was conducted and implemented as new activities, which included:

- Experiments from past WIT events and programs
- Akimeka's Digital Bus GIS/GPS Scavenger Hunt Activity

## **Recruitment**

The 2006 Camp (July 12-14) was limited to 20 girls, the optimal number recommended by the 2002 Excite Camp evaluation. Keeping the program small allowed each student to take full advantage of the opportunities and benefits offered by hands-on participation and personal mentoring. The entire unit was easily divided up into five groups with four girls per mentor.

In 2006, middle school girls of Native Hawaiian ancestry and other ethnic minority backgrounds were again targeted for recruitment. Each interested student was required to complete the Registration and Permission form. A total of 20 girls were selected from an applicant pool of 30.

To ensure WIT project's outreach services were equally distributed throughout Maui intermediate schools, selection was also based on securing a spot for a representative from each school. Students represented eight different middle schools on Maui, which included home-schooled students of 7<sup>th</sup> and 8<sup>th</sup> grade age.

## **Program Agenda**

The primary focus of the program in 2006 was to address the dual barriers of gender and ethnicity facing Native Hawaiian girls by exposing them to science and technology in the context of their native culture and community. A Native Hawaiian cultural consultant, referred to subsequently as *kumu*, Hawaiian for teacher, was engaged to serve that purpose of the program's mission.

Another focal point was to introduce the girls to the U.S. Air Force Research Laboratory's Maui Space Surveillance System. This facility sits atop the summit of 10,000 foot Haleakala Volcano, and houses the Advanced Electro-Optical System (AEOS) telescope, the nation's largest optical

telescope designed for tracking satellites. Haleakala Volcano provides some of the best viewing conditions in the world, and is also home to the University of Hawaii Institute for Astronomy.

The program also focused on exposing the girls to the technology companies of the Maui Research and Technology Park and the Maui High Performing Computing Center (MHPCC) which emphasize careers in astronomy, optical imaging, and supercomputing.

Participating organizations included Maui Community College, Maui High Performance Computing Center, Pacific Disaster Center, Oceanit and Monsanto. As in the previous year, Day One took place entirely at Maui Community College, Day Two began at Maui Community College and ended with the visit to the telescopes atop the Haleakala Summit, and Day Three was entirely held at the Maui Research and Technology Park in Kihei.

### **Students Teams**

Students were pre-assigned to teams versus self-selected teams at prior camps. The girls were paired in a team of two, who were then matched with another team to form a group. The methodology used to determine teams/groups included the following criteria:

- Each group was assigned members ranging in age from 11 to 13 so that older girls were teamed with younger girls. This was done to allow the older girls to serve as leaders or mentors to the younger girls.
- Girls who were known to be friends or from the same school were placed on different teams. This was done to encourage the girls to make new friends and minimize “clique” interaction.
- Instead of announcing the team assignments on Day One, each participant was given an envelope that enclosed half of a puzzle piece. They were instructed to find the person (team partner) who had the matching half of the puzzle. All puzzle pieces were strategically made the same shape, a star, with 5 different colors and Hawaiian names of the stars to designate the 5 groups. The puzzle pieces were either cut in zig-zags or curves to indicate which team the individual belonged to.

To encourage questions, a question and answer component was introduced, with the girls instructed to ask at least three questions from any of the presenters during the three-day entire camp. At the end of the Camp, the girls’ question and answer forms were collected, and in return, each girl received an “Excite Camp 2006” T-shirt.

### **Hawaii’s Past and Present**

Participants were given an introduction to Hawaii’s past and present in the context of science and technology by active Native Hawaiian members in our community, which included a Project Director of a community college program encouraging NH to pursue higher education and a recent astronomy graduate. The information they shared set the tone for the proud heritage of

sophisticated science practiced by the girls NH ancestors and further highlighted the importance of higher education for their people.

## **Hands-On Activities**

### *Spaghetti Bridge*

Students were tasked with building a bridge made from spaghetti and marshmallows by forming two pyramids connected by a piece of spaghetti as the “bridge.” After constructing the bridge, the girls were then instructed to see how many pennies the bridge could hold. In order to do that, they cut a corner of an envelope to form a triangular basket and hooked it onto the bridge with a paperclip. After four tries, they were tasked to hypothesize whether or not the linguine was stronger, and then test the results using linguine noodles.

This activity continues to be a huge hit with the girls and was the first hands-on activity of the camp on Day One. The objectives of the Spaghetti Bridge were to: 1) have the girls become acquainted with each other (ice breaker) by 2) working together as a team, while 3) both teammates had equal opportunity for hands-on time.

### *Astronomy Model — PVC Telescope Activity*

Oceanit, a progressive Hawaii-based engineering, science, and research company specializing in optics manufacturing, developed the PVC Telescope Activity, which was introduced in this program in 2004. To ensure that everyone had an opportunity to construct the telescope from PVC pipes, each student was given a kit. The dynamic and spunky Oceanit presenter highlighted important physics and astronomy principles which included the history of Hawaiian celestial navigation using the stars, while introducing the girls to the history of optics.

Additionally, the activity was a perfect tie-in to the next day’s Maui Space Surveillance System site visit to see the U.S. Air Force’s AEOS Telescope. The girls were permitted to take home the telescopes to experiment with viewing the moon, stars, and space and were encouraged to allow their friends and family members to do the same. In hopes to inspire a passion for science and astronomy, the girls were rewarded with the telescopes to keep as their own in exchange for a promise to continue using it.

### *Computer Disassembly and Reassembly Activity*

This hands-on activity is positively remembered by many of those surveyed as it was a first-time experience for all. Every year, it has been observed that the girls were initially apprehensive to do the activity for fear of breaking the computer. With encouragement by the mentors, the girls were given the confidence they needed to deal with this challenge. A 2001 participant, currently a high school junior, claimed that this was the activity that led her to take electronic and computer elective classes in high school.

The student teams learned to disassemble and then reassemble computers to working order. Disassembly and reassembly included the following steps:

- Opening CPU casing
- Removal and replacement of video card

- Removal of multi-I/O card and port adapter
- Removal and replacement of memory chips
- Removal and replacement of floppy drive, CD drive, and DVD drive
- Identification of BIOS and CPU chip
- Reassembly of computer into working order
- Completing a worksheet about computer disassembly and reassembly

The “test” came at the end when the teams reassembled the computer back to working order and booted it up.

### *Float Da Boat*

Float Da Boat, also known as Das Boat by Future Scientists and Engineers of America (FSEA), challenged students to design a boat using a single piece of 6” x 12” foil that could carry as many marbles as possible before sinking.

The history of Native Hawaiian voyaging using canoes as their vehicles was discussed prior to introducing the concepts of engineering design, buoyancy, and volume (Archimedes Principle of Displacement).

### *Ice Cream Engineering*

Concepts of freezing temperature and the effect of salt on freezing temperature were demonstrated in this fun, cold and tasty activity. The girls were taught that making ice cream the “old fashioned” way is all about science and engineering.

Students also learned how salt was used in ancient and current Hawaiian culture. Several varieties of salt organically made in Hawaii, also known as Hawaiian salt, were passed around for observation while their *kumu* discussed the many uses of salt in the common Hawaiian household like medicinal remedies and food preservation.

### *Molecule Mission*

The students were engaged in this challenging hands-on, team-based, and time-limited activity. As a group, they had to construct a model of a molecule using colored gum drops and colored toothpicks. Each student was assigned a defined role of scientist (the only ones able to see a prototype molecule which they had to analyze and communicate a description of), technicians (conveyers of information between the scientist and the engineer), or engineer (building the model based on the scientist’s description). The teams competed to see who could build the most accurate model.

When asked what key factors in successfully completing this activity were, the girls immediately responded with “teamwork and communication”. They understood the importance that good communication skills and the ability to work as a team were extremely important in getting the job done.

Like the previous hands-on pursuits and prior to starting the activity, the *kumu* provided the girls with a presentation about Native Hawaiian canoe-building and the details behind building a strong, working canoe. Following the canoe-building lesson, *kumu* played a popular, modern



day song that incorporated a well-known Hawaiian chant which referenced moving forward and working together as a unit. Many of the girls knew the chant and participated in the chanting. The presentation and the song instilled an energizing and inspiring mood for their *Molecule Mission*.

All 20 girls rated this activity either “very good” or “excellent”. One even commented that it was “fun and challenging”.

## Site Visits

### *Maui Space Surveillance System*

- *Native Hawaiian Voyaging Presentation.* Prior to the departure to Haleakala, a female University of Hawaii-Hilo Astronomy graduate, also an Excite Camp mentor, a Native Hawaiian consultant, and *kumu*, educated the girls about *The Ancient Art of Ocean Voyaging by Early Polynesians*. Through this Hawaiian cultural presentation she discussed the techniques used by Native Hawaiians via the stars, astronomy, and space to navigate and predict weather patterns. It was such a positive experience for the girls to see that young, cool local girls are intelligent and can be passionate about science and astronomy. One hundred percent (100%) of the students found this presentation very good or excellent. A student commented, “It was interesting to learn how and [with] what tools the ancient Hawaiians used to navigate.”
- *University of Hawaii – Institute for Astronomy.* UH-IFA is the caretakers of a sacred site where Native Hawaiians pay their respect to their ancestors. Prior to the tour of the telescopes, the participants were guided by the *kumu* with a Hawaiian chant requesting permission to access the land. An offering, *ho`okupu*, was placed at the sacred halter. This was such a spiritual and enlightening experience for everyone. The day was beautiful – clear skies and a view of the island of Hawaii’s twin volcanoes, Mauna Kea.
- *Telescope Site Visits*
  - *Faulkes Telescope.* Operated by the University of Hawaii’s Institute for Astronomy the girls were given a tour of the British owned telescope that is used by U.K. students noting their day is our night.
  - *Advanced Electro-Optical System (AEOS) Telescope.* With U.S. Air Force personnel conducting the tour, the students were able to view up close the AEOS Telescope, learn about its functions, and why Haleakala summit is considered one of the best telescopic viewing sites in the world.

### *Monsanto*

Students learned that Monsanto is a leader in biotechnology research with genetically-engineered corn crops on Maui. They were taken out to the crop fields to see firsthand the work being done.

### *Pacific Disaster Center Presentation*

Pacific Disaster Center provides applied information and research and analysis support for disaster management. Students learned how Global Informational Systems (GIS) could be used to build their own evacuation plan.

### *Akimeka's Digital Bus*

This visit was also considered as a hands-on activity as students were shown how to use Global Positioning Systems (GPS) units for their "Scavenger Hunt" and map-making.

### *Maui High Performance Computing Center – Visual Lab*

Students learned about satellite and aerial photography, and enjoyed a demonstration of how the Center's 3-D imaging technology is used for research.

## **Closing Remarks**

Over the course of the three days, the *kumu* executed a greater appreciation for the Native Hawaiian culture and its contributions to our community and society. The program closed with an inspiring message by the *kumu* that weaved all elements of the program's goals for these girls – to ignite an interest in STEM, to expose them to opportunities in their home, to encourage them to pursue higher education, to perpetuate and respect culture and community.

## **Maintaining Company/Presenter Participation and Relationship**

As a follow-up to the event and to continue positive relationships with Excite Camp hosting companies and presenters, parents were asked to encourage their daughters to write thank you letters to two companies/presenters. The companies and presenters were pre-selected in advance for each student based on the highest company ratings each provided on her own survey.

## **Cultural Elements**

Persons of Native Hawaiian or Part-Native Hawaiian ancestry make up approximately 25% of the population of Maui County<sup>9</sup>, yet Native Hawaiians comprise less than 6% of the University of Hawaii enrollments in STEM fields. Therefore, it is significant to increasing NH participation in STEM by increasing cultural aspects of the program and fostering their relevance to NH girls.

- Native Hawaiian females from the community studying or working in STEM areas are sought as mentors and role models for the event.
- Hawaiian history or culture was embedded into each activity and site visit for the girls to see a connection between their heritage and modern day science.
- The visit to Haleakala includes a presentation about the cultural, environmental and religious significance of Haleakala Volcano, including its role in Hawaiian creation myth. The presentation also highlights ancient Native Hawaiians who explored and populated the Pacific with seafaring canoes using traditional navigation techniques and astronomy.

To pay homage to the Native Hawaiian ancestors, the group began their day atop Halekala with a visit to a sacred site. With guidance from the *kumu*, they all participated in this ritual with a Native Hawaiian chant requesting permission to enter the land while presenting a *ho`okupu*, Hawaiian for offering or gift.

- Finally, tours of tech companies showcase the role of female and male Native Hawaiian employees, as well as women of other ethnicities.

## Program Evaluation

Like its name, Excite Camp’s mission is to expose the girls to math and science in their community in a way that they would perceive as exciting, fun, and relevant. In doing this, a balance needed to be struck between the educational objectives of the event and the need to keep it engaging for the girls.

A survey was introduced as a recent tracking element for past Excite Camp participants. The following data was gathered to see if the program successfully impacted them in STEM through pursuing those fields as a college major or career, gaining a more positive outlook and confidence in those subjects, and measuring their self-esteem in those areas.

The research was conducted on 2001-2004 Excite Camp participants, totaling 85 girls. Twenty-nine or 31% of those girls were contacted (26 high school students, 2 college students, and 1 in the workforce with hopes to go to college). Each one remembered their participation in Excite Camp and shared their most memorable moments of the program. Many of the girls mentioned the opportunity to view the telescopes atop Haleakala.

The results obtained were very positive. Overall, the girls gained confidence, increased the possibility of pursuing STEM interests and made valuable connections with job opportunities on Maui, their home.

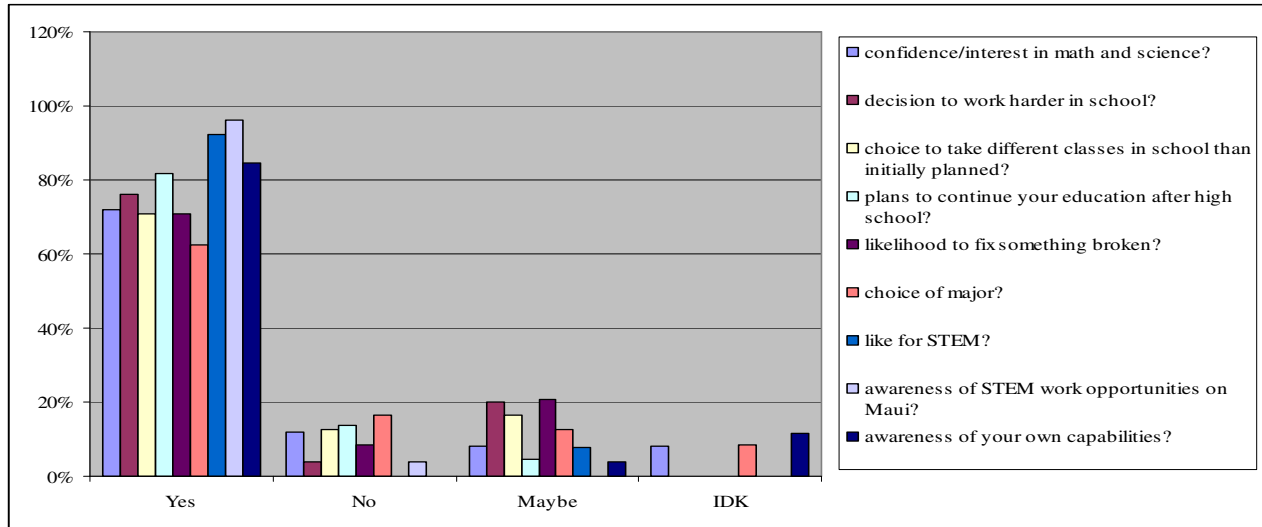
Those currently in high school were asked questions regarding their past, present courses and future plans. The chart below confirms that the girls are self-selecting STEM related courses as electives and the majority plan on continuing on to higher education.

Based on 26 high schooler responses	Yes Response
Currently enrolled in *STEM related elective courses	74%
Favorite school subject is *STEM related	73%
Excels in *STEM related subjects	67%
Plans on attending college after high school	91%

\* includes hard and soft sciences, technology, engineering, math, computers, electrical, and electronics courses.

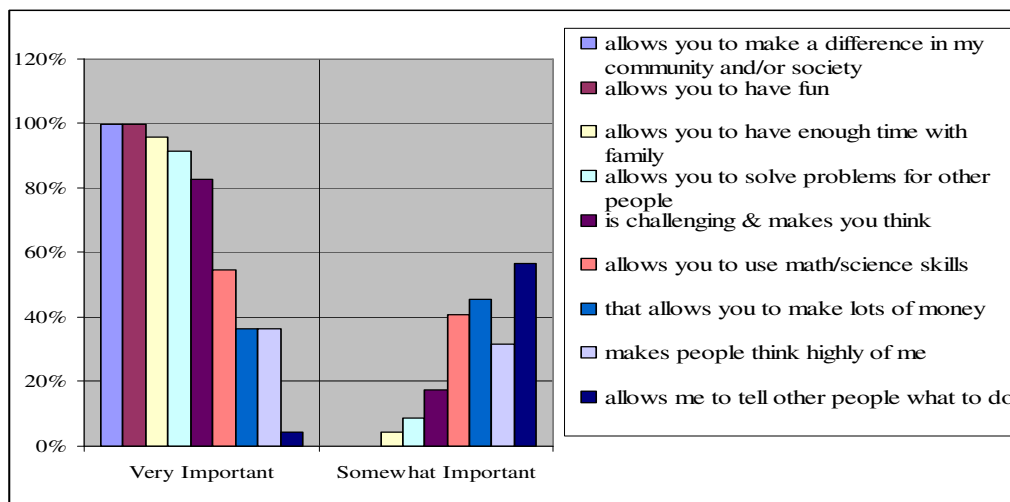
As a pilot project and established annual program, the results confirmed that Excite Camp influenced the girls’ awareness, interest, and understanding of STEM. Well over 60% of the

participants surveyed (29 total) responded with “yes” answers to questions that began with “Do you feel your participation in Excite Camp increased...” The chart below depicts the results of those questions.



Women are naturally the caregivers and humanitarians of our society as a whole. When comparing our research to nation-wide research results, we’ve noticed that women in general clearly want to do something that makes a difference in their community and society, work that is fun and allows them time with their family. In fact, over 80% of these young women claimed that they want work that’s challenging. Over 50% stated that using math and science skills in the workplace is very important to them. However, money, titles, and dictating orders were not a priority to them, which imply that women want to contribute as a serving equal to our livelihood.

Highlighting their confidence and choices in selecting a career, the questions in the chart below began with “How important is it for you in choosing a job, work that...?” The participants were given the following selection of answers: Very Important, Somewhat Important, and Not Important. Here are the results:



Based on their ranking of and comments on Excite Camp overall, the program continues to be successful in achieving the balance between the educational objectives and the need to keep it engaging for the girls. To illustrate the impact the program has made from its inception, in regards to infusing the Native Hawaiian program model in all the activities, 71% of the 2001-2004 participants claimed that the Camp brought about an awareness of their culture. When asked the same question to the 2006 Excite Camp girls, 95% indicated that they learned something new about the Hawaiian culture.

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