'Computers are incredibly fast, accurate, and stupid. Human beings are incredibly slow, inaccurate, and brilliant. Together they are powerful beyond imagination.'
(Albert Einstein; German and American theoretical physicist; 1879–1955.)

BPC-LSA: Girls Gather for Computer Science (G²CS) Project Description

Introduction

The Challenge

Kathleen Melymuka is among the many commentators who continually remind us that girls do not go into the information technology and computer science fields:

> A recent survey of high school students showed the top choices for both college major and career path are computer science and engineering – for boys, that is. But technology barely shows up on girls' radar screens. Girls are five times less likely to consider technology-related studies in college or tech-related careers. They're still bent on traditional female occupations such as teaching and health careers [Melymuka, 2001]

This report is hardly news to teachers of information technology and computer science, and is a common issue for employers wanting gender balance in the workforce. *To meet this challenge, we propose to run an innovative computer science summer camp for girls (***G²CS***),* leveraging ten years' experience of providing summer science camps, and drawing on a body of recent research. Additionally, we plan to sustain the impacts of the camp for a ten-year mentoring period following the camp, and foster a sense of community and continued communication among the participants. Underlying our approach is a focus on computational thinking, and developing a program that will fit small university settings that do not have extensive computer science resources.

The Research

Some clues as to why this state of affairs has developed among girls can be found in recent research. For example, a study funded by the National Science Foundation reports on the newest understandings of how girls and boys experience science in the middle- and high-school years [Fouad & Smith 2004]. Fouad and her colleagues argue that self-confidence, and the lack of it, remains a barrier for girls wishing to enter STEM (Science, Technology, Engineering, and Mathematics) fields. Interest is important, they argue, but building self-confidence is a pre-condition for interest to emerge. Fouad comments:

> 'For the last 20 years, there has been all this work done on boosting interest of girls early on. But I don't think that's it.' says Fouad, whose research has found evidence that confidence levels in math and science-related tasks are lower for girls than for boys [ScienceDaily 2008].

Overall, 'parental support and expectations' as well as 'engaged teachers and positive experiences' emerged as the key elements of a successful intervention [ScienceDaily 2008].

In an NSF/WGBH Boston collaboration [Benyo & White 2008], an initiative was taken on the 'interest' side of the equation to refashion the way teenagers 'see' computing, especially African-American boys and Latina girls. They focus on the 'nerdy, unattractive, unsocial and uninteresting' sociological message that computing generates, and they seek to rebuild this message. They remind us that this problem has serious national economic and security consequences if it is not corrected. Their new strategy suggests a 'make-over' to refashion and redesign the connotation associated with computing, to try and move the meaning from 'computer-geek' to computer-chic'. They propose working with a broad alliance of universities, businesses and educational agencies to make this happen. Their first findings from their survey suggest that girls 'associate computing with typing, math and boredom'. But messages that appear to have the most traction include 'Computing puts you in the driver's seat', 'Computing opens doors', and 'Computing empowers you to do good.' For teenagers, it appears that finding a job that is interesting, and about which one can be passionate, is a strongly-held value. Making a difference is also appealing, especially to girls.

We also draw on many of the other NSF research activities focusing on this issue. We plan to use culturally appropriate tools in the classroom, following the work of Taylor and Scott et. al. [Taylor 2008; Scott et. al. 2008]. Detailed curricular work in this area will enhance resources we ourselves have developed to advance a sophisticated and effective pedagogy [Sadler 2008]. Central to our work, and a finding that has emerged from our own past experience, is the need to develop a computer science 'learning community', which we will establish during the **G²CS** camp, as the most effective environment in which to create positive attitudes to computing [Rosson 2006]. Web resources on computing education will be widely used [Komlodi et.a. 2007]. We will also adapt parallel experiences from other such camps to fine-tune our own project [Lanius & Cooper 2002]. Together, these resources will provide the foundation of a program well poised to engage middle-school girls with computer science.

Goals, Objectives and Outcomes

Pacific University has become a leader in science education, with a close focus on problem and project-based teaching and learning in our ten years of experience in running summer science camps for girls [Fehrs 1992]. We now propose to run an innovative *computer science summer camp for girls* - **G²CS** - and, from this experiment, to develop a curriculum and media plan to scale this experiment nationally, providing the foundation of a program especially suited to the small university setting. Computational thinking will underpin our general approach. Partnering with the nationally-recognized public broadcasting station Oregon Public Broadcasting (OPB), and with over a dozen local businesses, software and computing companies, school districts and community groups, we plan to develop a national curriculum, and the electronic and media tools needed to disseminate that curriculum.

Our overall goal is *to draw together the detailed findings of the available research* listed above, together *with our ten years of experience running science camps* to change the way girls from all ethnic and class backgrounds can experience the field of computer science. This goal, once realized, will unlock the potential of a large population in the United States, and enable them to contribute fully to one of the most exciting fields in our emerging economy. This is an ambitious goal, and one that we believe we have the experience and evidence to realize.

To fulfill this ambition, our **four** specific objectives are to:

1. *Develop a pedagogical strategy for middle school girls that instills a view of women scientists as leaders*. The strategy will focus on *women mentors, parental involvement, positive learning experiences,* and an *intensive learning community* in a computer science summer camp, **G²CS.** Using the findings of recent research and our own work, we believe these four pedagogical elements are central to our success. Computational thinking is the common theme.

2. *Improve the female students' confidence and skills in an effort to recruit them into science careers, especially in computer science*. Following the detailed research findings, we will create a curriculum that offers positive experiences in computer science. The curriculum will emphasize active learning in the classroom, field trips to interesting sites where computer science activities are taking place, and a strong system of positive support for student achievement.

3. *Establish a collaborative learning community that includes students, teachers, parents, faculty, and community partnerships.* Using the summer camp model, positive reinforcement techniques, outstanding pedagogy, and the support of women leaders and mentors, as well as parents, we will create a strong *learning community* in the **G²CS** camp that will boost the girls' confidence in measurable ways.

To meet this objective we have set up an extensive network of partners, including Oregon Public Broadcasting (OPB), Intel, Vernier Software & Technology, Flying Rhinoceros, and other business partners, community and tribal groups, local school districts, and educational institutions. Partners will be involved in the teaching of computer science, act as permanent supporters and advocates of middle-school girls in this enterprise, and offer the infrastructure to ensure the continuation of this teaching process. This will result in a widespread opportunity for local teachers to expand their computer science knowledge, thus changing the ways schools teach computer science and technology. OPB's development of a **G²CS** website will establish a permanent record of the **G²CS** camp and offer the camp model to educators wishing to replicate it. Our business and industry partners, interested in nurturing a pipeline of highly educated workers, will be active participants in the community that we create.

We will track the improvement in girls' confidence and progress in computer science for ten years after the camp experience.

4. *Disseminate the results of the project (including curriculum and student products) via electronic media, presentations and publications, to create a national model.* We will work hand in hand with Oregon Public Broadcasting (OPB) to *develop a suite of media tools* to record, document and distribute the key ideas of the program regionally and nationally. Concretely this will mean producing a website, video clips, interviews, podcasts, blogs, game-like online interactives, books, pamphlets and other forms of media that make our findings available to the widest audience.

Pacific University's ten years of summer science camp for girls has shown us that a modular structure of curriculum, in which elements can be moved in and out with flexibility, is central to success in teaching children of this age. It is also central to the scalability of the project, since the faculty capacity to teach certain topics, and the facilities and personnel in industry who are available, also change across time and place. Thus a carefully thought out system of teaching, closely mentored, women-centered, and highly flexible, is proposed, with the emphasis on computational thinking.

Implementation Plan

The **G²CS** *Camp*

'The largest decline in female participation in computer-related activities and classes occurs during their adolescent years' [Regiec 2005] and for this reason we are targeting middle-school girls in 7th and 8th grade. Girls this age experience a drop in their sense of confidence in general, and one way this expresses itself is in their loss of interest in science-related topics, including computer science. Involvement in all-girl computer events can help alleviate that loss of interest [Margolis & Fisher 2002]. We will target schools geographically close to Pacific University and provide students with funds to cover public transportation costs to the university. Allowing the students to use public transportation was a 'surprising success' at the Summer Science Camp held at Pacific University for ten years and 'it seemed like a great adventure to them' [Fehrs 1992]. Activities will begin at 9:15 a.m. and be completed by 3:30 p.m. each day, five days per week for four weeks.

The **G²CS** camp will be non-residential. However since girls from the Confederated Tribes of the Umatilla Indian Reservation in Pendleton live 240 miles from Pacific University, we will provide on-campus accommodation for 6 students and their chaperones from that community. We will not be providing funds or activities for the girls outside of the regular activities of the camp.

G²CS *Camp Organizers*

Dr. Shereen Khoja will be the camp director, and organize and run all activities. Dr. Khoja has been teaching computer science at Pacific University for seven years. She holds a B.Sc, and a M.Sc. in computer science. Her experience of a female-only educational environment for 16 years will be an asset for this project. Her Ph.D. is in computational linguistics from Lancaster University in England. In 2003, she received a $2,000 grant from the Computing Research Association's Committee on the Status of Women in Computing Research (CRAW) to fund two undergraduate female students on a project to develop a neural network grammatical tagger for Arabic. Dr. Khoja is also a community member of the NSF CPATH Project: Building the Northwest Distributed Computer Science Department (award #0829651 funded in 2008).

The **G²CS** camp will be run by all-female instructors and will comprise university faculty, teachers recruited from the middle schools involved, and undergraduate computer science students. Student helpers will run team-building exercises and physical activity after the lunch period each day. After the first year, some past participants will be invited to return as camp interns. All instructors will be compensated for their time.

G²CS *Camp Format*

Each week of the camp will focus on a different computer science topic, and will include four days of on-campus education and activities. One day each week will comprise a field trip to a company or organization involved in work relevant to the topic for that week. The topics may vary from year to year, and example topics and field trips include:

- *Web Development*: The curriculum will include some basic HTML editing and web design tools to teach the students how to place information online, as well as education and discussions of online security. The field trip will be a visit to Oregon Public Broadcasting (OPB) to observe web professionals explaining how the OPB website is created including discussion of web 'interactives'[1] that are similar to the ones that will be developed as part of the camp's media resources (see below).
- *Game Programming*: We will use *Scratch*[2] and *Alice*[3] to teach computer science and

[1] Examples of the interactives can be found here: http://www.learner.org/courses/mathilluminated/interactives/index.php#prim
[2] http://scratch.mit.edu/

programming concepts in a thought-provoking way through the creation of games and using stories. The field trip will be a visit to Flying Rhinoceros to observe developers creating educational web games.

- *Science and Technology*: The relationship between science and technology will be explored during this week. The students will be provided with *LabQuest* devices[4] to explore hands-on science. Among other investigations, students will use real-time data collection and graphical analyses to a) identify musical notes based on their frequency, b) study their own motion and acceleration by measuring their speed going down a slide, and c) meet a challenge to produce the highest possible pressure in an empty container. The field trip will be to Vernier Software & Technology, where the girls will talk to female computer scientists working on the *LabQuest* devices.
- *Computer Hardware*: The girls will build a computer from scratch. Computer hardware will be provided and students will build a computer and install a basic operating system. Students will also learn about the binary number system using a physical game adapted from Boe et. al. 1983. Another topic for this week is electronics where the girls will use solder-less breadboards to create circuits that contain batteries, diodes, logic gates, transistors, and LED's. The field trip will be to Intel and include a tour of the manufacturing plant[5].
- *Robotics*: Girls will use the Lego Mindstorm NXT kits to build robots and program them to achieve tasks. Resources provided by Polar Radar for Ice Sheet Measurements will be used for this topic[6].
- *Biotechnology*: The students will learn about basic biology and its relation to computer science. They will use the "Origin: Unknown" website[7], which is an interactive game for students, in which they must identify the origin of an unidentified organic sample. The trips will be to St. Vincent's Hospital, where the students can observe technology being used in healthcare, and to OHSU (Oregon Health and Sciences University) where students can observe lab researchers working in the field of bioinformatics.

The girls will be given *Flip* cameras to use for the duration of the camp. They can use these cameras to shoot video diaries and film activities that they find particularly interesting and exciting. Videos collected during the camp will be edited and placed on the website as appropriate.

Computational Thinking

We will be incorporating *computational thinking* into all aspects of the camp. Jeannette Wing states that 'Computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science' and that 'Computational thinking is a fundamental skill for everyone, not just for computer scientists' [Wing 2006].

The participants will learn how computer science concepts can be applied to many areas. For example: a) using logical thinking to solve Sudoku puzzles, b) using algorithmic thinking in Tic-Tac-Toe and c) exploring efficiency by coming up with an algorithm to solve a puzzle, then counting the steps it took to reach the correct solution. Efficiency involves coming up with algorithms that use a smaller number of steps.

A Day at the **G²CS** *Camp*

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[3] http://www.alice.org/
[4] http://www.vernier.com/
[5] http://www.intel.com/community/tour/oregon/index.htm
[6] http://ku-prism.org/resources/polar/robotinfo.html
[7] See http://www.swbic.org/origin/ produced by the Southwest Biotechnology and Informatics Center (SWBIC)

One of the things that we have learned from our experience with the summer science camps is the importance of keeping the learning stimulating and exciting. Therefore there will be no lecturing, and the girls will gain an understanding of the topics through hands-on activities, and field work. There will be plenty of time for socializing to facilitate the development of a learning community amongst the girls. Friday afternoon will be dedicated to some physical activity such as swimming, soccer, volleyball, or softball.

An example schedule for a typical day is:

9:15 – 9:30	Meet and socialize
9:30 – 10:15	Instruction/hands on work/question and answer session
10:15 – 10:30	Snack
10:30 – 11:30	Instruction/hands on work/question and answer session
11:30 – 12:00	Lunch
12:00 – 12:30	Activity period with team building exercises
1:00 – 2:00	Instruction/hands on work/question and answer session
2:00 - 2:15	Snack
2:15 - 2:45	Instruction/hands on work/question and answer session
2:45 – 3:00	Online evaluation of days activities
3:00 - 3:20	Blog and video diaries
3:20 – 3:30	Conclude and distribute snacks for trip home

Overnight Trip

Early in the second week of the **G^{2}CS** camp, the girls will make an overnight trip to the coast. All instructors and student helpers will participate in the field trip and it will center on two things: a *mystery* that students will need to solve using the skills that they have learned, and a *scavenger hunt* that requires critical thinking and analysis. The students will also have time to socialize together, play on the beach, and prepare a meal together. The group will be staying at condominiums on the beach with 6-8 girls and 2 adults per condo. The experience will integrate the girls and the instructors into a cohesive whole. The girls will use their newly acquired skills in a group setting that is highly motivated and stimulating, and the fundamental goal is for students to associate computational thinking with positive, productive experiences.

Parent Involvement

Parental involvement will be an important component of the **G^{2}CS** camp. The research is clear that strong support from parents is essential to success [Scott et. al. 2008]. Parents and campers will be invited to attend an opening reception on an evening prior to the first day of camp at which they will be given a tour of the facilities, an overview of the camp and a presentation about the influence – both positive and negative – that parents can have on their daughters' interest in computer science. They will also attend an evening banquet on the final day of the camp when campers will showcase their work using posters, demonstrations and skits. The parents and girls will fill out attitude surveys at both the opening reception and the closing banquet. They will be asked to determine how much they agree or disagree with statements such as: a) women computer scientists are taken seriously in our society, b) in movies and TV computer scientists are portrayed as nerds and c) computer science is helpful in understanding today's world.

Teacher Involvement

We fully understand that organizing and running a camp for middle-school girls is very different from working with college students. We will therefore be employing female middle-school teachers from local schools to participate in the **G²CS** camp as instructors. The teachers do not need to have advanced skills in computer science, but they should have an interest in technology and how it impacts our lives. The teachers will be involved both as educators and learners. They will develop curriculum materials during the camp, and at the end of the camp, they will be designated as lead teachers for their school districts, bringing the new curriculum to their peers in the classrooms.

One month prior to the start of the **G²CS** camp, the instructors will gather for a half-day meeting (including lunch) to meet with each other and to discuss the topics and curriculum of the camp. The camp director will outline the schedule of the camp including all field trips and the overnight trip. The objectives of the camp and the parent and participant surveys will be distributed to the instructors, and they will fill out informational and attitude surveys.

Reunions

Pacific University will host an annual winter reunion of all the **G²CS** camp participants and all instructors. These reunions may involve an outside speaker, but will mainly serve the purpose of reconnecting the girls (and their parents) with the friends that they made during the camp, and reaffirming the learning community that was established during the camp. The girls and the teachers will fill out informational surveys on how they have used the skills they gained at the camp in both their school and extracurricular activities. Their continuing level of interest in computer science as a career will also be assessed.

Creating a Learning Community Among Camp Participants

As we have observed in past camps, a strong, supportive learning community will emerge among students and teachers during the **G²CS** camp. A key, missing component of earlier programs of this kind is a focus on continuing the presence of this learning community in students' lives [Rosson & Carroll 2006; Jayaratne et al 2003]. The latter article is especially adamant in insisting that long-term follow-up, and perhaps the persistence of a continuing virtual community through email, social networking and other electronic devices, is essential if students from ethnic minority groups are to receive the full benefits of such a program. We know, again both from research and experience, that it is important to maintain a sense of community after the camp has ended, and for some years to come, in order to maintain camper's involvement in computer science and technology. We achieve this objective in the following ways:

- Maintain a camp web site that the girls can use to demonstrate their work on a systematic basis to their family, friends, and teachers. The website will also be a portal that the girls can use to maintain contact with each other and with us. We will also have a Facebook group associated with the camp.
- Hold winter reunions for camp participants.
- Invite previous participants of the camp back to the camp the following year as helpers and tutors. The girls that will be invited back are those that showed the most enthusiasm, interest, and ability, as well as an interest in teaching.
- Contact all campers twice a year to fill out interest and attitude surveys. This data will be collected over a period of ten years to study the long-term effects of the camp. SurveyMonkey.com will be used to gather feedback information. We also plan to mount virtual conferences each year to get up to date with camp participants, offer advice and provide support when needed at key moments of their career path.

We will publish definitive results at the end of the study.

The G²CS Camp Media Resources

While the G²CS camp will offer hands-on activities, community building, mentoring, and field trips, a host of media resources will offer additional interactive experiences for camp participants, and will document and extend the reach of the G²CS project. The media resources will be hosted by the Berglund Center for Internet Studies at Pacific University.

The project web site will be a resource for the camp participants and other middle-school girls, teachers and anyone interested in emulating the camp. Formative evaluation will ensure the quality, usability, effectiveness and aesthetics of the media resources that will be developed[8]. The web site will feature:

- Example work produced by the girls at the G²CS camp.
- Video profiles of women computer science professionals: Oregon Public Broadcasting (OPB) Producer Sam Ward and OPB's professional television crew will visit and interview women working in computer science at regional companies and institutions, such as Oregon Health Science University, Intel, and others (partners on this project), and produce 4 or 5 short (3- to 5-minute) video profiles for the website. The profiles will be video portraits of computer science professionals, showing them at work in visually exciting settings, utilizing sound tracks and graphic elements designed to appeal to our audience of middle school girls. Each video will showcase a unique individual, and allow her personality and voice to drive the story. Producer Sam Ward has over fourteen years of experience creating award-winning media projects. As the Series Producer for OPB's Educational Media department, he provides creative direction and management for multimedia educational projects on a wide range of subjects. Currently, Sam is overseeing the production of *Across the Sciences*, a 10-part series on interdisciplinary science funded by NSF. Projects include video content, written textbooks, workshop activities, and online interactive simulations. In his work on OPB projects Ward has collaborated on video profiles of mathematicians, scientists, archaeologists and historians.
- Pictures and videos of camp activities.
- Participant blogs.
- Curriculum: The curriculum will be open source and modular so that it can be used by anyone wishing to emulate the camp and use our curriculum. The curriculum will include all the worksheets that we are creating for both the girls and the teachers as well as directions on how these worksheets were used, and how effective they were. Computational thinking underlies the writing of all our curriculum materials.
- Web interactives: These interactive games will illustrate computer science and technology concepts. Heather Young, Oregon Public Broadcasting (OPB) Web Developer since 2005, will create five interactives and build the website. Young has planned and developed web sites and interactives for a variety of large-scale multimedia educational productions, including *America's History in the Making*, *Mathematics Illuminated* (winner of the WebVisionary Award for Education in 2008) and *Across the Sciences*, as well as developing web sites for OPB's productions for broadcast on primetime PBS[9]. The web interactives will present ideas from *computational thinking*. As with OPB's previous work in educational multimedia, the interactives will provide the appropriate context for learning. Examples of the web interactives OPB will produce with Computer Science professors at Pacific University include:

[8] See section on evaluation.
[9] http://www.learner.org/courses/mathilluminated/interactives/index.php#prim

- *The binary number system:* Girls will be presented with binary numbers as a secret code they can learn to crack. They will be able to download an alphabet - decimal key to crack coded messages sent to those registered for camp. They will also be able to write messages to send to their friends in binary.
- *Sorting algorithms:* Girls will be presented with numbers that need to be sorted, and guided through the steps of various sorting algorithms (bubble sort, insertion sort). The girls will then count the steps taken and deduce that not all algorithms are the same (i.e., some take fewer steps). At the end there will be an animation illustrating various algorithms sorting the same data at the same time.
- *Finite state automata:* Girls will be given a starting point and an end goal. They will be asked to map out the steps required to achieve that goal using provided puzzle pieces (each piece represents a small logical step). We'll start with simply asking the girls to open and close a door, and work up to something more complicated, such as the steps required to make a peanut butter and jelly sandwich. This activity will help the girls learn how to break down complicated tasks into small steps necessary for computers.

Dissemination

We will publish and share results, methodology, curriculum and lessons learned from the **G²CS** with the community through the project web site, the Berglund Center for Internet Studies's online journal *Interface* and through additional possible venues such as:

- The *Grace Hopper Celebration of Women in Computing* conference.
- ACM Special Interest Group on Computer Science Education Conference (SIGCSE).
- Computer Science and Information Technology Symposium.
- ITiCSE: Innovation and Technology in Computer Science Education conference.
- Oregon Academy of Science conference.

Advisory Board

Pacific University will assemble an advisory board prior to the start of the **G²CS** camp. It will include specialists in computer science education, middle school education, sociology, and psychology. The board will serve for the duration of the camp and will meet twice a year. The function of the board is to advise on the activities of the **G²CS** camp, the curriculum of the camp, the data being collected, and the methods of dissemination. The external evaluator will attend advisory board meetings and share data as it is compiled.

*Future of the **G²CS** camp*

NSF funding for this proposal will support the running of the **G²CS** camp for three summers. However, our experience with our previous Summer Science Camp has shown that the momentum and success of the camp will facilitate obtaining funding for many more years. The original Summer Science Camp was funded by the Department of Energy for two years yet ran for eight more years with support from Intel, Vernier Software & Technology, Tektronix and others. We plan to seek further funding for the **G²CS** camp once it has been established and proven its success. We will also seek funding to continue tracking the girls for ten years as they progress through school.

Our Previous Experience with the Summer Science Camp

Pacific University ran a Summer Science Camp for girls from 1992-2001. This camp was

supported by the Department of Defense, Intel, Tektronix and Vernier and addressed a different content area each week (Chemistry, Physics, Biology, and Technology) following our modular pattern. Directed by Dr. Mary Fehrs and Dr. Juliet Brosing, the camp served 24 girls each summer.[10] At the end of each camp, surveys were distributed to the participants and their parents, and the data has been collected. Preliminary evaluations led to the refinement of the camp each year; however Dr. Juliet Brosing and the external evaluator will mine the data more extensively prior to the start of the **G²CS** camp. Dr. Brosing is a co-investigator on this project.

The general findings of this research include – the *need for women-centered teaching; the need for parent involvement, the structure of the camp to create a learning community, along with the modular teaching system, and the emphasis on field trips*. These understandings provide the basis for our present work. A more personal comment about the impact of this camp, recently received from a participant in the Summer Science Camp, is captured in the following words:

> 'I would like to add my personal feelings on the impact of your science camp on my life. The girl's science camp was an integral component in shaping my career. Prior to camp, I had always thought science was "cool," but my exposure to the different fields were limited (and remain limited for most girls that age). The timing of camp was wonderful, too, because it allowed for me (and presumably my peers) to start thinking of this career path throughout high school. It was a wonderful opportunity, and I sincerely hope that more girls are exposed to it. It provided an opportunity to learn without being over-shadowed by more boisterous males.'

Partnership Plan

Pacific University will direct the **G²CS** summer camp through the significant collaboration of project partners. Ongoing communication between these partners and participants in the program is critical to its success. We categorize two types of project communication: communication between project partners during the design and execution of the program, in addition to ongoing communication between project organizers, and camp participants.

The Berglund Center for Internet Studies at Pacific University will draw on its extensive experience in computer science to direct the communications plan, reaching out to partners as necessary to augment their institutional strengths. Frequent reports on the project will be reported in the pages of *Interface*, the electronic journal of the Berglund Center.

Oregon Public Broadcasting (OPB), in consultation with The Berglund Center, will apply its expertise in producing award-winning educational media to developing the web site for the camp, along with the interactive activities and video segments. Communication will occur via both face-to-face meetings, and over digital communications such as email, wikis, and other means. We have included a letter of support from:

- David Davis, Vice President of National Television Production at OPB. Davis has more than 30 years' experience in film and television production, Davis is a longtime producer

[10] A series of reports resulted from this set of camps, including annual reports to sponsors. Oral and written reports were provided to Intel for the five years of Intel sponsorship. A report, PREP, *A Summary of Poster Sessions,* U.S. Department of Energy Pre-Freshman Enrichment Program, 1995, documents the findings from the period when the camp was supported by the department of Energy. The director of that period, Dr. Mary Fehrs, was the author of that report. A detailed final report, *Pacific University Science and Technology Camp for Girls, (DE-Fg05-92ER 79073)* was written in 1995 by Mary Fehrs for the Department of Energy. At present. Dr. Brosing, who is a pioneer in Workshop Physics, and a past recipient of several NSF awards, is undertaking a longitudinal study of all these young women, among whom the oldest is now in her 30s, and the youngest is a junior in college. This work will occupy her sabbatical leave this year, and will be published in the science education literature in early 2010. Her preliminary findings and those of Dr. Fehrs provide the foundation for this study.

and executive producer of documentary specials and series for Public Television. He has three times received a National Emmy Award for television documentary production, in addition to winning the George Foster Peabody Award, the Robert F. Kennedy Award, and the Ohio State Award.

Local school districts have indicated strong interest in participating by encouraging teachers and students to participate. We have included letters of support from:

- Jerome Colonna, Superintendent of the Beaverton School District.
- Mike Scott, Superintendent of the Hillsboro School District.
- Jack Musser, Superintendent of the Forest Grove School District.
- Marv Ott, Superintendent of the Banks School District.
- David Beasley, Superintendent of the Gaston School District.
- James Grimes, Computer Technology Teacher and Building Mentor at Neil Armstrong Middle School in Forest Grove.

Local Silicon Forest technology firms and organizations are also eager to be involved. We anticipate, for example, developing an on-going mentorship and internship programs with these firms. We have included letters of support from:

- Morgan Anderson, Education Manager at Intel.
- Christine Vernier, President of Vernier Software & Technology.
- Ray Nelson, President and Creative Director at Flying Rhinoceros.

We will actively recruit girls from ethnic minority backgrounds to attend the camp. We have reached out to the local Latino community and Tribal leaders and have received letters from:

- Sabino Sardineta, Executive Director of the Centro Cultural of Washington County.
- Antone Minthorn, Chairmen of the Board of Trustees of the Confederated Tribes of the Umatilla Indian Reservation.

In addition, we include letters of support from:

- Dr. John Hayes, Dean of the College of Arts and Sciences at Pacific University.
- Dr. David Moursund, Emeritus Professor at the University of Oregon.

The **G²CS** project will be a truly collaborative endeavor, with the highest level of commitment from Pacific University, Oregon Public Broadcasting (OPB), Vernier Software and Technology, the Intel Corporation, and a large number of educational partners. Additionally, the project design will facilitate ongoing communication between the **G²CS** partners and camp participants, as well as among camp participants.

In our judgment, the common failure revealed in the literature discussing summer programs intended to encourage interest in high-tech careers for girls has been a lack of adequate continuing support. It is typical for girls to leave the experience with heightened interest, but such interest, particularly among ethnic minority girls, then falls off rapidly [Jayaratne et al 2003].

We believe the key to maintaining the positive effect of the summer programs is to create a continually evolving learning community in which all participants prize membership. We want, in short, not to change the lives of the student participants solely by helping them find a good career in technology, but to change their lives, and those of their parents, from the time they leave the summer camp, until they graduate from college and find a professional position in technology. This will be a powerful tool for small colleges and universities especially to use.

Evaluation Plan

The evaluation of this study will utilize a mixed-method approach, in accordance with the standards established within the profession by the American Evaluation Association (AEA). Specifically, the evaluation process will be based upon the *Guiding Principles for Evaluators*[11], with the following in mind as the ultimate aims of the project: 1) precipitating needed change; and 2) contributing to informed decision making and more enlightened change.

The following questions, aligned with the project goals, will guide the development of all assessment measures:

1. Have the camp curriculum and the instructors' methods instilled in student participants an understanding and appreciation of women as leaders in science? How has this impacted the students?

2. Have the activities of the grant served to increase students' confidence and skills? What is their long-term effect? Have they impacted students' career plans guiding them toward science, particularly computer science?

3. Has the establishment of a learning community been effective in meeting the other project goals?

4. Has the project leadership disseminated the results of the project effectively through both traditional and innovative means?

Data will be gathered both quantitatively and qualitatively as well as through performance and products. For example, the pre-/post-camp surveys will provide numerical data on achievement gains as a result of the workshops. The student interviews, 'Minute Paper'[12] (daily), and follow-up longitudinal study will provide a qualitative view of the interaction between the learner, instructor, and context, as well as the long-term impact of the experience. In addition, the performance of students will be gauged through a review of the products they generate as they acquire skills and knowledge of new technology applications. Scoring rubrics will be designed and shared with students prior to their development of media products, aligning the activity with the goals of the grant.

The pre-/post-camp assessment will be designed in alignment with the grant goals and specifically refined to provide data on achievement of the curriculum objectives of the four week-long modules. The 'Minute Papers' will be used daily to assess the students' perspectives of the strengths of the day's lessons and instruction as well as any issues or lack of clarity. The student interviews (twice-yearly) will utilize a protocol that can be coded to provide a wealth of qualitative detail, providing an appraisal of the success of the project as well as keys to fine-tuning the activities of the project.

The following table indicates the assessment measure that will be utilized to evaluate the progress of the project in meeting its specific objectives.

Measurable Objectives:

As a result of this project, female student participants will be able to:	**Assessment Methods and Instruments**

[11] The *Guiding Principles for Evaluators*, retrieved from http://www.eval.org/Publications/GuidingPrinciples.asp

[12] The Minute Paper assessment technique will be adapted from [Angelo & Cross 1993]

• demonstrate an increased understanding of women's leadership roles in STEM careers.	Pre-/Post-Camp survey Biennial interview
• identify an augmented sense of confidence in their ability to develop STEM knowledge and skills.	Pre-/Post-Camp survey Biennial interview
• develop sophisticated skills and knowledge aligned with ISTE Standards.	ISTE Performance Indicators[13]
• demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.	Biennial interview Peer evaluation of media products
• select advanced mathematics, science, and technology coursework.	Biennial interview
• develop an appreciation of the creativity, imagination, and ingenuity that characterize the field of computer science.	Pre-/Post-Camp survey Biennial interview

As a result of this project, female classroom teachers will be able to:	**Assessment Methods and Instruments**
• demonstrate an increased understanding of women's leadership roles in STEM careers.	Interview
• improve their teaching practices by focusing on traits of best practice identified in the nation standards (NSES, NCTM and ISTE)	Interview O-TOP[14]
• develop sophisticated skills and knowledge aligned with ISTE Standards for Teachers.	ISTE Performance Indicators[15]
• establish a local learning community in which they share their newly-acquired technology skills with faculty peers.	Interview Self-report

As a result of this project, the faculty and leadership staff will:	**Assessment Methods and Instruments**
• develop a research-based modular curriculum aligned with the project goals.	Observations Curriculum review
• provide instruction by means of strategies which demonstrate alignment with state and national content standards.	Observations Field notes
• demonstrate best teaching practices during the camp.	Observations Field Notes, O-TOP
• develop, with partners, media tools to document and disseminate the curriculum, activities, and products of the camp.	Review media tools
• work with Advisory Group to ensure the project adheres to the goals of grant.	Field notes from Advisory Group meetings.
• act as catalysts in instituting improved instruction in the use of appropriate technology in schools in the region.	Reports on meetings with administrators Presentation at COSA[16] annual meeting
• facilitate the development of an effective learning community.	Formative assessment of online dialogue artifacts

[13] For Students and for Teachers: http://www.iste.org/AM/Template.cfm?Section=NETS.
[14] O-TOP is a classroom observation protocol that is designed to provide a profile of teaching practice viewed through the lens of national standards [Wainwright et al 2003].
[15] For Students and for Teachers: http://www.iste.org/AM/Template.cfm?Section=NETS.
[16] COSA is Confederation of Oregon School Administrators. http://www.cosa.k12.or.us/. They have an annual meeting of superintendents, principals, and other administrators, and are always interested in presentation on improvement of their schools and their students' opportunities.

Responsibilities of the Evaluator:

- Review procedures for selection of Camp participants.
- Collect, code, record and analyze daily feedback (Minute Papers), student pre-/post-Camp surveys, interviews and field notes.
- Perform teacher interviews in the fall and student interviews in fall and spring.
- Determine the effectiveness of learning community development through formative assessment of online dialogue artifacts as well as interview data.
- Participate in the Advisory Group to facilitate data-gathering and reporting.
- Advise the PI on all aspects of the project.
- Collaborate with the PI in preparation of annual and final reports.

The external evaluator, Dr. Camille Wainwright, has extensive experience in both management of major grants and evaluation of such grants. Along with writing grants that raised an additional $3 million in state and federal grants, these include:

- Currently: external evaluator of Howard Hughes AHEC grant through Oregon Health Sciences University ($5 million over 5 years).
- Served as external evaluator for NSF *Horizons* grant (Portland State University), 2000.
- Awarded NSF "Oregon Collaborative for Excellent in the Preparation of Science and Mathematics Teachers" (OCEPT) as Co-PI ($5 million over 5 years) and PI of Pacific University sub-grant (1997).
- Awarded US Dept. of Education National Diffusion Network Continuation Grant (1995): "CASTLE Training Project" as PI ($850,000 over 3 years).
- Awarded NSF OCEPT II (2002) grant as Principal Investigator ($600,000 over 3 years).

Timeline and Budget

We are requesting a three-year grant from the NSF (a complete budget has been submitted separately). The project will begin in January 2010.

Activity	*Timeline*
Form advisory board for the G²CS camp	January '10
Create a basic website for the camp and create marketing fliers	January '10
Contact schools, distribute fliers, and request applications	February '10
Contact teachers, faculty, and students to run first G²CS camp	March – April '10
Review and notify successful applicants	March '10
Create curriculum for first camp	March – May '10
Organize logistics of the camp	March – May '10
Create web media resources	March – July '10
Finalize the list of instructors for the camp and notify them	April – '10
Instructor pre-camp meeting	May '10
First G²CS Camp	June – July '10
Analyze surveys and store data; preliminary Evaluation Report	July '10
Update website with all material	July '10
Update curriculum used in first camp	July '10
Contact schools, distribute fliers, and request applications	January '11
Hold reunion for participants in the first G²CS camp	February '11
Contact teachers, faculty, and students to run camp	March – April '11
Review and notify successful applicants	March '11
Create and update curriculum	March – May '11
Instructor pre-camp meeting	May '11
Second G²CS Camp (including pre-/post-assessment)	June – July '11

Analyze surveys and store data; second Evaluation Report	July '11
Update website with all new material	July '11
Update curriculum used in the camp	July '11
Publish and disseminate results	August '11– ongoing
Contact schools, distribute fliers, and request applications	January '12
Hold reunion for participants in the first **G²CS** camp	February '12
Contact teachers, faculty, and students to run camp	March – April '12
Review and notify successful applicants	March '12
Create and update curriculum	March – May '12
Instructor pre-camp meeting	May '12
Third **G²CS** Camp (including pre-/post-assessment)	June – July '12
Analyze surveys and store data; final Evaluation Report	July '12
Update website with all new material	July '12
Write report on all activities and lessons learned	August - December '12
Continue tracking participants of the **G²CS** camp	January '13 – December '20
Publish and disseminate results of 10-year tracking period	January '2020 – December '2021

Conclusion

Computational thinking is now being considered as one of the cornerstones of student learning, and is spoken of in the same breath as reading writing, and arithmetic. The lack of young women in computer science is well documented, and there is a growing, but still incomplete body of research pointing to the cause of this situation. Based on our careful reading of existing research, and on our ten years of experience running science camps for girls, we believe that our model will be successful, especially for small colleges, in changing this exclusionary pattern of girls' involvement in computer science.

Thus, we propose to run a four-week-long computer science summer camp for 7th and 8th grade girls independent of financial need. The camp will run for three years, and we will follow the progress of the camp participants for the next ten years. We will scale this undertaking to the national level and make the curriculum resources available online, publicized through a wide media campaign. Software, curriculum and media resources will be readily available. A group of local teachers will also be trained to act as mentors to their colleagues in the local schools. Presentations and publications will result from this undertaking. With our long list of partners, we are confident of a very imaginative and creative media environment being in place to publicize this work very broadly. Our goal is to provide an exemplary program that many will use to encourage girls to consider computer science as an interesting and satisfying career path in the future.

We believe the impact of such a camp will be decisive, not just for the 90 girls who will go through the camp, but also for their parents, their friends and their teachers. Because we include middle school teachers in the program, we will be able to send them back to their school districts as mentor teachers for the peers, thus having a regional impact.

But our most significant impact will be on the national level. Close involvement of OPB and other partners will ensure that the widest possible exposure will be allowed the program. An aggressive plan for publications and media resources will ensure that the educational community, and those beyond it will become knowledgeable about the camp, and its effect will thus be multiplied. The most significant impact we can have is to alter the thinking of students, parents and educators in their views on computer science, and this is our goal.