Attracting Minorities to ET through TECHFIT

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Alka Harriger joined the faculty of the Computer and Information Technology Department (CIT) in 1982 and is currently a Professor of CIT. For the majority of that time, she has been actively involved in teaching software development courses. From 2008-2014, she led the NSF-ITEST funded SPIRIT (Surprising Possibilities Imagined and Realized through Information Technology) project. Since October 2013, she has been co-leading with Prof. Brad Harriger the NSF-ITEST funded TECHFIT (Teaching Engineering Concepts to Harness Future Innovators and Technologists) project. Professor Harriger's current interests include application development, outreach to K-12 to interest more students to pursue computing careers, applying IT skills to innovating fitness tools, and wearable computing.

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Brad Harriger has over 30 years of experience teaching automated manufacturing and has authored/co-authored several related articles. Professor Harriger has served in several leadership roles with Society of Manufacturing Engineers and the American Society for Engineering Education, and is a founding member of an international Aerospace Automation Consortium, serving on its steering committee for several years. He has invested over twenty-five years in the development and maintenance of a multimillion dollar manufacturing laboratory facility complete with a full scale, fully integrated manufacturing system. Professor Harriger has been a Co-PI on two NSF funded grants focused on aerospace manufacturing education and is currently a Co-PI on the NSF funded TECHFIT project, a middle school afterschool program that teaches students how to use programmable controllers and other technologies to design exercise games. Additionally, he co-organizes multiple regional automation competitions for an international controls company.

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Abstract:

Attracting any group to a particular discipline requires providing opportunities for that group to participate as well as making the experience engaging enough that the participants are eager to learn more. TECHFIT (Teaching Engineering Concepts to Harness Future Innovators and Technologists) is a three-year project designed to spark interest in engineering technology in middle school students, especially minority students. TECHFIT teaches participants about electricity, wiring, safety, programming, and fitness. Each participant team creates their own functional, prototype exergame using a provided technology toolkit. The primary goal of this intervention is to increase student interest in pursuing science, technology, engineering, or math (STEM) study, but a related secondary goal is to encourage a healthy lifestyle related to physical activity. This paper will share the design of the TECHFIT program and provide recommendations regarding the approach used to attract all groups, including minorities, to engineering technology.

Background

The Teaching Engineering Concepts to Harness Future Innovators and Technologists (TECHFIT) project is an NSF-funded project that seeks to spark interest in middle school students in STEM subjects by showing them that these skills can equip them with the tools to innovate solutions to societal problems such as obesity by creating their own exergames.[3] Student interest in engineering and technology fields experienced the largest decline with the high school class of 2001.[7] Although interest has been slowly increasing, they have yet to reach previous levels of interest.[7] STEM fields offer some of the best opportunities for job growth and have wages that are nearly double the nation's average job wage.[6] However, according to Adecco:

> "For every two open STEM job listings, there is only one qualified unemployed individual. And that gap will only increase."[1]

Clearly, it is important to America's future to get more students to pursue STEM subjects.

The TECHFIT program also highlights the importance of an active lifestyle. The Milken Institute discovered a direct link between use of information and communications technology and the rise in obesity rates in over 25 countries.[4] Television can no longer be blamed as the sole cause of the couch potato syndrome: More people are spending too much time using technology while sitting, such as playing video games, and the resulting inactivity is contributing to the nation's obesity crisis. Fortunately, with the interest in fitness tracker wearables, mobile fitness apps, etc., technology can start becoming part of the solution to getting people moving.

TECHFIT includes a professional development program for teams of middle school teachers to equip them with technology, skills, and the knowledge needed to create their own exergames. They, in turn, run the equivalent of a ten-week afterschool program, under the guidance and support of the TECHFIT staff, in which they share the same lessons with their students to accomplish the objective of their students to innovate their own exergames. The experience is designed to inform, educate, excite, and reinforce the importance and value of STEM through

team-based innovation. A side benefit causes the participants to engage in more regular physical activity.

The teacher program consists of six days, Monday through Saturday, during a week in the summer. TECHFIT leaders provide instruction on electricity, wiring, safety, programming, and fitness. Teachers also learn about all components that are in a technology toolkit provided to each teacher team. By the end of the six days, each team has learned enough to create their own functional, prototype exergame using the provided toolkit.

During the subsequent school year, each teacher team offers the equivalent of a ten-week afterschool program in which they teach their students the same things they learned with the goal of the students designing another exergame with the same toolkit components. The afterschool experience culminates in a showcase event where each school's team shares their afterschool experience and demonstrates their exergame innovation in competition inspired by FIRST Robotics.[2]

TECHFIT planning began in fall 2013, and the first summer professional development programs were offered in summer 2014. The first afterschool programs were offered in fall 2014 with the showcases occuring in December 2014. A total of 22 teachers from 8 schools in 2 states (Indiana and South Carolina) completed the summer programs.

Recruitment

TECHFIT is offered in both Indiana and South Carolina. Different methods of marketing the opportunity were employed in the two states. However, both states required interested teachers to complete an online application form to be considered for the program. After the application deadline, a committee was charged with scoring the applications using a blind review process. The reviews combined with other factors such as the size of the school, the proportion of the minority student population at the school, and the subject areas of the teacher teams were used to assign each school's teacher team a score. These scores were used to identify the schools initially selected into the program. In the event the teacher team from a selected school was unable to participate, the next teacher team was offered the opportunity to participate.

For reaching Indiana schools, the Department of Education website provided access to school data, including school locations, administrators' contact information, and student demographics.[5] A personalized email was constructed to inform the school officials about the TECHFIT program and to request their encouragement of teacher teams to apply. The email included information about the program and goals, incentives offered to participating teachers, and contact information of TECHFIT staff.

For South Carolina schools, the host institution was located in a county that had multiple schools with large minority populations. The TECHFIT staff made personal visits to the schools in their county to share information about the program and encourage applications.

Once the application deadline had passed, the team discovered that the applications received were more than double the number of spaces available, both in terms of teachers and schools.

After the committee review, 22 teachers representing 8 schools in both states were selected to complete the summer program. As of January 2015, a total of 159 students successfully completed the afterschool programs at their schools. The registration form includes self-identification of the students' ethnicity. Based on this self-reported data, slightly over half of the students were minorities: 48 African American students, 23 Hispanic students, 1 Asian student, 75 Caucasian students, 8 students who reported multiple ethnicities and 4 who declined providing ethnic data.

Assessments

The approved IRB protocol includes several assessments for teachers and students as shown in Tables 1 and 2. The analysis of the data collected from the teacher and student participants should be completed by the time of presentation of the paper.

Time of data collection	**Surveys**
first day of participation in summer professional development (PD) program	Attitude towards Technology and Engineering Design Practices
	Attitude towards Fitness
	Attitude towards Interdisciplinary teamwork-A
	Teacher Self-Assessment of Learning Gains (SALG) – Survey 2
Last day of summer PD program	Attitude towards Technology and Engineering Design Practices
	Attitude towards Fitness
	Attitude towards Interdisciplinary Teamwork-A
	Attitude towards Interdisciplinary Teamwork-B
	Teacher Self-Assessment of Learning Gains (SALG) – Survey 1
	Teacher Self-Assessment of Learning Gains (SALG) – Survey 2
Last day of the 5th week of the after-school program,	Teacher Self-Assessment of Learning Gains (SALG) – Survey 2
	Attitude towards Interdisciplinary Teamwork-A
1 week after the finishing date of the after-school program implementation	Teacher Self-Assessment of Learning Gains (SALG) – Survey 2
	Attitude towards Interdisciplinary Teamwork-A

Table 1: TECHFIT Evaluation Plan for Teachers

Time of data collection	**Surveys**
First day of participation in afterschool program	A single survey that will include the following scales: 1. Attitudes to technology 2. Attitudes to fitness 3. Perceived relevance of teamwork 4. Perceived relevance of STEM 5. STEM interest and aspiration
End of showcase	
Follow-up 3-6 months after showcase	

Table 2: TECHFIT Evaluation Plan for Students

Data was also collected from the community of adult fans who attended the showcase. Because the quality of an Internet connection and availability of devices to access online surveys was questionable, to increase the response rate, the survey was designed as a half-page, double-sided, cardstock postcard survey. The front side collected the following demographic data: the school being supported, role of the individual, gender, and ethnicity. Table 3 summarizes the demographic data collected from adult attendees at both showcases. The reverse side of the postcard had ten, 4-point Likert-scale questions as shown in Table 4.

Characteristic	F	%
Gender		
Male	21	42.86
Female	25	51.02
Missing	3	6.12
Self-reported ethnicity		
African American (non-Hispanic)	10	20.41
Caucasian (non-Hispanic)	32	65.31
Hispanic	1	2.04
Decline to answer	1	2.04
Other	1	2.04
Missing	3	6.12
2 options	1	2.04
Affiliation *(NOTE: some selected multiple options, so the total exceeds 49)*		
Parent/grandparent/family member	27	50.94
School official/teacher	9	16.98
Industry professional	4	7.55
Resident of the community (non-parent)	5	11.32
Other (e.g., student, Purdue staff, media)	3	5.66
Missing	4	7.55

Table 3: Demographic Profile of Adult Showcase Attendees

On a scale of 0-4 (4 is strongly agree…1 is strongly disagree, and 0 is no basis for judgment), please rate each of the following statements based on your knowledge and experience with the TECHFIT afterschool program at your school:

_____ 1. The TECHFIT afterschool program makes learning fun for students.
_____ 2. The TECHFIT afterschool program helps students understand that science, technology, engineering, and math are important to learn.
_____ 3. The TECHFIT afterschool program helps students understand that being active contributes to learning.
_____ 4. The TECHFIT afterschool program helps students understand how different subjects are related.
_____ 5. The TECHFIT afterschool program encourages creativity in students.
_____ 6. The TECHFIT afterschool program encourages innovation in students.
_____ 7. The TECHFIT afterschool program improves students' confidence in school.
_____ 8. The TECHFIT afterschool program increases student interest in technology and/or engineering careers.
_____ 9. I will support my school's future participation in the TECHFIT afterschool program through my time and/or financially.
_____ 10. I would recommend the TECHFIT afterschool program to other schools, teachers and students.

Table 4: TECHFIT Postcard Survey for Community Supporters

Forty nine guests responded to the showcase post card survey. The respondents were asked to rate their agreement with the items shown in Table 4 on a scale of 0 to 4, where 0=no basis for judgment, 1=strongly disagree, … 4=strongly agree. Descriptive statistics (e.g., frequency counts and means) were used to summarize responses to the survey and may be reviewed in Table 5.

Items	N	Mean	SD	SA/A		SD/D	
				F	%	F	%
The TECHFIT afterschool program makes learning fun for students.	48	3.98	0.14	48	100.00	-	-
The TECHFIT afterschool program helps student understand that science, technology, engineering, and math are important to learn.	49	3.86	0.40	48	97.96	1	2.04
The TECHFIT afterschool program helps student learn that being active contributes to learning.	49	3.84	0.37	49	100.00	-	-
*The TECHFIT afterschool program helps students understand how different subjects are related.	48	3.63	0.75	45	931.84	2	4.08
The TECHFIT afterschool program encourages creativity in students.	49	3.88	0.43	47	95.92	2	4.08
The TECHFIT afterschool program encourages innovation in students.	49	3.84	0.47	47	95.92	2	4.08
*The TECHFIT afterschool program improves students' confidence in school.	49	3.57	0.81	46	93.88	2	4.08
*The TECHFIT afterschool program increases student interest in technology and/or engineering careers.	49	3.82	0.63	48	97.96	-	-
**I will support my school's future participation in the TECHFIT afterschool program through my time and/or financially.	48	3.54	1.04	43	89.88	2	4.17
I would recommend the TECHFIT afterschool program to other schools, teachers and students.	44	3.95	0.22	44	100.00	-	-
*Note: SD= strongly disagree; D= Disagree; S.A = Strongly agree; A= Agree; Response categories for the items ranged from "strongly disagree" =1 to "strongly agree" = 4, and included the option "No basis for judgment;" *= One participant selected the option "No basis for judgment" and ** = Three participants selected the option "No basis for judgment."*							

Table 5: Analysis of Postcard Survey Data from Community Supporters

Some of the key findings from the showcase survey are listed below:

- All survey respondents (100%) agreed/strongly agreed that the TECHFIT afterschool program:
  - Makes learning fun for students
  - Helps students understand that science, technology, engineering and math are important to learn
  - Helps student learn that being active contributes to learning
- About 96% agreed/strongly agreed that the program:
  - Encourages creativity in students
  - Encourages innovation in students
  - Improves student confidence in school

    - Increases student interest in technology and/or engineering careers
- All respondents agreed/strongly agreed that they would recommend the program to other schools, teachers and students
- Two respondents provided open-ended comments about the impact of their program on their children:
    - "TECHFIT has been fantastic for my son! Thank you!"
    - "Love love this! Our son developed relationships w/a whole new group of kids who like what he likes. I loved seeing kids present material. Thank you for acting on an idea!! God bless you!"

Future Plans

Based upon the experience gained with running the first set of TECHFIT programs, the approach to recruitment will be changed in both states. The Indiana schools with the highest minority populations had considerably fewer minorities than the South Carolina schools with the lowest minority populations. For this reason, the Indiana staff plan to make personal visits to several schools in the areas identified as having the largest minority populations.

For South Carolina, although there are several more schools in the local county that should be considered, it is important to disseminate information about the TECHFIT program more broadly across the state. For this reason, the South Carolina staff will use public school data to identify the schools they should target for email invitations and personal visits.

As information about TECHFIT reaches across state boundaries, it is possible that application opportunities will be extended to schools in neighboring states. However, because part of the support for the afterschool programs may require visits to those schools, proximity to the host institutions will remain part of the selection criteria.

Conclusion

It is important to spark interest in America's youth to pursue STEM fields of study. The TECHFIT program offers engaging experiences to teachers and students that demonstrate the tangible values that STEM knowledge can have towards building solutions to big, societal problems. Showing students and teachers that they have the ability to acquire and employ those skills to innovate solutions can help bridge at least some of the interest gap in STEM study.

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