Abstract - As the IT-Adventures program was being developed, we discovered teachers of all disciplines needed a way to improve their knowledge and skills in IT to facilitate student learning as part of their school’s IT-Club. The IT-Adventures program is built around the formation of an IT-Club at a local high school where students are given learning materials and then conduct their own inquiry-based learning in three content areas: cyber defense, game design programming and robotics. An IT-Advisor, a teacher who sponsors each local high school IT-Club, helps students in exploring the learning materials and finding solutions to the challenges they are presented. The large, non-IT base of teachers who serve as IT-Advisors caused us to offer a free, for-credit class for those individuals working with the IT-Clubs. This paper is a report on the success of a pilot project of teacher educational programming conducted as part of the IT-Adventures’ inaugural year (the 2007-2008 academic year). It covers how the IT-Adventures program works, the IT-Advisor role, the details of the teacher course and the lessons learned from the pilot project. It also briefly discusses how the teacher course has been modified through feedback and experience for the 2008-2009 academic year.

Index Terms – Training, Information Technology, Teachers, STEM, K-12 Partnership, Educational Programming

INTRODUCTION

An ongoing concern to post-secondary educators in science, mathematics, engineering and technology (STEM) areas is the downward trend of students interested in pursuing training and careers in STEM disciplines [1]-[2]. Specifically, the authors of this paper are concerned with the decline in the number of students enrolling in areas related to information technology (IT), including, but not limited to, Computer Engineering, Software Engineering and Computer Science.

There has been a recent report of a very small increase in enrollments in computer science nationally [3] and one approach to take could be to wait for the free market to drive an increase in students choosing IT-related areas as a major and career. However, that option is not a judicious long-term choice for the nation’s businesses or industries that rely on IT technology. Therefore, the Iowa State University’s Information Assurance Center decided to take a proactive approach to reverse this downward trend by creating the IT-Adventures program.

IT-Adventures is dedicated to increasing interest in and awareness of information technology among high school students across Iowa using three content areas: cyber defense, game design programming and robotics. The program uses an inquiry-based learning approach which allows students to explore IT in a non-threatening experimental environment.

The premise of the program is that through increasing understanding of and excitement for IT at the high school age group, the number of students enrolling in IT-related programs at post-secondary institutions and the number of graduates who will fill future IT positions can be increased. A secondary, but ultimately as worthy, goal of the project is to make the whole experience of learning and working with IT fun for high school students.

IT-Adventures’ objective of increasing high school students’ interest in IT is accomplished through the use of secondary, post-secondary, and industry partnerships in educational programming, competitive events and service learning projects, as well as educational programming for high school teachers. Additionally, the program has components that are geared toward post-secondary students at the community college level. The focus of this paper is on the educational programming for the high school teachers involved in the program. There are two other sessions at FIE in which the full IT-Adventures program delivery and the community college components are discussed.

The need for teacher development in the K-12 system to help encourage student interest and excitement for STEM topics is part of the driving force behind the teacher educational component in the IT-Adventures program. The authors believe that teachers can stimulate learning in areas that are not their area of expertise, specifically IT, if they are provided with an ongoing teacher development component.

This paper is a report on the success of a pilot project of teacher educational programming conducted as part of the IT-Adventures’ inaugural year (the 2007-2008 academic year). It is divided into four sections. The IT-Adventures Description section explains how the program works. The IT-Advisors and Their Roles section details the role the teacher has in the program. The Teacher Course Details section explains how the pilot project class was conducted. In the Lessons Learned and Future Directions section, information about how the teacher class was received is
been modified through feedback and experience for the 2008-2009 academic year.

**IT-ADVENTURES DESCRIPTION**

IT-Adventures takes place outside the confines of coursework and classrooms to give high school students the freedom to explore and experiment with IT. The program was created as an after-school, extra-curricular activity where students can explore IT for an entire academic year using inquiry-based learning. Inquiry-based learning is a multifaceted approach that involves reviewing information about what is known about a problem, gathering additional information, proposing solutions or explanations and communicating or acting on the results. The focus of all activities is on critical and logical thinking, as well as exploration of alternative solutions [4]-[6].

Modeled after two years of successful pilot project cyber defense competitions, the foundation of the IT-Adventures program is the formation of IT-Clubs in high schools across Iowa in the fall of the academic year. The IT-Club provides an avenue for educational content and technical challenges delivery to students in three areas: cyber defense, game design programming and robotics. Using the inquiry-based learning model students take the learning materials provided, ask their own questions about how best to solve the challenge and explore additional materials. Inquiry-based learning is facilitated by IT-Advisors (high school teachers) and IT-Mentors (local IT professionals). These roles are discussed in more detail below. In addition to conducting year-long inquiry-based learning, the IT-Club is required to perform a community service project related to IT.

The capstone event for students who participate in IT-Adventures is a two-day competition named the IT-Olympics held in Hilton Coliseum on the ISU campus. Students showcase the IT knowledge they gained during the past year of work by exhibiting a primary challenge solution they have worked on prior to the event, undertaking real-time challenges that are introduced during the competition and making a presentation about their clubs’ IT-related community service projects.

IT-Olympics is also a celebration of IT which is open to the public. Family members, high school counselors, teachers and the general public can watch the students in their quest to be the best or can explore IT careers and opportunities on their own through display booths from community colleges, four-year institutions, state agencies, IT professional groups, and corporations.

In its first year, IT-Olympics attracted 46 teams made up of 213 students from 25 high schools competing in the three venues: cyber defense, game design programming and robotics. Since the high school cyber defense competition was in its third year, when the two pilot years of work are counted, it was the most popular event with the highest enrollment. More than three-quarters of the participants in the cyber defense venue (76.3%) with the remaining quarter almost evenly split between robotics (12.2%) and game design (11.5%).

The student population that participated in IT-Olympics was heavily male (89.8%), although for the first time in three years of conducting high school cyber defense events an all female team competed. When looking across respondents participating in all three venues, 18.8% of the robotics respondents were young women as compared to 9.2% of the cyber defense and 7.1% of the game design respondents, though these levels were not statistically different from each other (p<.05).

An additional 159 teachers, mentors and volunteers, not counting graduate and undergraduate students, participated in the event. There were also nearly 30 vendors and colleges with booth displays for the students to visit and see additional technological innovations.

For the 2008-2009 academic year the IT-Adventures program had 46 high schools and nearly 500 students enrolled in the year-long program. Nearly 350 attended the IT-Olympics in April 2009. There were 76 teams representing 33 high schools who were able to come to Ames. While we were happy with the IT-Olympics attendance, the numbers were not as high as we had originally forecast based upon the year-long enrollment. Unfortunately, in the downturned economy, several of our participating high schools were not given travel money by their school districts to attend the two-day event. At the time of writing of this article, a survey is being underway of the participants so additional demographic information is not available.

**IT-ADVISORS AND THEIR ROLES**

While there is not a monetary cost for a high school to form an IT-Club, the IT-Adventures program requires a teacher or staff person at the high school to agree to be the IT-Advisor for the club. This person is the primary contact for the IT-Adventures staff, is responsible for enrolling students into the program and for helping the students with their projects, challenges and community service project. This person is also the chaperone for the students when they attend the IT-Olympics event in the ISU campus and coordinates all logistics for their attendance.

The IT-Advisor also fulfills the role of facilitator to guide the student experience which is an important piece of the inquiry-based learning model. Since few high schools in Iowa have an in-depth IT or computer curriculum, it was anticipated that many of the IT-Advisors would not have backgrounds in an IT-related area. While a small number of the IT-Clubs’ advisors did teach IT-related subjects at their high school, many more were teachers who simply cared about expanding student opportunities and bolstering student learning. Many of the high school teachers were more than willing to be an advisor, but felt underprepared to help supervise in IT areas. Some example job titles for the teachers who served as IT-Advisor in the first year of the IT-Adventures program included talented and gifted...
coordinator, science/biology teacher, industrial arts teacher and librarian/media reference specialist.

From the project’s inception the IT-Adventures staff recognized that having individuals with a non-technical background in facilitator roles could present challenges in working with technical material for the teachers and the students. Three components were put into place to help support the IT-Advisors in this new-to-them area they were agreeing to support. First, IT-Clubs were designed to have not only an IT-Advisor, but also an IT-Mentor who has IT knowledge and experience. If a local high school could not find an IT professional to volunteer as their IT-Mentor, the IT-Adventures staff worked with the Technology Association of Iowa (TAI) to find a volunteer. In the cases where the advisor was an IT instructor, the need for a mentor was not as great. But, when the advisor had little to no IT background, the mentor filled in the missing gaps.

Second, a series of conference calls were conducted throughout the spring semester for the teachers to ask questions of the IT-Adventures staff. And, third, because of the large, non-IT base of teachers who perform the role of advisors to IT-Clubs, the IT-Adventures staff created a free, for-credit class for the advisors. All advisors, both with IT background and without, could learn about IT concepts needed in the program, how to create their own educational materials around IT, share ideas and materials related to IT-Club facilitation, examine the challenges and opportunities for IT education and expand their professional vision by examining societal IT trends.

Although it in no way off-sets the time investment the teachers are making in their teams and the learning they are doing in teaching with technology, the free, two graduate credits or continuing education credits are one way to say thank you and to encourage teachers to continue to learn about IT-related content.

**Teacher Course Details**

The pilot project teacher class was conceptualized as a four-hour in-person course for the IT-Advisors to attend during the IT-Olympics on Friday afternoon with a web-based/distance education component that would occur in the weeks after the in-face meeting. There were 10 IT-Advisors who took advantage of this free credit option offered to them. Another six IT-Advisors sat in on the presentations and roundtable discussions, but did not opt to complete the distance education portion of the class, which included submittal of a reflection paper to earn the free credit. The cost of all credits, whether two hours of graduate or continuing education, were covered by the IT-Adventures budget. All 10 of the teachers who participated in the web-based follow-up sessions selected the graduate credit option.

The class met in-person on the first day of the IT-Olympics competition. After attending the opening ceremonies for the event at noon and settling their teams into their respective competitions, the IT-Advisors attended a two-hour session which was facilitated in an interactive, roundtable atmosphere by one of the authors of this paper who at the time of the class was an Electronics and Information Technology instructor at Des Moines Area Community College in Ankeny, IA. The topics of discussion were sharing competitive best practices; the recruitment and diversity issues IT-Advisors met when recruiting and supporting an IT-Club membership; sharing of the community service projects; outlining areas where the IT-Adventures program and IT-Olympics could be improved; and examining what other events or competitions might interest their students in IT.

At the conclusion of the course roundtable and after a short break to check on their students, the IT-Advisors attended a two-hour interactive session presented by the ISU Department of Electrical and Computer Engineering to help them understand the career options available for high school students who might be interested in pursuing a career in an IT-related area. Since the presenters were career counselors for an engineering department at ISU, their information was geared toward an engineering career, but they also tried to accurately represent other areas such as Computer Science, Software Engineering and Management Information Systems which are all programs available at ISU.

The IT-Advisors were required to attend the evening IT Summit Panel at the IT-Olympics. There both teachers and students heard from IT industry leaders, IT academic advisors and currently enrolled IT students about IT-related careers, the types of work IT professionals undertake, the courses taken in a post-secondary institution to earn a degree in an IT-related area, as well as other current IT issues.

Throughout the competition, the IT-Advisors were encouraged to visit with the various industrial and education booth representatives surrounding the competition venue. The purpose of the visits was to provide direct exposure to other post-secondary educational opportunities not shared in the prior day’s interactive session and to hear, firsthand from employers, the desired skill sets for those successful in IT careers.

After returning home from the IT-Olympics competition, the IT-Advisors continued their coursework via web-based learning system. To receive a grade and course credit, the IT-Advisors had to submit a summary of exhibitor conversations, a lesson plan that summarized the objectives and activities of their IT-Club, as well as conduct an informal assessment of their IT-Club’s activity over the past year. Participants also had to write a reflection paper which evaluated the diversity of their IT-Club membership; the effectiveness of their IT-Club’s community service project to the community and their club; problems with and possible improvement to IT education in secondary settings; and to suggest ways to improve their IT-Club, the IT-Adventures program and the IT-Olympics competition in the future. Finally, each teacher completed a self-assessment evaluating their role and what they learned as the IT-Advisor.
LESSONS LEARNED AND FUTURE DIRECTIONS

Although the teacher class was a pilot project in the inaugural year of the IT-Adventures program, it received strong support from the 10 IT-Advisors who participated in the course for graduate credit. The support from the IT-Advisors, as well as the value of the suggestions given from roundtable discussion and from the reflection papers, proved useful to the program and the IT-Adventures staff decided to offer the free credit course for a second year of pilot study where there are 19 individuals currently participating in a revised version of the course.

According to their reflection papers, the IT-Advisors found sharing information about their competitive events experience and community service projects in a roundtable format useful. Since IT-Adventures was a new program, there were few past experiences to which teachers could look to determine what types of challenges to expect for their students, as well as what types of community service projects could be undertaken. The roundtable discussion helped fuel a brainstorming session where teachers could take the best ideas back to their schools and implement in their IT-Advisor roles.

The topic of diversity was encouraged as a discussion point in the final reflection piece, as well as in the roundtable session. While all of the participants were able to share formal definitions of diversity within the realm of education, most useful comments centered on the gender imbalance of the IT-Club membership. There were several suppositions offered as to why their respective teams were either exclusively or predominantly male. These included disparate promotion of the club in academic courses that that also had predominantly male enrollment and conflicting school activities of interest to females that otherwise might have participated in IT-Olympics. As antitodal evidence, the authors are aware of one team of all females that were able to join in the IT-Olympics game design programming venue for a portion of the competition, but then left the event to participate in their school’s prom activities. Also, there was one team of all females who participated in the cyber defense venue. Class members also speculated that the three IT-Adventures content areas of cyber defense, game design programming, and robotics, although varied, still lacked appeal to broader, gender-balanced audience.

The IT-Advisors expressed sincere desire in trying to “recruit” more females to participate in future years. Several of the community service activities the clubs participated in included working with younger students with primary or secondary objectives of helping capture and/or strengthen IT interest at a younger age.

The reflection papers also provided more antitodal evidence that the IT-Adventures program was successful in increasing high school students’ interest in IT in its first year. IT-Advisors reported although many of their students felt their performance at IT-Olympics was not as strong as they wanted, the students now had an idea of what to expect at the competition and left Ames with big ideas about the next year including how to improve their primary challenge solutions, a better community service project they could undertake and what types of careers they could pursue with an IT major. One teacher’s comment resonated with us, “Although our first attempt at competition was inadequate, it did generate an excitement in the students that I have not seen in the classroom. This competition gives them a goal and deadline that will keep them focused during the upcoming year.” This is the main goal of our program. Get the students interested in IT and focus them on a project to work on throughout the year.

Additionally, in the reflection papers we received a very positive reaction by the IT-Advisors and their students to their community service projects. Community service projects were not included in the pilot projects we conducted prior to IT-Adventures and we were uncertain about the response we would receive from the high school students. All teachers wrote that the community service component was useful to their IT-Club, that they had additional ideas on how to improve their IT-Clubs’ projects and wanted to disseminate their project out to a larger audience in the coming year. One teacher wrote that he/she was worried about their IT-Club’s community service project because the students decided to show middle school students about IT options they were studying. The project involved training middle school students how to hook up computer cables, identify internal components, creating a short Alice program, and watching a demonstration on robotics. The teacher had great fears about how successful the high school students doing the presentation would be and how the younger students would react to the presentations. However, everyone involved, both the teachers and students in the middle school, was very excited about the project. The IT-Advisor had requests for even more middle school workshops for the upcoming school year. And, the high school students in the IT-Club really enjoyed the excitement of the middle school students and already at the IT-Olympics were planning for the 2008-2009 year’s workshops for middle school students.

All suggestions about ways to improve the IT-Adventures program and IT-Olympics competition that came from the round table and the reflection paper, as well as a survey of IT-Advisors taken at the end of the IT-Olympics, were recorded and distributed to the IT-Adventures planning committee and also distributed and discussed at the IT-Adventures Advisory Board meeting. Many of the requests and suggestions were attempted to be implemented during the second year of the IT-Adventures program (the 2008-2009 academic year.)

One suggestion that was taken to heart was the point that by the end of the year-long work with the IT-Adventures program and the completion of the two days of competition in the IT-Olympics events, IT-Advisors did not want to return home to complete a reflection paper via the web. Additionally, the teachers wanted more educational programming for them from the IT-Adventures program provided earlier in the year to better support student learning and preparation of IT-Olympics competition. Therefore, in
the current year’s programming (the 2008-2009 academic year), the teacher educational learning component has been expanded to a two-month window that occurs just prior to the IT-Olympics event. IT-Advisors are given weekly reading assignments, papers to reflect upon and discussion points to comment about. Based upon the success with this format, the class may be expanded to a full semester class. The class meets via distance education primarily using a web learning system for all assignments. The coursework for the IT-Advisors culminates in a face-to-face final class session at the student competition where they make reflective presentations on their IT-Clubs and what they have learned in the course. Topics covered in the class include cyber defense, game design programming, and robotics to match the three venues of the IT-Adventures program. However, additional topics will be added as the program grows or the interest of the teachers changes. If the two-month format is successful and if the teachers desire it, the course will be expanded to a full semester length or year-long class in the future.

Also in the second year of IT-Adventures, the IT-Adventures staff moved from the conference calls with just the teachers to presenting real-time video classroom to both teachers and high school students to support the IT-Advisors and IT-Clubs. Through a partnership with Iowa Public Television (IPTV) six Iowa Communications Network (ICN) sessions were hosted where students and teachers are in a real-time video classroom with the IT-Adventures staff and venue specialists. The 50-minute sessions included a 15-minute presentation by one of the IT-Adventures staff and then the microphone and classroom is turned over to the students and teachers in the IT-Club for questions and discussions. The presentations done by the IT-Adventures staff included information what to expect your first year in the IT-Adventures program, about how to use the educational materials provided and what to expect at IT-Olympics. The questions asked during the sessions included specific programming logic issues for game design and robotics or configuration questions for cyber defense which if are simple are answered in real-time. If they are complex and require additional investigation before a solution can be reached are resolved off-line with one of the staff. The ICN sessions also have questions about specifics about rules at IT-Olympics, logistics of the program and student requests to tour the engineering campus, learn about scholarships available to students who study engineering, and meet with advisors when they come to campus. The IT-Advisors also get to know each other through the ICN sessions and learn from what other students and teachers are asking during the sessions.

In the third year of IT-Adventures (2009-2010 academic year), the IT-Adventures staff plans to further expand the real-time video classroom sessions for IT-Club members and IT-Advisors. While the sessions described above were infrequently scheduled due to funding constraints, the plan is to monthly host a session where there is 15 minutes of educational material provided and then opened up for questions. At the end of the 50-minute session a challenge for the month will be posted to the web site and discussed with the students briefly. Students will work on the challenge for that month. In the next month, one possible solution to the challenge will be presented and questions answered about the solution, another brief 15-minute learning session will be conducted and then another challenge will be posted on the web site.

As the IT-Adventures program has expanded to more schools, the project staff has seen more inquiry-based, after-school learning. Additionally, companies and mentors have started to take ownership of the learning within individual high schools which has led to further adoption by other schools and a shift of the ownership of the program from the IT-Adventures staff to those IT-Advisors and IT-Mentors who are locally spearheading IT-Club efforts.

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