

Finding Success through SPIRIT

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Background

There are many misconceptions about Information Technology (IT) careers, opportunities, value (to society), and job outlook. The numbers of female students pursuing computing majors in college has been declining steadily since the mid-1980s.¹ Sax asserts that the reason women stay away is not due to lack of ability, but rather in lack of interest based on misconceptions.² U-Wire reported that the lack of women in technology negatively impacts product design.³ It also mentioned that the negative press coverage about IT outsourcing may be keeping women away. On the contrary, there are plenty of IT jobs in the U.S. In fact, nearly 150,000 jobs in IT were added by the U.S. technology industry in 2006.⁴ In addition, nearly half of the senior executives surveyed said that the large number of soon-to-be-retiring baby boomers is the most significant workforce trend facing America in the next decade.⁵ These impending retirements will increase the number of IT skilled workers needed in the future. If the industry could get more women to pursue study of IT, it could address both the skilled worker void as well as enhance product development through the use of more diverse teams.

Computing majors include computer science, information technology, computer engineering, and other such programs. Graduates from these programs may work in traditional jobs that include computer programming, systems analysis and design, data management, networking, and project management, to name a few. They can also work in non-traditional jobs that include such areas as cyber forensics, healthcare IT support, and biotechnology. However, it is not widely understood that a computing/IT degree can lead to such a variety of jobs and support so many domain areas.

The Committee of 200 (2002) reported that the top two motivators that lead girls to their ultimate career are “*helping others*” and “*making the world a better place*.”⁶ Unfortunately, misconceptions continue to flourish about the type of work Information Technology (IT) people do as being boring, solitary, and not meaningful to society. Because of these misconceptions, the people who counsel young women about future

career choices tend to direct young women away from IT. Turner, Bernt, and Pecora’s 2002 study reported that parents, high school teachers, close friends, males in IT, and male professors were among their most encouraging career counselors.⁷ Ironically, high school teachers, along with guidance counselors and male professors were also the most common negative influencing factors. Teachers who mistakenly divert girls’ interest away from computing contribute to the IT gender gap. Huang, Ring, Toich, and Torres (1998) stated that the combination of girls’ negative perceptions of computing and their teachers’ inadvertent discouragement of computing contributes to a self-perpetuating cycle that feeds girls disinterest in computing.⁸

The 2005 report by the National Foundation for Educational Research confirmed that girls listen to career advice from family members, friends and teachers.⁹ Brown’s (2004) advice to teachers is to break the gender stereotypes and encourage interest in computing.¹⁰ Thus, part of the solution requires an approach that removes the misconceptions of teachers who are in a position to influence the future career choices of girls.

The primary objective of the SPIRIT program for high school teachers and counselors is to educate them about the abundant and rewarding opportunities in IT for women. The educational program will show teachers how to prepare their students for greater success when they do pursue a computing major in college. This element is important because one of the early computing courses is computer programming, and this course is always a challenge for newcomers. Some of the general-purpose programming languages that have been used in introductory courses in computing programs across the country include Visual Basic, C, C++, C#, and Java. These traditional programming languages are textual and require students to learn the language syntax, which might be compared to learning a foreign language.

Students get lost in the syntax nuances of the programming language at the expense of gaining a solid grasp of the algorithmic reasoning required for programming. Fortunately, non-traditional programming languages and tools are available to introduce students to program-

Abstract

Purdue University recently received \$1.2M over three years in funding from the National Science Foundation (NSF) for the development of educational programs for high school teachers, high school counselors, and high school students. The purpose of these intervention programs is to show that women (and men) can have interesting, useful, and society-impacting careers in Information Technology. The collection of these programs, named SPIRIT (Surprising Possibilities Imagined and Realized through Information Technology), offered the first set of teacher institutes and student/counselor summer programs in July 2008. This paper will share the SPIRIT plan, preliminary anecdotal results, and the reasons why SPIRIT may have been successful in receiving funding from NSF.

Keywords: Teacher education, STEM, NSF, successful funding, gender gap

ming in a manner that promotes greater success. Kelleher and Pausch (2005) reviewed a number of systems designed to remove barriers to learning programming.¹¹ Some of these tools included Logo turtle, Squeak, and HANDS. (The reader is encouraged to review the Kelleher and Pausch paper for a summary of these and many other programming language alternatives that have been developed and tested.) However, many of these systems either support only a subset of the programming constructs or do not have broad appeal.

Researchers at Carnegie Mellon University developed a 3D graphical development environment called Alice that was designed to teach object-oriented programming concepts without the overhead of learning textual syntax. Colleges that have used Alice to introduce programming concepts have demonstrated that a large percentage of at-risk students who later took more traditional programming courses improved their grades considerably, by a whole letter grade (Moskal, Lurie, and Cooper, 2004).¹² Cooper (2005) noted that some people who used Alice in programming workshops for children found that boys opted to create interactive computer games (many with a fighting element), while girls and minorities used Alice for storytelling.¹³ Nonetheless, both groups gained a better understanding of object-oriented programming principles and enjoyed equal levels of programming success. A study by Hutchinson, Moskal, Dann, and Cooper (2006) reported that completing a college course on Alice helped both men and women improve their programming skills.¹⁴

Currently, NSF has funded several projects that use Alice to draw the interest of young women to computing. However, the majority of these programs use Alice in the context of computing. In the case of SPIRIT, Alice was used in the context of Science, Technology, Engineering, and Math (STEM) disciplines as well as other subject areas including English, foreign languages, and consumer science.

The SPIRIT Approach

It is difficult to imagine a discipline today that cannot benefit from IT. IT has helped accelerate progress in many disciplines, resulting in greater societal benefits being realized earlier. SPIRIT's approach takes advantage of the coupling of IT with disciplines that have a natural appeal to women. The team's premise is that by showing people how IT makes a positive difference to society through its support of STEM disciplines,

more people, including young women, will keep IT open as a possible field of study in college.

The people who are best positioned to positively impact the course and career choices of large numbers of young women are high school teachers. For this reason, SPIRIT's major focus is on the development of intensive professional development institutes for high school teachers, particularly those who teach science, technology, engineering, or math. Teachers complete a two-week residential program where they learn about how to enhance instruction in their discipline using Alice as a supportive tool. The first week teaches them to become proficient in using not just the basic features, but also the advanced features of Alice. The instruction included several Alice lessons in STEM subjects typically taught in high school. Then the teachers converted their own traditional lessons into Alice-based lessons.

During the following week, the one-week residential summer camp for high school students began. The goal of the student program is to show the students the many fun and interesting computer applications as well as to illustrate rewarding career opportunities in IT. One example shared in the July 2008 SPIRIT program showed participants how to use a mobile phone application to better track their nutritional intake to better manage their dietary health. A second session allowed them to use Maya to create a simple three-dimensional model of an animated character. A third session showed them how to search for criminal evidence left behind on portable storage media that the owner thought had been completely erased.

Students were assigned two projects to complete during the week. One of these projects required them to create an Alice world. After a one-hour introduction to Alice by SPIRIT staff, the teacher participants worked with small groups of students to get feedback on their Alice-based lessons as well as to teach them more about using Alice to build storyboards. By the end of the week, students created an Alice world that told their version of a popular story or shared their career goal and their approach for accomplishing it.

The second project asked students to build a slideshow that could convey their version of a popular story or describe how to achieve a career goal. To help them think about the value of IT in a variety of areas, students were exposed to other IT applications with a focus on illustrating the positive impact these applications have on society. They met IT professionals and observed their career presentations to

learn about the surprising and rewarding career opportunities available to graduates of an IT program. For example, a Johnson and Johnson executive explained how her role in IT contributed positively to the surgeries in hospitals today. She explained that IT was used in the design, development, testing, and data management of the sutures that are used in over 80% of today's surgeries. Another speaker in law enforcement shared many ways that they use IT to support their jobs as well as how they work with IT professionals to develop new software to help them better track criminal activity and capture electronic evidence.

The summer camp gave teachers the opportunity to practice using their Alice-based lessons on small groups of students. SPIRIT's objective is to give teachers the opportunity of observing the students' increased interest level and enthusiasm for the subject. This feedback also enabled the teachers to further refine the lessons for future implementation in their classes during the school year. In addition to practicing their Alice-based lessons, the teachers also observed the other weekly summer camp activities and listened to the dynamic career speakers. Before the conclusion of the summer program, teachers developed an implementation plan to incorporate their Alice-based lessons into at least one of their classes during the school year. Required activities that teachers will complete during the school year are continuous improvement of their Alice-based lesson plans, maintenance of reflective logs, individual meetings with SPIRIT staff, and participation in four in-service conferences at the Purdue campus.

High school counselors participated in a one-week program that ran in concert with the students' summer camp. They, too, got experience using Alice and watching the IT career presentations. A deliverable that the counselors created during the week was a set of slides that described the broad-ranging and enriching career opportunities available to IT graduates. This material will then be used during the school year to provide better career counseling to students who could pursue IT study in college.

An important characteristic of SPIRIT is the added benefits offered to participants as a result of funding. Purdue offers numerous summer programs to various groups, including teachers, counselors, and students; however, the majority of these programs charge a fee to participants to recoup food, housing, and activity expenses. Thanks to the generous funding provided by the National Science Foundation, SPIRIT was able to not only offer these programs to all par-

ticipants at zero cost, but in fact all participants received a daily stipend for their participation. Teachers and counselors received an added benefit of earning Certification Renewal Units (CRUs), which may be used to support renewal of their professional licenses. Teachers have some additional benefits that include the opportunity to be considered for a paid internship, the opportunity to return as a paid instructor the following year, and the opportunity to receive partial travel support to present their results at teacher conferences.

SPIRIT's History

The SPIRIT team had been brainstorming ways to address the IT gender gap more than a year before submitting the first proposal. The author conducted a fairly exhaustive literature review to better understand the problem as well as share the types of solutions other investigators had tried. The team believed that the most important issue to address was misconceptions held by many groups regarding the career opportunities available to women with expertise in IT.

When the team was ready to take action, the literature search expanded to locating possible funding opportunities. NSF's ITEST (Information Technology Experiences for Students and Teachers) program was selected because it supported educational programs for high school teachers, counselors, and students, three important groups that held misconceptions about IT.

The team's lead investigators are programming educators, so the educational program's (indirect) goal became creating experiences that would introduce participants to programming in a fun, unthreatening manner. The team was already familiar with Alice and agreed to make that a focal part of the program. The literature search revealed that NSF had funded many projects that used Alice to teach programming, but they attracted students who enjoyed programming. SPIRIT's goal was to attract students who may not necessarily like or understand IT, but are open to learning about the exciting possibilities for people with IT skills. Because the primary advisors to high school students were their teachers and counselors, SPIRIT also sought to attract them. The team decided to teach them how Alice could be used as a storyboarding tool in the STEM disciplines to engage student interest more than their traditional approaches.

SPIRIT's Funding Success

In the last two cycles of NSF's ITEST (Information Technology Experiences for Students and Teachers) program, applicants were asked to submit preliminary proposals. Applicants who received favorable reviews on their preliminary proposals were encouraged to submit full proposals. SPIRIT received positive reviews to the preliminary proposal in both cycles. The author believes that these initial successes were due to developing a clear idea and presenting it in a manner that allowed reviewers to see the appropriateness of the idea to ITEST's goals.

It may be surprising to learn that many proposals are not written with the reviewer in mind, so the first guideline is to follow a structured process for the overall writing process. Every good proposal starts with a clear idea. Reviewers evaluate proposals against specific criteria that are contained in the solicitation, so it is important to write the proposal in a way that allows the reviewers to easily locate the answers to their questions. The recommended way to do that is to organize the proposal to match the order of the content discussion in the solicitation. To break up the monotony of fifteen pages of just written prose and to help reviewers easily locate select content, use headings composed of keywords from the solicitation. Where possible, use charts or tables to convey ideas visually. Include a thorough literature review to adequately support the project ideas and to demonstrate that the team is knowledgeable about the current state of practice. Be sure to include relevant information from related NSF-funded projects and from commonly accepted authorities in the field. Always ask several trustworthy colleagues with an eye for detail to read the proposal and provide constructive feedback.

The reader should be aware that the 2007 NSF funding rates were 26% overall and 21% within the Directorate for Education and Human Resources (EHR), which houses NSF's ITEST program.¹⁵ Thus, despite having very favorable feedback from many colleagues, there is a greater likelihood that the proposal will not be funded. Keeping this in perspective, the second guideline is to persevere. If the idea is sound and some favorable feedback was contained in the returned NSF reviews, it would be a good idea to refine the proposal based on that feedback and resubmit the proposal. Just make sure that the new proposal adheres to the requirements in the new solicitation. It took the SPIRIT team two attempts to receive funding from NSF for the SPIRIT project. In revising the proposal,

the team was keenly sensitive to all comments from reviewers of the first proposal and to suggestions from the NSF program officer.

There are many possible reasons for success during the second cycle. Many of these can be equated to the learning experiences that resulted from failure the first time and useful advice offered by others who had successfully received funding from NSF. It is important to keep in mind that the basic plan and primary team were the same in both cycles, but details about the implementation were changed to address issues or limitations. Thus, a third guideline is to learn from mistakes by paying careful attention to concerns raised by the reviewers and asking questions of the program officer to get critical clarification. Three examples of these lessons learned by the SPIRIT team are presented below.

For the first example, consider one of the benefits SPIRIT offered to teachers. Both solicitations stated a maximum stipend that can be offered to teachers. In the first cycle, SPIRIT used half the maximum, but in the second cycle, the full amount was used. The suggestion given to the SPIRIT team by an experienced NSF grantee was that although a maximum stipend amount is specified in the solicitation, the applicant should use that figure as the actual amount.

The next example is about defining a solid evaluation plan. In the first cycle, the SPIRIT team selected an external evaluator with very limited evaluation experience but considerable experience using Alice. The Principal Investigator (PI) developed most of the evaluation plan and got agreement from the evaluator. In the second cycle, the SPIRIT team found an evaluator who had some experience with Alice as well as served as an evaluator on several other, similar projects. This evaluator wrote the text of the actual evaluation plan based on past (successful) experiences and got agreement from the PI. Because an effective evaluation plan is so critical to the success of a project, it is important to use experienced evaluators both on the team and in the development of the prose. Given the latest changes to the most recent ITEST solicitation, having a solid evaluation plan supported by an experienced evaluator is highly recommended.

The third example is about demonstrating that the SPIRIT program will undergo review by appropriate experts. Based on advice from a colleague, the SPIRIT team instituted an advisory board for the second proposal. The members of this board included an award-winning high school teacher, a renowned faculty mem-

ber in the College of Education, and an Alice expert. The advisory board will be consulted on all aspects of project development from design through implementation. A well-thought out, effectively documented plan becomes even more convincing with the right team in place, and in this case resulted in a successful proposal.

Once the SPIRIT project was funded, the principal investigator had the opportunity of attending an NSF ITEST Summit. This meeting supplied further knowledge about strategies for building a winning proposal. These strategies will be summarized as the fourth guideline – write the proposal so that the reviewers will see that all of the pieces are in place.

For example, a large majority of the other projects had partnered with schools and/or other organizations prior to proposal submission, which showed that there would be a guaranteed number of participants for the proposed programs. To accomplish this, the team should meet with targeted school officials who are willing to show their support by providing a letter of commitment with tangible signs of support that can be included with the proposal.

Strong industry partnerships can also strengthen a proposal. In the first SPIRIT proposal, the project description included statements about working with industry partners, but included no written commitments from industry. In the second proposal, the team had a letter of commitment from an industry partner that included two key tangible benefits – offering up to five paid internships for teachers who completed the SPIRIT program and providing free use of hardware and software for SPIRIT programs. Statements about industry partnerships are meaningless without tangible commitments that translate into real support that will strengthen the proposed program.

SPIRIT's Preliminary Success

Although the assessment data that was collected throughout the program is still being processed by the team's evaluator, observations throughout the week suggested preliminary success regarding a change in perceptions about IT. For example, one female student commented that she still plans to be a doctor, but now is thinking about adding a minor in IT based on how she believes that knowledge will positively impact her future medical career.

Another female student who was pretty adamant about not pursuing a computing major before SPIRIT stated that after a few of the career presentations, she now believes that she was

getting a sign from above that she should be more open about IT. Her mother later sent email to the author to state that her daughter is now talking about pursuing IT as a major in college.

Finally, one of the teacher participants had convinced a student at her school to apply to SPIRIT. At the end of the program, she shared some background about why she had so strongly encouraged this student to attend SPIRIT. Apparently, he had a brother who dropped out of school and he was planning to follow in his footsteps. By the end of the week, he had told his teacher that he now plans to go to Purdue to study technology.

Based on this anecdotal evidence, the SPIRIT team expects the formal results to show a positive change in attitude about computing/IT. More importantly, the results are expected to reveal the specific aspects of the program that had the greatest impact in this change. Because the student participants included freshmen through senior students, the ultimate impact on students' selection of college majors will take many years to track. Nonetheless, SPIRIT will continue to maintain communication with as many of these students as possible in order to gauge the long-term impact of SPIRIT.

Conclusions

SPIRIT will continue to educate high school teachers and counselors, the people well-positioned to influence the college choices young women make, about the many exciting, rewarding, and fun careers in IT. Having teachers and counselors observe the positive response that students have to IT further strengthens the message that IT careers are good options for students. Through the generous funding received by NSF, the team has the opportunity to implement educational programs and offer them without cost to any participants. After completing the SPIRIT program, participants will serve as secondary sources of this information to further correct the misconceptions surrounding IT.

The SPIRIT plan was conceived a few years ago, but it has gone through many refinements based on knowledge gained by the author in the development of proposals for NSF's ITEST program. By starting with a good idea, and developing it into a successful proposal through learning from failures along the way, the SPIRIT team is now positioned to begin encouraging more women to pursue computer-related careers, resulting in improved gender equity in the workplace and increasing the pool of future IT workers.

There are many other national problems that require creative solutions. By following the guidelines in this paper for developing a grant proposal, the reader, too, can increase the likelihood of receiving funding, which is an important step towards making a positive change.

Acknowledgement

This work was supported by a grant from the National Science Foundation, #DRL-0737679.

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