IT-Adventures: A Program to Spark IT Interest in High School Students Using Inquiry-Based Learning With Cyber Defense, Game Design, and Robotics

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***Abstract*—The IT-Adventures program is dedicated to increasing interest in and awareness of information technology among high school students using inquiry-based learning focused on three content areas: cyber defense, game design programming, and robotics. The program combines secondary, post-secondary, and industry partnerships in educational programming, competitive events, and service learning projects targeted at high school students to accomplish its goals. This paper provides details about the IT-Adventures program as well as the capstone event for students—the IT-Olympics. Project assessment findings, such as differences between students who compete in different content areas, and descriptive measures about the participants are also provided.**

***Index Terms*—Cyber defense competition, game design, inquiry-based learning, IT-Adventures, K-12, partnerships, robotics, STEM enrollment.**

I. Introduction

NATIONALLY, the number of students entering into and completing degrees in scientific areas is declining. While the National Academy of Sciences report [1] primarily focused on the loss of students pursuing degrees to create basic scientific knowledge, it also noted that the country is not producing professionals and skilled labor able to apply technology in industry. The IT-Adventures program is specifically concerned with their secondary fact: the downturn in the number of graduates to fill professional information technology (IT) positions. Since the IT profession is a highly creative, highly innovative industry segment that crosses many boundaries of academic study, departments of computer engineering, electrical engineering, computer science, management information systems, and others are troubled by the downward trend.

These downward trends are significant and have been occurring over the past several years. Computer Research Association documented a 20% decrease in the number of people who graduated with an IT-related degree in Spring 2008. Likewise, the number of students who enrolled in computer science programs was down 50% in the five years from 2003–2008; a 43% decrease occurred between the 2005–2006 and 2006–2007 academic years [2]. Ironically, this dramatic downward spiral is occurring at the exact same time as a 24% growth in professional IT jobs over the next 10 years is predicted [3]. At the current rate of enrollments in IT-related areas, community colleges, universities, and trade schools are not positioned to graduate the number of required candidates to fill new positions created by the projected job growth [4].

The IT-Adventures program (www.it-adventures.org), which is in its second year, is a proactive approach to reverse the downward trend in IT enrollments. The program is dedicated to increasing interest in and awareness of IT among high school students, using inquiry-based learning focused on three content areas: cyber defense, game design programming, and robotics. The program uses secondary, post-secondary, and industry partnerships in educational programming, competitive events, and service learning projects aimed at the high school students, as well as workshops and classes for high school teachers, to accomplish its goal. Additionally, the program has components that are targeted at post-secondary students at the community college level. The focus of this paper is on the high school student experience in educational programming and competitive events.

IT-Adventures uses an inquiry-based approach, which allows students to explore IT in a nonthreatening, experimental environment. Modeled upon two years of successful pilot project high school cyber defense competitions, the basis of the program is the formation of IT-Clubs in high schools across Iowa. The IT-Club provides an avenue for students to gain access to learning materials from Iowa State University (ISU), Ames, and to ask questions of IT professionals. The capstone event for students who participate in IT-Adventures is a two-day competition, named the IT-Olympics, on the ISU campus. It features competitions and presentations where high school students showcase the IT knowledge they have gained during the year. IT-Olympics is also a celebration of IT and 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.

This paper is organized into five sections. Sections II and III provide the details of the IT-Adventures program and the two-day IT-Olympics event. Section IV shares findings from the pilot assessment conducted with the student participants

Manuscript received January 31, 2009; revised March 31, 2009. First published September 25, 2009; current version published February 03, 2010. This project was supported in part by Iowa State University, the Iowa Department of Economic Development, the Technology Association of Iowa, the Iowa Chapter of Infragard, the Iowa Math and Science Education Partnership, and other business and industry partners in Iowa.

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Digital Object Identifier 10.1109/TE.2009.2024080

during the IT-Olympics competition. Section V provides conclusions and information about further work being conducted in the second year of the program (the 2008–2009 academic year).

II. IT-Adventures Program 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, extracurricular activity where students can explore IT 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. It also involves critical and logical thinking as well as exploration of alternative solutions [5]–[7].

The primary goal of IT-Adventures was to pique the interest of students in IT and, through that increased interest, to expand the number of students who selected an information technology area as their college major and employment path. A secondary and equally worthy goal was to make the whole experience fun.

A. IT-Club Structure

The requirements for high schools to participate in the program were few and inexpensive. A high school had to allow an IT-Club to be formed, provide an advisor, allow students to meet in the high school, and provide transportation to ISU for participants in the IT-Olympics competition. Some of the advisors to the IT-Clubs were high school IT instructors. However, most of the advising teachers were just individuals in the school system who really cared about students and student learning, such as the talented and gifted coordinator, the science/biology teacher, the industrial arts teacher, and the librarian.

The non-IT background of advisors, of course, presented challenges in working with them on technical material. Therefore, IT-Clubs were structured to have not only an advisor, but also a mentor who had IT knowledge and experience. For those advisors with little to no IT background, the mentor filled in the gaps. The IT-Mentor was a local IT professional who could help the club members when they experienced technical problems in their labs and experiments. Additionally, the IT-Mentor could provide real-world insight into careers, technical problems, and solutions in the IT area that would also stimulate interest in these career paths and foster future success [8]. Once a mentoring partnership between a high school and business was developed, the relationship continued from year to year.

B. Educational Materials and Equipment Provided

When a high school formed an IT-Club in the Fall of the academic year, the student group decided if it wanted to study one, two, or all three content areas: cyber defense, game design, and/or robotics. While IT-Clubs were encouraged to sign up to study all three areas so the students had the widest range of content to explore, some opted to focus on just one content area.

The learning materials provided to the clubs are described by content area later in this paper. Which materials were shipped to an IT-Club depended upon its selected content areas. There were two approaches for acquiring and delivering educational materials to the IT-Clubs. In the robotics and game design venues, materials were readily available for purchase and subsequent dissemination to high schools for the platforms selected. In the cyber defense area, materials were created inhouse.

As anyone who studies or works with IT knows, the learning materials provided by IT-Adventures could not possibility cover the complete gamut of information needed to be an expert in any one of these areas. The program instead strove to provide enough material so the students could then conduct their own in-depth, inquiry-based approach on the specific primary IT challenge given to them.

Content area not only determined what learning materials would be provided, but also what equipment would be distributed to the IT-Club. All IT-Clubs were offered the opportunity to receive up to 10 refurbished desktop computers and up to three Microsoft Windows XP licenses. The desktop computers were provided through a generous donation of used equipment from a large grocery chain based in Iowa. The machines were not installed with operating systems, but a PowerPoint tutorial with audio and video on how to install Windows XP was created inhouse and provided in the equipment shipment so that the students could learn how to do the setup themselves. Additionally, all schools were shipped an Ubuntu desktop CD to let the students experiment with the installation of an easy, GUI, open-source operating system. Again, a tutorial created inhouse was provided to help students be successful in installing and configuring the operating system.

1) Specific Game Design Materials: Since understanding the logic of programming is one of the foundations of work in IT, the IT-Adventures staff decided to send all IT-Clubs the game design learning materials whether they opted to study game design or not. Frequently, students who study computer science and computer engineering find learning the syntax of a new language to be the greatest challenge [9]. The use of the Alice software removed the need to memorize syntax since the programs are created with drag and drop functions. The materials included the book *Learning to Program with Alice* [10] and the Alice software, along with the learning materials available from Carnegie Mellon University, Pittsburgh, PA. To get students started with Alice, there was a PowerPoint tutorial with audio and video created inhouse that walked the students through the installation of the software and helped them learn to use Alice and their provided learning materials.

2) Specific Robotics Materials and Equipment: Each IT-Club that signed up to work with the robotics content area was given the Lego Mindstorms NXT base education kit [11], the educational resource kit [12], and the Mindstorms NXT software ver. 1.1 [13]. The book *Building Robots with Lego Mindstorms NXT* [14], as well as two sets of DVDs titled *Robotics Engineering Vol I* [15] and *Robotics Engineering Vol II* [16], were also supplied [17]. Again, a PowerPoint slide show with audio and video was created inhouse to help students understand how to install the Mindstorms NXT software. The tutorial also explained to students and teachers where to start with the DVDs, how to use the video demonstrations, what parts and sensors they received, and where to find some robot designs to get started.

3) Cyber Defense: Because there were no materials available for purchase in the cyber defense venue, a graduate student created nine lectures that covered services necessary for the cyber defense competition as well as basic networking concepts. Each lecture included a printed document with step-by-step instructions and any visual aids used in the presentation so that students or advisors could use them for review and practice. The lecture topics included FreeBSD installation; basic Unix commands; basic network concepts; an explanation of ports and protocols; implementation of sendmail, POP/IMAP, and DNS; securing a remote programming environment; installation and securing of an Apache Web server and PHP; installation and setup of a firewall; as well as securing Windows and Unix-based systems through limiting of services and watching of log files.

While the desktop computers shipped to the IT-Clubs for the other content areas were treated as work stations, the machines provided to the IT-Clubs in the cyber defense content area were intended for the students to setup their own cyber security lab and to replicate the lecture steps that were demonstrated. In addition to the nine instructional DVDs, installation CDs of open-source operating systems were provided to each IT-Club. It could not be assumed that the students would have access to a computer with a CD burner, where they could download the ISO image and create their own installation CD.

III. IT-Olympics Competition Description

Given that the IT-Clubs in the IT-Adventures program study three content areas, there were three competition venues during the IT-Olympics event: cyber defense, game design, and robotics. Due to timing constraints on team events, a student was only allowed to compete in one venue during the IT-Olympics. However, as part of the IT-Club activities leading up to the IT-Olympics, students could collaborate on multiple venues. By February, an IT-Club needed to determine what venues it wanted to have teams participate in, name its teams, register the team in the correct venue via the Web, and list its team members in order to be eligible to compete. Teams could have as few as three or as many as 10 members, but a five- to six-person team was recommended to allow everyone on the team an equal chance to participate. Additionally, to compete in IT-Olympics, each IT-Club had to perform a community service project related to IT and produce a poster that detailed the project.

Although the staging of the event, the rules governing the competition, the educational methods used, and the technical skills required vary widely in previous competitions in game design [18]–[20], robotics [21]–[24], and cyber defense [25]–[32], in general, past competitions have focused on a single project challenge. The students work on the technical challenge, create their project, and bring it to the event to compete. Like its predecessors, the IT-Olympics also had a primary challenge that the students worked to complete and bring to the two-day event. However, it differed from previous competitions by providing an additional series of challenges to the teams that occurred during the event and were not known ahead of time. IT-Olympics also included a community service component that the students had to complete, which was a significant portion of their overall score. Finally, while teams obviously wanted to win the competition, extreme competitiveness was downplayed, and an emphasis was placed on the fun and excitement of the event to the point of turning it into a carnival atmosphere.

As stated above, in each competition area (venue) in IT-Olympics, the teams were judged on three components: community service, the primary challenge, and real-time challenges. The community service score was determined based upon the quality of the community service project, the poster, and the oral presentation made during IT-Olympics. The primary competition was the portion of the competition that allowed teams to demonstrate technical abilities in interpreting and building a project where the specifications were given before the competition. The real-time challenges were projects that were given to the teams during the two-day event. The details of the real-time challenges were not known until the moment the challenge was presented. This gave students the ability to discover how well they were able to innovate and design with a time constraint, using only the resources available. Examples of the primary and real-time challenges are detailed below, broken down by venue.

A. Game Design Competition

In the game design venue, the primary challenge was to design an educational game that could be used to teach a concept in the areas of science, technology, engineering, or math (STEM) to students in grades 6–8. This game was submitted in electronic format and loaded onto machines for the judges to evaluate and play. After scoring, the games were made available for the general public to play so they could see the talent of the students.

As soon as the game design teams had submitted their primary challenge project, their real-time challenges began. Approximately every 2 h, the teams were given a new challenge. At the end of the 2-h window, the teams were asked to submit the game electronically and then were given another new challenge. The challenges were presented to the teams as a written one-page summary of the program that was to be built, and a base Alice program was provided that supplied some simple characters or scenery from which to start. The provision of this base program ensured that acceptable progress could be made on the project and that each team would have something to show for their 2 h spent on the coding project.

In one of the real-time challenges, the teams were given a maze where players had to select one of three characters and then help their character find his/her way through the maze. This particular maze challenge was based very loosely upon the characters of Harry Potter, Fluer Delacour, and Victor Krum in the Tri-Wizard tournament from the fourth Harry Potter series book, *Harry Potter and the Goblet of Fire* [33]. While the teams were given the characters and the maze, it was their job to create movement for the characters and to give the characters the ability to avoid surprise obstacles that had been programmed to appear. To win the game, the character had to navigate through the maze avoiding all obstacles and touch the Tri-Wizard cup trophy that was in the center of the maze. Fig. 1 shows the starting program for the challenge.

Fig. 1. Starting program for Tri-Wizard challenge.

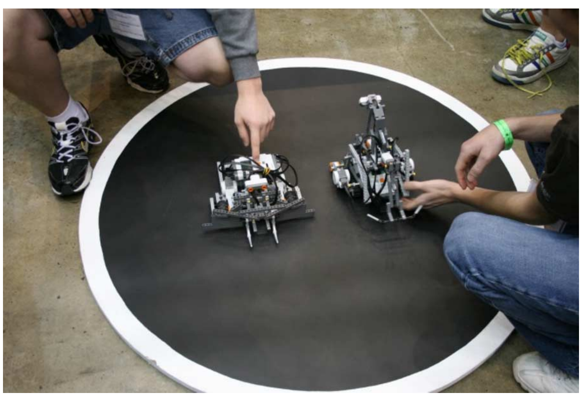

Fig. 2. Sumo robots begin their bout.

B. Robotics Competition

The primary challenge for the robotics venue was to design and program a sumo wrestling robot using the Lego Mindstorms NXT platform. A Lego sumo competition is when two autonomous robots try to push or flip each other outside of the circular ring. The first robot to touch the floor outside of the ring loses the bout. The competition mat is a circular ring 4 feet in diameter with a 2-in border and is made of 3/4-in MDF plywood. The robots are placed in the ring 12 in apart, an equal distance from the center of the ring, parallel to each other and facing in opposite directions so they have to search for each other at the start of the bout. The robot must find its opponent and then start trying to flip, lift, disable, or push it out of the ring. The combat continues until one robot is disabled or the bout time of 3 min is over.

The IT-Clubs used the kits they were shipped in the fall to create their sumo robots. They could only use the gears, sensors and connectors that were provided in these kits. Without the ability to purchase additional connectors, sensors or weights, the focus became on the engineering and design of a more competitive sumo robot and the writing of smarter code for the robot reactions. Fig. 2 shows a picture of two sumo robots starting their bout.

For the real-time challenges in robotics, each team was provided a second set of Lego Mindstorms NXT kits at IT-Olympics. Examples of the real-time challenges for the robotics venue included creating a string-running robot that raced down a 6-ft-long wire track suspended 3 ft in the air, and the creation of a sorting machine that could distinguish between red and blue balls that arrived out of a mixer.

C. Cyber Defense Competition

Students in the cyber defense venue were required, as their primary challenge, to configure a set of four computers to function as a network to support a fictional college. A short-story narrative detailed the services that they had to implement as well as their network address space. The team was told they were the IT support staff for a small college that had been slow to adopt information technology on its campus. The team's job was to implement services including e-mail, Web mail, remote programming, file sharing, and Web hosting. They were also told they were responsible for their own DNS and were encouraged to implement a firewall to help protect their networks. The teams were also given a machine that had been installed with a legacy system that had to be supported in its present state. This machine provided inherent security vulnerabilities, and the team had to devise a way to protect the system and its data without upgrading or moving the services to a new device.

The computers used by the teams were physically located at the Internet-Scale Event and Attack Generation Environment (ISEAGE—pronounced "ice-age") research facility.[1] This required the high school students to access the equipment remotely approximately four weeks prior to the IT-Olympics. Additionally, they had to learn how to configure computers in the research environment. A printed document on how to access the remote setup and a tutorial on remote setup were provided.

The four computers in their network could be remotely loaded with any legal operating system and configured in any manner they chose. Operating systems were primarily installed through a PXE-boot environment with operating system images from which they could choose. The requests for the additional software was accomplished through the use of a chat room that was manned approximately 20–30 h per week, mainly in the evening, by members of the ISU Information Assurance Student Group for the month leading up to the competition. In addition to assisting the students physically with operating system installation, the college students provided assistance in answering setup questions through chat, installing additional memory or network cards, and rewiring the students' networks so that their firewalls could be implemented. This was a beneficial exercise both for the high school students and the college students in terminology, network design, and implementation.

The judging of the primary challenge in cyber defense was different from the other competition venues. Instead of using judges in the traditional manner, in this venue, a group of individuals played the role of "hackers." These IT professionals and graduate students conducted vulnerability and penetration testing of the teams' competition networks. If vulnerabilities existed, the "hackers" exploited them to see what countermeasures the cyber defense team members took. Their exploits, and the students' reactions to them, were one type of real-time challenge presented to the high school teams.

[1]www.iseage.org

Fig. 3. Students in cyber defense working on their networks.

The second real-time challenge was a group of people playing the role of end-users of the competition networks. In addition to the team needing to support services for end-users and those services needing to be functional throughout the competition, the users could also make requests of the teams. The way these requests were made corresponded more closely to the way the other venue's real-time challenges were made. The real-time challenges were handed out on sheets of paper and described what needed to happen and within what time constraints. These real-time challenges were what kept the teams focused on continuing to provide a useable network, as well as a secure one, throughout the competition. Fig. 3 shows the students working on their racks of equipment during IT-Olympics.

IV. Project Assessment

Assessment of the IT-Adventures program was made as a post-test-only survey and was administered to the students during IT-Olympics near the end of a grueling two days of competition. It was not a required element in any of the events. It was stressed to the students that the survey did not improve or diminish their overall score in the competition and that it was strictly voluntary, but their input would help with the format and delivery of the program for the upcoming year. While a post-test-only survey has shortcomings, the instrument and its results provided input to guide the 2008–2009 academic year's programming and evaluation.

A. Descriptive Information on Participants

A little more than half of the students and high schools who signed up in the Fall for the IT-Adventures program actually came to the ISU campus in April 2008 to participate in IT-Olympics. The two-day event had an enrollment of 46 teams made up of 213 students from 25 high schools competing in the three venues. The enrollment records for the teams competing in IT-Olympics required the student's year in school to be entered as part of the registration process. Two-thirds of the students who competed in IT-Olympics were upperclassmen (54 seniors and 88 juniors), with the remainder being evenly split between sophomores and freshmen. Of the 213 students participating in the two-day event, 132 completed surveys, a 62.0% completion rate. Those 132 student surveys represented 32 teams (69.6%) and 21 high schools (84.0%).

Since the high school cyber defense competition was in its third year, when the two pilot years are included, it was anticipated that venue would have the highest enrollment. The distribution of completed surveys was similar to enrollment. More than three-quarters of those who completed the survey participated in the cyber defense venue (76.3%). The remaining students participated in either robotics (12.2%) or game design (11.5%).

The student population that participated in IT-Olympics was heavily male (89.8%), although an all-female team competed for the first time in three years of conducting high school cyber defense events. Of respondents participating in all three venues, 18.8% of the robotics respondents were young women, 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 $(\mathrm{p} < 0.05)$. Additional descriptive statistics about the respondents are available in Table I.

B. Confidence in Using Technology

In an effort to evaluate how secure the students felt in working with the technology in their venue, a series of 11 Likert scale items were created, based upon work completed by [34], where observed variables were combined to create a latent construct of self-efficacy with computers. However, in this paper, the observed variables were the objects of interest and not the latent construct. The students were asked to use a 7-point scale ranging from strongly agree (1) to strongly disagree (7) to rate their confidence in their selected venue given different types of help they could hypothetically receive. Table II shows the percentage of respondents and their perception of the type of help where percentage of responses in the range of strongly agree (1) to agree (3) were summed together for a cumulative percentage. While many of the responses show a high desire for personal help, which was expected, there were more than a quarter (28.0%) of respondents who were comfortable with manuals only, and nearly one-third would be satisfied with built-in help (31.8%).

In looking at the confidence rankings across venues, results from a general linear model (GLM) found statistically significant differences among the venue groups on four of the measures. The results of the GLM are shown in Table III. Using the Tukey test for honest significant differences (HSD), a pairwise examination between the three groups' means was conducted *post hoc* to find where the variations occurred. The results of these tests are displayed in Table IV. The relative effect size is shown by the partial Eta^2, where a value of 0.01 is a small effect, 0.06 is a medium effect, and 0.14 is a large effect [35], [36].

In examining the differences between groups responding to the "having someone provide step-by-step instructions" question, $\mathrm{F}(2, 128) = 10.84$, $\mathrm{p} = 0.00$, the Tukey HSD results demonstrated that the cyber defense group would be significantly more confident with the step-by-step instructions $(\mathrm{M} = 2.54)$ than the game design group $(\mathrm{M} = 4.60)$, $\mathrm{p} = 0.00$. This is the strongest effect observed with a partial Eta^2 at the 0.14 range.

On all other measures, the differences occurred between the cyber defense group and the robotics participants. As shown in Table IV, the students who participated in the cyber defense venue were more likely to have additional confidence based

TABLE I
DESCRIPTIVE INFORMATION FOR SURVEY RESPONDENTS

	Percentage Answering "Yes" or "Agree" to "Agree Strongly"
Math Classes Taken	
Alegebra I	72.7
Geometry	72.0
Algebra II	63.6
Trigonometry	33.3
Calculus	26.5
Computer Classes Taken	
Programming	28.0
Web Page Development	25.0
Network Administration	26.5
Other	28.8
Plan to attend 2- or 4-year college	97.6
Plan to earn IT-related degree	66.1
IT-Olympics made them more aware of careers available in IT	80.8
IT-Olympics made them more interested in learning about IT	85.4

TABLE II
PERCENTAGE OF RESPONDENTS AND THE TYPE OF HELP THAT WOULD INCREASE THEIR CONFIDENCE IN IT-OLYMPICS ACTIVITIES (CUMULATIVE PERCENTAGES ARE SHOWN, WHICH SUM THE PERCENTAGES FOR THE RESPONSES OF "STRONGLY AGREE" TO "AGREE")

Type of Help	Percentage ("Strongly Agree" to "Agree")
if there was someone giving me step-by-step instructions	65.9
if there was no one around to tell me what to do as I go	18.9
if I had never performed an activity like it before	23.7
if I had only the manuals for reference	28.0
if I had seen someone else doing the activity before trying it myself	67.4
if I could call someone for help if I got stuck	78.0
if someone else had helped me get started	67.4
if I had a lot of time to complete the activity	73.5
if I had just the built-in help facility for assistance	31.8
if someone showed me how to do it first	73.8
if I had performed similar activities before this one to accomplish the same task	84.1

upon the types of help listed than those in the robotics area. These are medium effects within the 0.06 range of partial Eta^2. With little or no previous experience in setting up a network, it would seem appropriate that the cyber defense students would want more specific types of help and instructions. Their contextual references are limited to the learning materials provided by ISU and their IT-Mentor's experience. Conversely, in game design and robotics, students are freer to improvise on their solutions to the challenges and can more readily transfer some of their everyday life experience into the design of a robotic or the coding of a game.

C. Involvement With Current Technologies

To gauge the students' involvement with current IT technologies, they were asked a series of 11 questions, on a 7-point Likert scale ranging from strongly liked (1) to strongly disliked (7), about certain IT-related activities. This series of questions was based upon work done with interest markers by [37]. Table V shows the respondents' involvement with current IT technologies, where the percentage of responses represents a cumulative percentage of those answers ranging from strongly like (1) to like (3).

There were four statistically significant differences in involvement with current IT technologies questions between the three venues, as shown in Table VI. Again, a GLM was run to determine if the differences existed, the Tukey HSD test was run *post hoc* to find where the differences occurred, and the partial Eta^2 provided the power of the significance, as shown in Table VII. While the effects were small to medium based upon the power, interestingly, all four measures where differences occurred could be considered traditional computer science or traditional IT areas dealing with hardware, software, taking IT classes, and building computers. In general the robotics respondents were less likely to enjoy the activities that are historically

TABLE III
STATISTICALLY SIGNIFICANT DIFFERENCES IN CONFIDENCE MEASURES FROM GLM

Type of Help	df	F	Sig.	Partial Eta^2
if there was someone giving me step-by-step instructions.	2	10.836	.000	.145
if I could call someone for help if I got stuck.	2	3.757	.026	.055
if someone else had helped me get started.	2	6.622	.002	.094
if someone showed me how to do it first.	2	5.062	.008	.074

TABLE IV
TUKEY HSD FOR CONFIDENCE MEASURE DIFFERENCES BETWEEN GROUPS (RESPONSES WERE MADE ON A 7-POINT SCALE WHERE $1 = \text{Strongly Agree}$, AND $7 = \text{Strongly Disagree}$. MEANS THAT DO NOT SHARE SUBSCRIPTS DIFFER AT $P < 0.05$ IN THE TUKEY HONESTLY SIGNIFICANT DIFFERENCE

if there was someone giving me step-by-step instructions.	Cyber Defense	2.54_a
	Game Design	3.62_b
	Robotics	4.60_{ab}
if I could call someone for help if I got stuck.	Cyber Defense	2.27_a
	Game Design	2.27_a
	Robotics	3.38_b
if someone else had helped me get started.	Cyber Defense	2.64_a
	Game Design	3.33_{ab}
	Robotics	4.19_b
if someone showed me how to do it first.	Cyber Defense	2.33_a
	Game Design	3.13_{ab}
	Robotics	3.53_b

TABLE V
PERCENTAGE OF RESPONDENTS' INVOLVEMENT WITH IT-RELATED ACTIVITIES (CUMULATIVE PERCENTAGES ARE SHOWN, WHICH SUM THE PERCENTAGES FOR THE RESPONSES OF STRONGLY LIKE TO LIKE)

IT-related Activity	Percentage of Affect (“Strongly Like” to “Like”)
Acquiring latest electronic technology	84.8
Maintaining hardware and software for my family and/or friends' computers	74.8
Maintaining a website	59.1
Keeping up-to-date on the latest software	75.8
Taking a course in computer technology	81.5
Researching components and building my own computer	79.5
Using computers to archive music/videos	75.6
Improving computer performance	85.5
Writing my own programs	80.0
Installing a new computer system	77.1

TABLE VI
STATISTICALLY SIGNIFICANT DIFFERENCES IN INVOLVEMENT WITH IT-RELATED ACTIVITIES FROM GLM

IT-related Activities	df	F	Sig.	Partial Eta^2
Maintaining hardware and software for my family and/or friends' computer(s)	2	3.499	.033	.052
Keeping up-to-date on the latest software	2	3.445	.035	.051
Taking a course in computer technology	2	5.670	.004	.083
Researching components and building my own computer	2	8.516	.000	.118

associated with computer science and IT classes, while the cyber students were more likely to enjoy those activities.

Ironically, three additional interest questions that, at first glance, would seem to fall into the traditional computer science or IT area (improving computer performance, writing my own program, and installing a new computer system) showed no statistical differences among the venues. While writing programs seems to make sense in light of the coding needed for all three venues, it was unclear why the other two did not show statistical differences across the venues. It may be that the items were sufficiently broad for the students to interpret them as things they liked to do within their own venues.

TABLE VII
TUKEY HSD FOR INVOLVEMENT WITH IT-RELATED ACTIVITIES (RESPONSES WERE MADE ON A 7-POINT SCALE WHERE $1 = \mathrm{Strongly\ Like}$ AND $7 = \mathrm{Strongly\ Dislike}$. MEANS THAT DO NOT SHARE SUBSCRIPTS DIFFER AT $P < 0.05$ IN THE TUKEY HONESTLY SIGNIFICANT DIFFERENCE COMPARISON)

Maintaining hardware and software for my family and/or friends' computer(s)	Cyber Defense	2.42_a
	Game Design	2.87_{ab}
	Robotics	3.50_b
Keeping up-to-date on the latest software	Cyber Defense	2.33_a
	Game Design	2.60_{ab}
	Robotics	3.50_b
Taking a course in computer technology	Cyber Defense	2.00_a
	Game Design	2.13_{ab}
	Robotics	3.38_b
Researching components and building my own computer	Cyber Defense	2.00_a
	Game Design	2.93_{ab}
	Robotics	3.62_b

V. CONCLUSION AND FUTURE WORK

This paper provided an overview of the IT-Adventures program, which was designed to attract high school students to a major in IT upon entering college, as well as a discussion of findings from a post-test-only survey of high school students in the program. The foundation of IT-Adventures is the statewide creation and maintenance of IT-Clubs in high schools where students can receive educational materials and insight into IT-related projects. The year culminates in the IT-Olympics competition, which focuses on the three areas of cyber defense, game design, and robotics.

Interesting findings that stem from this pilot project demonstrate that the venues selected to be included in the IT-Adventures program and the IT-Olympics competition may be able to attract different types of high school students. Although small effects, differences were seen between the groups of students who competed in the robotics venue and those who competed in the cyber defense competition; these differences have made the IT-Adventures staff begin to examine the methods used to deliver the learning materials, to look at the types of real-time challenges being presented to the two groups, and to decide whether this venue could be structured to attract a broader group of high school students. Additional venues may also be added in future years to widen the group of students attracted to the IT-Adventures program. Specifically, the IT-Adventures staff has recognized the high number of young men and the lack of young women in the program, as well as in STEM areas in general, and has taken upon itself to work on ways to attract more young women into the program. While the numbers were not statistically different, it was interesting that the robotics venue attracted a higher percentage of young women, and it is possible a different venue could be identified that more young women would find intriguing and inviting. At the present time, it is unclear what course of action is needed to encourage additional female participation in the program. However, these findings of statistical differences with medium power may provide the beginning of that understanding.

In the four confidence measures where there were statistical differences between groups, the data point to a desire on the part of the students for personal interaction, having help, and being shown how to do something. This finding emphasized one of the key underpinnings in the IT-Clubs. By coupling the IT-Club with an IT professional, there can be a personal interaction where the IT-Mentor shows students how to do certain tasks and helps walk them through information. Additionally, the lessons and learning materials provided demonstrations of how to install, use, or design in their chosen content areas and sought to fill the needs identified in the survey responses.

While the IT-Adventures program has shown high success and promise in its first year, there are still areas for future work. A much-needed improvement for the program is to test the effectiveness and effects of the program more thoroughly, with a more rigorous research model with a pre- and post-test as well as a more detailed survey testing instrument. This has been implemented for the 2008–2009 academic year with the pre-test being administered over the Web for easy implementation. Additionally, in its second year, the IT-Adventures program has grown to include nearly 500 students and 46 high schools, with nearly 350 of those students attending the 2009 IT-Olympics. Additionally, the IT-Adventures program has proven that the development of IT-Club/IT-Advisor/IT-Mentor combinations at high schools across Iowa has scaled well. It is only a logical next step that within five years the IT-Adventures program will branch out to a regional program with state competitions feeding into a national IT-Olympics event. This national event would allow high school students from across the country to get involved, get interested, and get excited about IT.

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