“Girls as Inventors” - The Technovation Challenge is a full research and development project addressing Challenge 2: How can all students be assured the opportunity to learn significant STEM content? STEM disciplines represented will be Computer Science and Mathematics.

“Girls as Inventors” will implement, study efficacy and improve an innovative, interdisciplinary computer science curriculum and program model. We propose to deepen the impact of an existing basic Technovation Challenge course by extending it into a college directed computer science pathway and providing advanced computer science and entrepreneurship learning experiences.

The basic Technovation Challenge course is currently run by a national, science education non-profit, Iridescent. The program brings real-world computer science and entrepreneurship experiences to high-school girls so that they increase their interest in STEM and begin to see themselves as inventors of technology. High school girls learn computer programming by inventing and building mobile phone application prototypes. They develop business plans and present these ideas to venture capitalists for the chance to have their application professionally redeveloped and globally distributed. The pilot conducted in Spring 2010 with 45 high-school girls was so successful that Iridescent was awarded a $2.4 million grant from the Office of Naval Research to implement the basic Technovation Challenge program in Los Angeles, New York City and the San Francisco Bay Area.

Through “Girls as Inventors”, we propose to provide 200 minority 9th and 10th grade girls with multi-year, advanced computer science programming and high-tech entrepreneurship experiences. The girls will be strongly supported and mentored by women professional and university mentors. In addition we will provide college and career counseling throughout high school and into the girls’ college freshman year.

INTELLECTUAL MERIT

“Girls as Inventors” will research, gather and disseminate findings on recruiting, engaging and retaining minority high-school girls in computer science. This is an important area of research given the low level of participation of girls in computer science. We will share our curriculum through professional development sessions for high-school teachers. We will also support curriculum implementation in a high-school classroom, thus contributing to the knowledge of effective practice in computer science education, curriculum development and instruction.

STEM deliverables include implementation of four, nine-week advanced Technovation Challenge courses, a replicable, mentor training program and an interdisciplinary 18-week curriculum focusing on computer science and entrepreneurship. Media deliverables include 90 “how-to-program” instructional videos.

The Stanford School of Education will provide STEM education research expertise, the Center for Children and Technology will conduct research and the formative evaluation, the Urban Assembly high school for Technology will provide formal technology curriculum expertise, Ms. Gaylen Moore will be the external evaluator and Iridescent will implement and coordinate the project.

BROADER IMPACT

The primary audience is urban, minority 9th and 10th grade girls in the San Francisco Bay Area. The secondary audience is the professional women mentors, undergraduate and graduate women students and faculty who support the high-school girls. The program is transformational for both audiences. Mentors and high-school girls experience a positive change in their attitudes towards entrepreneurship and in their own abilities to think and act like inventors. Impact of the program will be measured through formative and external summative evaluations and a longitudinal evaluation of the program.

The project will strategically impact STEM education by broadening the ways girls think about computer science, technology and entrepreneurship and by providing new models for introducing computer science to more diverse audiences.
Girls as Inventors - The Technovation Challenge

Project Narrative

“Girls as Inventors” - The Technovation Challenge is a full research and development project addressing Challenge 2: How can all students be assured the opportunity to learn significant science, technology, engineering and mathematics (STEM) content? The project will address the research question: Can “Girls as Inventors” help high-school girls imagine a satisfying future for themselves in STEM?

1. Goals and Purpose

1.a. Need for more women in computer science

The National Science Foundation estimates about 4% of the workforce works directly in STEM and is responsible for much economic innovation and productivity. In the coming years many STEM occupations are estimated to grow faster than the average of all occupations, and some of the greatest growth will be in computer-related fields where women are underrepresented and hold a quarter or fewer positions [1, 2].

We need to attract more women in STEM, and in computer science specifically, so that they have an opportunity to contribute to and influence a growing field. By diversifying the workforce we will be able to utilize the scientific and technological talents and experiences of women, potentially increasing our abilities to solve some of the most difficult problems of our time [3, 4].

“Girls as Inventors” - The Technovation Challenge will provide multi-year support to minority 9th and 10th grade girls and give them the opportunity to learn and apply fundamental computer science concepts. We will work with the same girls each year for five years and provide progressively more advanced instruction to them. The project will address the imbalance within STEM disciplines where girls and women are more likely to be users rather than inventors by encouraging them to build, design and invent solutions to real-world problems [5-7].

1.b. Description of the current basic Technovation Challenge – proof of concept

“[I learned] how to make apps, that not all computer people are geeks, [and that] you can have fun while doing something to further your education.” – Technovation Challenge alumni

The first basic Technovation Challenge was conducted by Iridescent, a science education nonprofit, in March 2010 with 45 high-school girls. The focus of the program was real-world computer science and entrepreneurship. Two-hour classes were held twice a week for nine weeks at Google in Mountain View, CA. The girls worked in nine teams and were mentored by 25 professional women from high-tech companies. Together the teams developed 10 mobile phone applications using a visual programming language called Google App Inventor for Android. At the end of the nine-week course, the girls pitched their prototypes and plans for taking them to market to a panel of Venture Capitalists at a high visibility, “Pitch Night” event.

The program was sponsored by Google and Microsoft and was featured in TechCrunch, one of the leading media properties that delivers breaking tech news [8]. Validation of the program’s impact was evidenced by the 12 summer internships that the participating girls secured in various technology-focused startups after the program. Subsequently the Office of Naval Research (ONR) awarded Iridescent a $2.4 million grant to implement the basic Technovation Challenge in the San Francisco Bay Area, Los Angeles and New York City every spring from 2011-2013.

Lessons learned from the pilot were to: 1) provide more programming support by having two teaching assistants (TA’s) for each team; 2) have a specific training program for the mentors and TA’s through which they gain new communication and teaching skills; 3) offer opportunities for long-term involvement
to the students; 4) provide greater support and access to equipment (laptops and phones) out-of-class; 5) offer more comprehensive information about STEM careers and applying to college.

1.c. “Girls as Inventors- The Technovation Challenge” – emphasis on long-term support

We propose to build on the basic Technovation Challenge and provide multi-year computer science and entrepreneurship experiences to minority high school girls through four, nine-week advanced Technovation Challenge courses. The main goals of the “Girls as Inventors” project are to:

*Increase minority girls’ interest in careers in computer science and technology.* Many girls report that they are not interested in STEM fields [9-12]. Even girls and women who excel in mathematics, often do not pursue STEM fields and instead earn degrees in humanities, life sciences, and social sciences. The reverse is true for men [13].

*Deepen their understanding of what computer science and high-tech careers entail.* We conducted a survey with the basic Technovation Challenge alumni six months after the course and 89% of the respondents reported having a clear understanding of roles in a high tech company. In addition, 78% of the respondents felt confident that they could be part of a team which starts a high tech company. These results are similar to those observed by other STEM projects focusing on minority, high school girls [14].

*Increase the girls’ confidence in their ability to learn advanced STEM content* and to realize that proficiency is an acquirable rather than innate skill that can be improved with effort [15].

1.d. Target Audience

The primary audience for our initiative is minority 9th and 10th grade girls in the San Francisco Bay Area. As evidenced through the success of the pilot program, high school girls have the requisite maturity, interest and prior skills needed to make the best use of the real-world, mobile phone programming, business planning and “pitching” aspects of Technovation Challenge. Within the primary target audience of high-school girls we chose to focus on minority students as they are even more underrepresented in STEM.

A secondary audience for the project is women instructors and mentors. Women computer science undergraduate and graduate students will serve as teaching assistants and instructors for the program, and professional women from high-tech will serve as mentors. The TA’s, instructors and mentors will go through an eight-hour training program that will help them communicate complex computer science concepts and engage effectively with high-school girls. Through the Technovation Challenge they too will have the opportunity to experience being entrepreneurs and inventors.

2. Results from prior NSF support

*PI, Ms. Chklovski* is currently leading an NSF-ISE project, “Be a Scientist!” (2010-2015). This project will measure the longitudinal impact of engineers developing and conducting family science courses with minority families over five years. The project has similar elements of following a group of students over five years to measure longitudinal impact and training STEM professionals to communicate complex ideas to children through hands-on, project based courses. Ms. Chklovski is also Co-PI on an NSF GK-12 project, BE-LA: Body Engineering Los Angeles (2011-2016) that will train and support graduate student fellows to share their research with 6th-8th grade students. Findings from this project will help us develop an effective instructor training program for the Technovation Challenge.

*Co-PI Prof. Kim* is one of the senior researchers for Programmable Open Mobile Internet, an NSF project to develop and evaluate ubiquitous wireless mobile computing and interactive systems for K-20 formal and informal learning and assessment scenarios. The project aims to create an "open" alternative to mobile computing and communication that can spur innovations, which will have a dramatic impact on the way users compute, store and communicate their data and information. For instance, their architecture
will enable an open, programmable and secure environment, where it is easy to write and deploy applications on secure devices.

**Educational Development Center’s Center for Children and Technology (CCT),** a recognized leader in education and technology evaluation, is a partner on the “Girls as Inventors” project. CCT has served as the external evaluator on the following four related NSF projects: 1) GreenFab, a three-year ITEST project designed to introduce low-income, minority high school youth in New York and New Jersey to sustainable technologies. All modules incorporate NETS Technology Standards, NSTA Science Standards, and 21st Century Learning Skills; 2) SCRATCH-ED, an ITEST program that develops, implements, and studies new strategies for professional development and collaboration among educators, so that they are better able to support STEM learning in the context of Scratch, a graphical programming environment developed under a previous NSF grant (ITR-0325828). “Girls as Inventors” participants will be using Scratch to develop their mobile phone applications; 3) A five-year study, funded by NSF to investigate the impact of an advanced biology online professional development course on teachers' content and pedagogical knowledge as well as their students' knowledge; 4) The *Teachers’ Domain - Engaging Alaska Natives with the Geosciences* special collection, funded by the NSF’s Opportunities for Enhancing Diversity in the Geosciences (OEDG) program, is an integrated set of multi-media products that will inform and inspire high school students and teachers to pursue academic degrees and possible careers in the atmospheric, earth, and ocean sciences.

**3. Research and Development Design**

“Upon entering college, females are faced with many more men who seem to have more experience and get better scores effortlessly. As a result, they start to doubt their ability to learn computer science. They begin thinking that learning computer science takes innate talent and no amount of hard work will pay off...

*The way lectures are presented seem to appeal to men more. In general, females feel that the birds-eye view of a problem and the end result is more relevant than the coding details in between*” - Ting-Chih Shih, an undergraduate Women@SCS (School of Computer Science), Carnegie Mellon University) Council member [16]

We address the research question: Can a program like “Girls as Inventors” help high-school girls imagine a satisfying future for themselves in the professional STEM universe?

This research question grows out of literature and gender research conducted at CCT over the decades [17-20]. Findings suggest that if we aim to broaden participation in technology then we should emphasize diverse interests and backgrounds, the rewards of authorship, introduce technology via its social purpose and include concerns about the unintended consequences of new technology [21-24].

Another implication from gender research takes into account role models and their career stories. Women role models need to acknowledge the complexities of balancing multiple roles and responsibilities. They should share these personal accounts and stories of struggle instead of only focusing on the professional story. In doing so they show girls that proficiency in these fields is an acquirable rather than innate skill [15].

“Girls as Inventors” addresses the above recommendations in the following ways: 1) The focus on telephone apps makes all programming immediately useful and establishes a real purpose. 2) The emphasis on a business model places it into a social context, in which consequences are not only considered, but specifically addressed. 3) The focus on role models and broad discourse that mixes personal and professional concerns is also likely to be reassuring and inviting to girls.

**3.a. Project description and supporting activities for the advanced Technovation Challenge**

“Girls as Inventors” will build on and extend Iridescent’s expertise in recruiting students from minority communities, engaging engineers and scientists in service learning, partnering with universities and
technical corporations and communicating complex STEM concepts to lay audiences. “Girls as Inventors” will offer 100 ninth grade and 100 tenth grade girls the opportunity to deepen their computer science and entrepreneurship learning through four, nine-week advanced Technovation Challenge courses and four weekend “hackathon” sessions. We will also provide college and career guidance to the girls to increase their chances of pursuing STEM academic degrees and careers.

The advanced courses will have many of the same features as the basic course, namely two-hour evening classes held twice a week for nine weeks at a high-tech company. Teams will use visual programming languages such as App Inventor and Scratch to develop mobile phone applications. They will also work towards developing a business plan for taking the application to market. After the nine-week course, the girls will be given the opportunity to collaborate with expert programmers and take their application to completion during a weekend “hackathon” session. At the end of the “hackathon” session each team will have the opportunity to present their application and business plan to the audience.

Recruiting high-school girls We will use the ONR grant to recruit two cohorts of 100 ninth grade girls in year one and 100 tenth grade girls in year two of the project and engage them with the basic Technovation Challenge course (Figure 1). We employ this strategy for the following reasons: 1) to leverage the existing funding and resources to execute the challenging task of recruiting a large number of girls from a population that is traditionally underrepresented in STEM; 2) to ensure we account for some program drop-outs and still have enough girls in the advanced program towards the end of the project; 3) to ensure we have the same age range of girls each year to facilitate program instruction. The girls will be recruited in summer from 40 partner high schools in the San Francisco Bay Area.

Iridescent will be able to recruit the 200 girls as it has significant experience recruiting students from low-performing schools. Some of the successful strategies that Iridescent employs include conducting an information session with teachers and guidance counselors and sharing the Technovation Challenge mission, goals and approach. Guidance counselors and teachers are handed a “nomination form” that they fill out with girls’ names and give to girls as an invitation to attend the Technovation Challenge presentation. Girls who are nominated feel they have been specially selected and are more likely to be excited about the program. We then request permission from the school administration to present to the girls during class hours instead of during lunch-hour which is their only social time of the day.

Another successful strategy has been to ask Technovation Challenge alumni and women computer science undergraduates to go to schools and talk about the program.

Recruiting mentors, TA’s and instructors Girls will work in teams of five, with each team being supported by one professional woman mentor and two undergraduate women TA’s. We will have one graduate student instructor for each group of 50 girls.

Iridescent will be able to recruit these numbers of mentors and TA’s as it has significant experience recruiting professionals and university students to commit to long-term service learning. Iridescent will use this experience to recruit computer science women undergraduate and graduate students from Stanford, Berkeley and University of San Francisco. We will recruit mentors through online forums such as Women 2.0, Linkedin groups, networking events, internal, high-tech company list serves and organizations such as National Center for Women & Information Technology (NCWIT) and Girls-In Tech. Partnering high-tech corporations include Google, Microsoft, Linkedin and Factual. To increase participation from women professionals, the Technovation Challenge sessions will be hosted either close to a university or at a high-tech company like Google. The sessions will be held after work-hours making it easy for the women professionals to participate.

3. b. Project plan and timeline

As seen in Figure 1, during the spring and summer of 2012, we will develop an eight-hour training program for the mentors and TA’s and recruit 100 ninth grade students, 20 professional mentors, 40 TA’s and two graduate student instructors for the basic Technovation Challenge.
FIGURE 1. YEARLY COMPUTER SCIENCE AND MENTORING SUPPORT PLAN FOR 200 MINORITY HIGH-SCHOOL GIRLS AND DISSEMINATION PLAN FOR 180 HOURS OF CURRICULUM
We will invite parents, mentors, TA’s, instructors, students and their parents to an annual Technovation Challenge kickoff event in early October each year. We will welcome and engage with the parents and share the project’s mission, goals and approach to get their full support. We will implement a basic Technovation Challenge course in Fall 2012 and videotape all the sessions.

Curriculum development for the advanced Technovation Challenge course will take place every fall with the implementation of the first advanced Technovation Challenge in March 2013. All sessions will be videotaped. The advanced Technovation Challenge will culminate in a weekend “hackathon” session and a year-end celebration to which we will invite all members of the teams and volunteer programmers from the hackathon session.

Every summer we will conduct a four-hour professional development session for 30 high-school teachers. We will edit footage from the basic and advanced Technovation Challenges and share the 18 “how to program” videos through various online channels. We will also recruit 100 10th grade girls for the basic Technovation Challenge that will be implemented in Fall 2013. Subsequent cycles of curriculum development, implementation and dissemination will be the same.

In years 3-5 we will share our curriculum with the Urban Assembly high school for technology in New York City and support them in implementing, evaluating and adapting the curriculum to meet their needs.

We will provide increasing college and career guidance each year continuing into the girls’ college freshman year.

We will send an electronic, monthly Technovation Challenge newsletter throughout the five years to the girls that would connect them to other project-based programs that provide opportunities to create, learn and innovate, such as MESA, Write Girl, 826 LA, Techbridge, MIT Fablab and FIRST Robotics.

3.c. Research and development strategies for implementation

To achieve our goals, we have designed the program to have the following elements that have been proven to support persistent interest in STEM:

Allowing participants to explore a broad range of problems from the start. Each year we will pose a challenge for the teams to solve. The challenge would strike a balance between being complex enough to allow everyone to engage their prior knowledge and interests and feasible enough so that the teams can create working prototypes in nine weeks [7, 25-28]. We will avoid the “pink software trap” that draws upon stereotypical images of women and femininity as it limits the pool since few girls actually fit such stereotypes and consequently do not feel targeted by the initiatives [4]. Learning from the MIT Media Lifelong Kindergarten Group, we will create a short video explaining the challenge, providing ideas and inspiration, sample solutions and good examples of engineering and design [7, 29].

Increasing minority girls’ access to social capital by helping them interact and build relationships with women university students as well as women faculty and professionals. Through these close interactions with women mentors and role models, girls will learn more about pursuing STEM academic degrees and careers and potentially perceive these paths as being more accessible [4, 30-33].

Anchoring learning through real-world challenges and real-world deliverables so that participants can see the immediate relevance of their learning [34]. Students will be given opportunities to develop their leadership skills, make important decisions that affect the team and take on real responsibilities such as pitching a business plan to market a product [35]. In addition students will learn about real-world resource constraints and tradeoffs such as when deciding between favoring usability or aesthetics [7, 26].

Creating a growth mindset environment so that girls are more likely to believe that computer programming is an acquirable skill that can be improved with practice [15, 32, 36, 37]. “Girls as Inventors” will provide multiple ways in which girls can have greater confidence in their ability to
succeed in STEM [38, 39]. The project will also enable girls to deepen their programming skills and decrease the feeling of being misfits in a male-dominated environment [5, 40].

Providing an environment structured for group programming to broaden classroom participation, to prepare students for working in the real, knowledge-based world and to show that programmers do not necessarily work in isolation [41-43].

Providing a structured path from a woman-only, woman-centered, safe, learning space to high visibility technical presentation events. The Technovation Challenge sessions will only be open to women participants so that they can safely step out of their comfort zones and address learning biases and learn new skills [44]. In addition we will facilitate informal socials and other opportunities for the students and adults to build relationship and a sense of “belonging to the team” [35]. Through gradual preparation, students will develop the skills and confidence needed to present formally at high visibility events in front of top-tier venture capitalists and expert programmers.

3.d. Computer programming for all

The International Society for Technology in Education (ISTE) student standards for technology (2007) form the basis of the Technovation Challenge curriculum. In particular we emphasize "creating original works as a means of group expression" (teams work together to invent a new mobile phone app), "identifying trends and forecasting possibilities" (teams learn to do market research to predict adoption of their app), "identifying and defining authentic problems and significant questions for investigation"(teams define and narrow the scope of the problem so that it can be feasibly addressed in nine weeks), "using multiple processes and diverse perspectives to explore alternative solutions" (students conduct brainstorming sessions, elicit and consider different perspectives and finally identify one app idea), "troubleshooting systems and applications" (team learn to debug systems as soon as they start programming their apps), "transferring current knowledge to learning of new technologies" (students learn to gradually build upon their understanding of programming by learning progressively more complex languages and using state-of-the-art-tools) [45].

We will gradually introduce computer programming concepts to the girls, moving from visual to text-based programming. In the basic Technovation Challenge course they will use App Inventor, a visual, block-based programming tool that is built upon Scratch (developed under NSF funding) [46, 47], Logo [48], LogoBlocks [49] and EToys [50]. Continuing students will be given the opportunity to participate in advanced Technovation Challenge Courses and develop more sophisticated applications using Scratch and Python [51]. At the end of the nine weeks students will have the opportunity to participate in a “hackathon” session where they can collaborate with expert programmers and developers and take their prototypes to completion.

The first and second advanced Technovation Challenge courses will focus on Scratch as it: 1) simplifies the mechanics of programming by providing a drag and drop, visual environment; 2) provides the necessary support for learners in the form of numerous tutorials and sample projects (more than 200,000); 3) motivates students to learn to program [52-54].

The third and fourth advanced Technovation Challenge courses will focus on Python, a language that was originally designed for education but soon became very popular among practical programmers. Python is now used both for teaching and for development of powerful, real-world applications by organizations such as Yahoo, Google, Disney and Nokia [55, 56]. Lastly, it is very well supported by numerous course resources such as detailed self-guided labs, learning modules, extensive e-texts, numerous sample programs, quizzes, and slides. These resources are specifically geared towards novice high school programmers.

“Low Floor, High Ceiling” A project design challenge is to find the right balance between having a “low floor” that makes it easy for new students to get started and a “high ceiling” that allows returning students to develop increasingly sophisticated projects [27, 51]. Both Scratch and Python are technologies and
tools that support a wide range of explorations and outcomes. The advanced Technovation Challenge Courses will equip students with the skills to use specific tools and will then provide them with the intellectual space to develop solutions that connect with their own interests and passions.

**Technovation Challenge, “Pitch Night” and “Hackathon” sessions** The “Pitch Night” and “Hackathon” will be high-visibility events that will be instrumental in showing that computer science is accessible to all. Through media coverage of the events we will: 1) popularize technology and entrepreneurship; 2) show that girls can be very successful in male-dominated fields such as computer science; 3) spread the message that girls are particularly wanted as computer science and engineering students; 4) make more girls more aware of the program [4].

3.e. College-readiness and survival support

In addition to providing computer science content and mentorship, we will also provide college readiness support to the high-school girls. We will provide one Technovation Counselor who would provide academic, financial-aid and career guidance to the girls over the project’s five years. Due to the long period of interaction in “Girls as Inventors”, the Technovation counselor will be able to build a relationship with the girls who remain in the program till the end and provide them with very personalized guidance as they get ready to enter college [57].

**Academic support:** The counselor will regularly research and share information about college-track programs, STEM education and career organizations, entrepreneurship programs and online resources with the girls and their parents. In addition we will send a monthly newsletter to the girls and their parents and will conduct yearly field trips to high-tech companies and to engineering and computer science departments at local universities [58].

**Career support:** The counselor will set students up with a profile on a career-oriented social networking site, Linkedin. Students will create a profile that summarizes their accomplishments and interests and will join the official Technovation Challenge group. The counselor will help students write resumes and cover letters and identify internships at high-tech companies.

**Financial aid application support:** The Technovation counselor will work directly with students and their parents and help them complete financial aid applications, conduct research on scholarships, federal work-study programs and student loans.

We will continue providing support to the Technovation Challenge alumni through their college freshman year to ensure they are able to successfully complete it. We will provide this extended support as it has been found that the first year in computer science departments is one where the pipeline becomes “leaky” and women start dropping or shifting out of their majors. Women who start off being enthusiastic about computer science find their interest waning due to a gap in programming experience, self-doubt, curriculum that doesn’t seem relevant or a hostile peer culture. Consequently many of the women transfer to other majors in their freshman or sophomore years [5, 16, 59, 60].

The Technovation Counselor will provide extensive support to the girls who have graduated through all four advanced courses and continued into college. The counselor will regularly check in with the girls and provide academic, financial-aid and career support as before. In addition the counselor will connect the girls to resources and support systems and women groups on campus.

3.f. Deliverables and Impact

We will implement the project with 100 minority 9th grade and 100 10th grade girls in the San Francisco Bay Area. Project findings are important for STEM education as these will give educators specific strategies on engaging with and teaching computer science to urban, minority high-school girls so that they develop persistent interest. We will:
1. Determine specifically what recruiting and advertising strategies are most effective in bringing more minority high-school girls to computer science and entrepreneurship programs
2. Identify aspects of the program (e.g. use of visual programming languages, group programming, role models, authorship and entrepreneurship) that are most effective in helping girls understand fundamental computer science concepts and in supporting persistent interest
3. Identify the most important areas of support that will help minority girls successfully navigate their first year in college
4. Develop, implement and evaluate 45 weeks/180 hours of basic and advanced computer programming and entrepreneurship curriculum
5. Develop and study the efficacy of a training program for mentors, TA’s and instructors
6. Conduct five professional development sessions with 150 teachers through which we disseminate our curriculum and project findings
7. Disseminate and support the basic and advanced, 18-week curriculum in an urban high-school in years 3-5.
8. Develop and disseminate 90 videos of the curriculum through online channels and summer professional development sessions with high-school teachers.

3.g. Indicators of success

Based on results from our pilot basic Technovation Challenge in Spring 2010, we expect the “Girls as Inventors” participants will develop skills and increase self-awareness in the following areas:

**Academic**
- Perceive that objects in the world are designed and can be re-designed
- Learn to apply traditional academic skills in real-world settings such as learning how to use computers to retrieve and analyze data, using graphs and tables or estimating costs.
- Develop a better understanding of the process of design and core engineering and computer science concepts
- Learn problem-solving and time management skills, how to solve unexpected problems, how to manage time under pressure, how to weigh issues and options before making decisions, and how to gather and analyze information

**Self-awareness**
- See themselves as inventors of technology, not just users of technology
- See themselves as entrepreneurs
- See the value of science and technology in everyday life
- Develop an increased interest in STEM fields and careers
- Increase their motivation to do well in school

**Social**
- Learn teamwork and develop interpersonal skills. Specifically they will learn:
  - To get along with other students and mentoring adults
  - To work within the rules of a new organization or team
  - New ways of thinking and acting from others
  - Ways to stop or decrease conflicts between people.
- Improve their communication skills such as learning how to listen, how to respond to other people’s suggestions and how to make a presentation in front of people they do not know.

We expect the professional women from high-tech, undergraduate and graduate students and women faculty who mentor the girls will:
- See themselves as inventors of technology, not just users of technology
- See themselves as entrepreneurs
- Learn new ways to engage girls with technologies
- Develop new skills needed to support girls in creative engineering and design activities
3.h. Sustainability
The two biggest factors that will contribute to maintaining the long-term interest of the Technovation Challenge students are the real-world, project-based nature of the activities and access to role models. These we believe will encourage girls to return each year.

The Technovation Challenge is one of Iridescent’s core programs and Iridescent is committed to raising funds to sustain the Technovation Challenge post award. Examples of similar programs that have been successful are the FIRST LEGO League and the KISS Institute’s Botball. Both of these programs run national robotics competitions by charging nominal fees to support a small central staff and by raising local sponsorships [35]. Iridescent will explore feasibility of these models to sustain “Girls as Inventors”.

4. Evaluation
4.a. Formative Evaluation
Dr. Cornelia Brunner, Deputy Director at CCT and an expert on gender and technology, will lead the formative evaluation of the five-year Girls as Inventors – Technovation Challenge project. CCT researchers will use a mix of qualitative and quantitative methodologies (e.g., survey, interview, site visits), and adopt a thoroughly integrated research and development approach [61-71] to show how the proposed project helps high-school girls imagine a satisfying future for themselves in STEM. CCT researchers will center the formative evaluation on five core activities: curriculum design and development, courses and instruction, field trips and mentorship, entrepreneurship and parental involvement.

Curriculum. To understand whether the girls’ interests and needs are taken into account in the design process of standards-based technology curricula, CCT researchers will review the curricula and interview the high-school girls, project staff, instructors and TA’s. The interviews will focus on the high-school girls’: 1) approaches to and interpretation of technology [22]; 2) interests in designing devices that have social significance (e.g., phone apps); 3) abilities to explore relationships among familiar technologies (e.g., phones) and activities that enable them to investigate technology design processes, and 4) desire to solve problems personally relevant to them. In addition, CCT will monitor how well the project staff integrates feedback from users into the curriculum design process.

Courses and Instructions. To determine whether the level of intellectual and technical sophistication needed to succeed in the sessions is appropriate for the girls, CCT researchers will: 1) conduct on-site observations; 2) survey all participating high school girls, mentors, and TAs, and (3) interview a representative sample of mentors, TA’s and girls, and all instructors. They will examine the success of the gradual introduction of computer programming concepts. They will test the project’s concept of “Low Floor, High Ceiling” by conducting a gap analysis of the levels of intellectual/technical sophistication needed by girls to perform well in the Technovation Challenge sessions. Further, they will document ease-of-understanding of the programming software (e.g., Scratch, Python) by identifying and tracking how frequently the girls experience difficulties using the software, and quantifying how much time instructors and TAs devote to instruction on the use of software and debugging.

Field Trips and Mentorships. CCT researchers will survey all the girls and mentors, and interview a representative sample to investigate to what extent the girls recognize the mentors as people they can identify with and imagine emulating in the future. After interactions between mentors and girls, CCT researchers will monitor how the girls perceive their mentors and identify with their mentors’ education, interests in and approach to technology, and career stories.

Entrepreneurship. The pitch nights and hackathon sessions will offer girls the opportunities to present their technology products (apps) and business plans to experts at four annual high-visibility events. CCT researchers will use surveys, interviews, and observations to document the girls’ awareness of and abilities to follow the established criteria for making a successful pitch, project, and collaboration. They
will pay special attention to the girls’ development of problem-solving, collaboration and communication skills.

**Parent Involvement.** To determine the usefulness of the information provided to parents via the project’s newsletters and parent information sessions, CCT researchers will survey and interview the parents for feedback on the quality and relevance of the information provided and their understanding of the benefits and limits of the project. In addition, they will document how parental involvement supports the girls’ interests in STEM fields and careers.

**College and Career Support.** To understand the most important areas of support that help girls successfully navigate their first-year in college, CCT researchers will survey all of the first-year college students and interview the counselor and a representative sample of the first-year students. The surveys and interviews will ask questions about the extent to which the counselors are ensuring that participating students are on track, are sharing their profiles on a career-oriented social networking site, and have access to internships at high-tech companies.

**Data Analysis.** CCT researchers will employ both quantitative and qualitative methods of analysis on the data collected in all the phases of the formative evaluation. For quantitative data (e.g., surveys, outcome data), they will use SPSS, a statistical software package, to conduct frequency, cross-tabulation, correlation analyses, and T-test where appropriate [64, 65]. They will use a grounded theory approach for qualitative data [63]. They will read and code the interview transcripts and observation data to identify the salience and substance of themes that surfaced around changes in girls’ experiences of the project and ways they imagine themselves in STEM professions.

**Reporting.** CCT’s integrated research and development approach will allow us to ensure that all project staff and partners remain on track to meet project goals [70, 71]. CCT researchers will deliver timely formative research summaries that present findings in usable ways and share recommendations about how to improve the development and implementation of key project components. In addition, a final research report will be created that will summarize key findings and lessons.

### 4.b. External Summative Evaluation

Gaylen Moore will use a mixed method research design to conduct a summative evaluation of the implementation and impact of “Girls as Inventors” [61-69]. The evaluator will review student attendance and demographics data, conduct surveys, interviews, focus groups with the high-school girls, mentors, TA’s, parents, project staff and the Technovation Counselor to answer the questions below.

**To what extent were program activities implemented as proposed?** The evaluator will determine: 1) the program’s effectiveness in recruiting and retaining the targeted minority female population; 2) quality and effectiveness of the advanced course content and instruction; 3) quality and usefulness of the mentor/TA training; 4) quality of college and career guidance.

**What has been the program’s impact on students’ attitudes related to invention, technology and STEM careers?** The evaluator will gather data on how participants perceive computer science and entrepreneurship and whether they see themselves pursuing a career as an inventor of technology or entrepreneur.

**Do students perceive a relationship between the knowledge acquired from the program and the science/math/technology they encounter in school?** The evaluator will assess students’ knowledge of the process of design, core engineering, computer science concepts, program-related technologies, ability to gather and analyze information, solve problems, see the connections between their formal school STEM curriculum and knowledge acquired in “Girls as Inventors” and their understanding of the connections between formal education and the real world.

**What has been the program’s impact on students’ actions related to higher education and careers?** The evaluator will assess the nature and extent of students’ planning for high school STEM courses, pursuit of
other learning or internship opportunities in STEM fields and pursuit of higher STEM education and careers.
The evaluator will use traditional statistical methods to analyze the qualitative and quantitative data. In Years 1-4, the evaluator will prepare a brief summary report and in Year 5 will prepare a final summative report of the program’s effectiveness. The final report will highlight lessons learned and provide guidance for others in replicating the model.

5. Dissemination

Project findings and materials will be disseminated to the following audiences:

**STEM Teachers:** We will share curriculum videos and lesson plans during professional development sessions with 30 teachers each year. We will share project findings at conferences such as the National Science Teachers Association. We will share the Technovation Challenge curriculum and videos on teacher blogs and forums. Lastly, we will share our curriculum with the technology high-school teachers at the Urban Assembly high-school for Technology (UA Tech) in New York City. We will train their teachers on our curriculum and support implementation in their school.

**STEM Education Researchers:** We will submit conference session proposals to the annual conference of Association of Science and Technology Centers (ASTC). We will submit 2000 word articles to ASTC Dimensions. We will submit articles to American Society for Engineering Education, Computer, Computers and Education, journal articles to the Journal for Engineering Education, Journal of Science Education and Technology and minority organizations such as the Society for Hispanic Professional Engineers and National Society of Black Engineers. We will present at conferences held by Women in Engineering ProActive Network (WEPAN), Science & Technology in Out of School Time, Society of Women Engineers, American Society of Engineering Education and American Educational Research Association. We will also present findings at the Grace Hopper Conference.

**Parents:** We will share project findings with parents of the participating girls each year through the Technovation Challenge kickoff events. In addition we will share findings on parent blogs and forums.

**Community for Advancing Discovery Research in Education:** We will share research and development designs, findings, and overall project information with the DR K-12 Resource Network and report annually to the online data system. We will contribute blog posts and articles to the CADRE website.

**Informal Venues:** We will contact urban STEM education panels through which we can share project findings with other out-of-school time organizations. Other dissemination venues will include the App Inventor, Scratch, Alice, Greenfoot and Python online user forums, STEM, engineering education and science communication blogs. We will regularly post Technovation Challenge videos on Iridescent’s YouTube channel and update our website and blog. We will regularly post updates and pictures of our courses that document, motivate and inspire viewers to attend our events and cheer for the progress of participants. A Technovation Challenge Facebook group houses on-the-ground updates, photos and will be where event invitations originate from. Our dedicated photo vault resides on Picasa allowing us to integrate and streamline photo sharing to multiple applications from a primary source. Our online community is supported by a monthly newsletter that is distributed to over 2500 nationwide subscribers. The newsletter provides substantial programmatic updates and achievements, as well as a call to participate in one many initiatives.

6. Expertise

**Iridescent** is the lead organization on “Girls as Inventors”. Iridescent’s mission is to help engineers, scientists and high-tech professionals bring cutting edge science, technology and engineering to girls and underprivileged minority children and their families. In the past four years, Iridescent has reached ~7700 minority children and parents in three sites across the nation – San Francisco Bay Area, Los Angeles and
New York City. Iridescent’s programs increase participants’ interest in STEM, content knowledge and self-efficacy.

Iridescent brings core expertise and strengths in the following areas to “Girls as Inventors”: 1) Building long-term relationships with minority communities; 2) Engaging long-term with parents; 3) Providing meaningful training to mentors; 4) Communicating complex STEM concepts to lay audiences; 5) Developing inquiry-based, STEM curriculum; 6) Identifying low-performing, high-need school partners who are deeply invested in improving STEM education for their students; 7) Experience conducting a successful pilot and raising significant federal funding for scale up of the Technovation Challenge nationwide.

**PI Tara Chklovski** Ms. Chklovski is the Founder and CEO of Iridescent. Ms. Chklovski brings STEM content knowledge and executive administration abilities to the effort. She has previously worked as the principal at a 300 student K-6 school in India. She has consistently and cost-effectively doubled Iridescent’s impact every year by heavily relying on technology, synergistic partnerships, rigorous evaluation and volunteers. She brings extensive knowledge of involving minority communities in STEM, training and supporting engineers and mobilizing hundreds of volunteers to unite and accomplish big projects. As PI she will lead this effort and ensure senior personnel and project staff have defined roles and responsibilities. She will establish clear channels of regular communication so that the team and advisory board are informed and able to contribute effectively. Ms. Chklovski will bring new resources to the project in the form of synergistic partnerships, team members and funding to ensure long-term sustainability of “Girls as Inventors”.

**Co-PI Prof. Paul Kim** Prof. Paul Kim is Chief Technology Officer and Assistant Dean for Stanford University School of Education. His courses focus on contextualized innovations in education, mobile empowerment design, and enterprising higher education systems. He is currently one of senior researchers for Programmable Open Mobile Internet, an NSF project to develop and evaluate ubiquitous wireless mobile computing and interactive systems for K-20 formal and informal learning and assessment scenarios. He is also working with numerous international organizations in developing mobile empowerment solutions for extremely minority communities in developing countries. In his recent experiments in Latin America, Africa, and India, he investigated the effects of highly programmable open mobile learning programs with literacy, numeracy, and entrepreneurship education programs (e.g., math games, storytelling, and farming simulations). As part of his research, he is also exploring mobile wireless sensors in simulation-based learning and ePortfolio-based assessment to promote creativity and critical thinking in problem solving and innovation designs.

Prof Kim and his graduate students will provide the STEM education research framework to the project. They will work with the project team to develop the training curriculum for the mentors, TA’s and instructors and the curriculum for the four advanced Technovation Challenge courses.

**Co-PI Dr. Cornelia Brunner** Dr. Brunner is the Deputy Director at the Center for Children and Technology. She has been involved in the research, production, and teaching of educational technology in a variety of subject areas for thirty years. In addition to conducting research projects about the relationship between learning, teaching, and technology, she has designed and implemented educational materials incorporating technologies to support inquiry-based learning and teaching in science, social studies, media literacy, and the arts. She has worked extensively with staff and students in a variety of school environments on curriculum development projects, teacher support and training, and informal education. She has taught experimental courses at Bank Street College and the Media Workshop New York, in which teachers are introduced to new technologies, learn how to integrate technology into their curriculum, and to use multimedia authoring tools to design their own educational programs. Dr. Brunner has been an industry consultant for the design of educational and entertainment products for children during the last thirty years. She will lend her expertise to this project as Co-PI.

**6.a. Senior Personnel**
**Dr. Harouna Ba, Formative Evaluator:** Dr. Ba is a research scientist at the Center for Children and Technology. He has extensive experience in investigating the contexts of children’s development of digital literacy skills, and evaluation of the impact of complex multimedia and interdisciplinary programs in formal and informal educational settings. Dr. Ba has explored the influence of different educational environments on children's and adults' computing experiences. He has also investigated the relationship between minority communities and technology. Dr. Ba will manage the day-to-day implementation of the formative evaluation.

**Jeri Countryman, Program Director:** Ms. Countryman brings ten years of expertise in project management, development of trainings and resources, implementation and scale up of science, engineering and technology programs for girls. Jeri has led role model trainings and partnership development with organizations involved in outreach and has extensive experience working with role models. She has a Master’s degree in interdisciplinary computer science from Mills College and a Master’s degree in science education from the University of California, Santa Cruz. Ms. Countryman will be responsible for organizing, coordinating and implementing four advanced Technovation Challenge courses, the four weekend “hackathon” sessions, conducting the summer professional development sessions for teachers and supporting implementation of the 18-week curriculum at UA high school for Technology.

**AnnaLise Hoopes, Recruiting Director:** Ms. Hoopes holds a Bachelor's degree in Philosophy and Studio Art from the University of Notre Dame, a Master's in Education from Harvard University, and a California teaching credential. In 2005, she founded a community-based organization called Teach Compassion, which brought university students into over 50 classrooms in ten regional schools to teach children about social and environmental justice issues. She has taught elementary school for two years in the Albany Unified School District. Ms. Hoopes will be responsible for recruiting and retaining the girls in the program throughout the five years. She will conduct the annual Technovation Challenge kickoff events, parent information sessions, informal socials and year-end celebrations. She will also be responsible for recruiting the professional mentors and undergraduate and graduate women students for the advanced Technovation Challenge courses and expert developers and programmers for the four “hackathon” sessions.

**Curriculum Director:** We will hire a curriculum director with a degree in computer science and education to adapt existing Scratch and Python curriculum for the four advanced courses.

**Gaylen Moore, External Evaluator:** Ms. Gaylen Moore is an independent program evaluator who has more than 20 years of experience evaluating federal, state, and locally funded education programs. At the national level, she has conducted evaluations of National Science Foundation grants for elementary, middle, and high school science and mathematics. She is currently evaluating a National Science Foundation ITEST grant for the Harlem Children Society in New York City; a student mentoring program funded by NASA for the American Museum of Natural History; and a local citywide middle school science professional development initiative called Urban Advantage. Ms. Moore also has extensive experience designing and conducting evaluations of teacher and student programs in science, environmental education and technology.

**Partnering School, The Urban Assembly** will implement our basic and advanced Technovation Challenge curriculum in years 3-5 of the project in their high school for technology. The Urban Assembly (UA) is a non-profit organization that has created and manages 21 New York City public middle and high schools dedicated to preparing students from under-resourced neighborhoods for success in college. The Urban Assembly brings expertise in instructional support and college planning.

**6.b. Advisory Board**
“Girls as Inventors” provides a rich and varied learning experience to the girls. Our advisory board brings together a diverse team with expertise in entrepreneurship, K-12 curriculum development in technology, computer science research, gender equity and STEM education for underprivileged girls.

**Dr. Anuranjita Tewary** developed and implemented the first basic Technovation Challenge. Dr. Tewary has a strong interest in the merger of entrepreneurship and technology. Dr. Tewary is currently a Sr. Data Scientist at LinkedIn. Before LinkedIn she was a product manager at AdMob, where she has gained extensive experience in mobile technology and advertising through her work in product management, marketing, and analytics. Dr. Tewary holds a PhD in Applied Physics from Stanford University and BS degrees in Physics and Math with Computer Science from MIT. She will bring entrepreneurship, start-up and high-tech expertise to the project. In addition she will review and evaluate the mobile phone application prototypes developed by the high-school girls.

**Dr. David C. Dwyer** is the first holder of the Katzman-Ernst Chair in Educational Entrepreneurship, Technology and Innovation at the University of Southern California Rossier School of Education. He brings more than 30 years of experience as an industry leader, researcher, and educator, and as an acclaimed expert in the application of technologies for learning. Dr. Dwyer will support “Girls as Inventors” by providing expertise in STEM education research, classroom teaching and curriculum development.

**Ms. Gayatri Buragohain** is the founder of a non-profit organization called Feminist Approach to Technology (FAT), based in New Delhi, India. She is also the Association of Computing Machinery’s – women in computing, Ambassador in India. FAT works to empower women by enhancing women's awareness, interest and participation in technology. Ms. Buragohain is the recipient of the 2010 Change Agent Award from the Anita Borg Institute. She has a B.E. in Electronics and Telecommunication Engineering from Gauhati University. Ms. Buragohain will provide expertise in engaging underprivileged girls in technology.

**Prof. Rada Mihalcea** is an associate professor of computer science and engineering at the University of North Texas. She is among the 100 university researchers to earn recognition from the Presidential Early Career Awards for Scientists and Engineers, the highest honor a beginning scientist or engineer can receive in the United States. She was honored by the White House for her groundbreaking research on understanding the meaning of text and for her exemplary commitments to education and community service. She was also awarded the NSF CAREER award in 2008. Prof. Mihalcea will provide advice on identifying what support systems are successful in retaining women in computer science. In addition she will review the curriculum developed and provide computer science and programming expertise.

6.c. **Collaboration Process**

We will use an online project management website, Basecamp to coordinate activities and maintain contact with alumni. We have successfully used Basecamp to coordinate ~500 people on 45 projects. We will employ bimonthly teleconferencing and net meetings to allow direct, real time collaboration on documents and planning. Informal events and socials will also be held for the students, parents, teachers, mentors, TA’s, instructors, counselors, project team members and other stakeholders so that everyone feels part of a powerful program and shares a sense of purpose and achievement.

6.d. **Strategic Impact**

Our goal is to broaden the ways girls think about computer science, technology and entrepreneurship and provide new models for introducing computer science to broader and more diverse audiences. Our project team has a strong track record for bringing deep STEM content learning to the public in large numbers. Iridescent has directly reached more than 7,700 minority children and parents in four years. We believe that “Girls as Inventors – The Technovation Challenge” will achieve similar success.
References


45. in *The ISTE NETS and Performance Indicators for Students (NETS•S)*. 2007, International Society for Technology in Education.