Changing the World for Good: Tech Trek Alabama Changes 8th Grade Girls' Attitudes Towards STEM

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Abstract

The inaugural Alabama Tech Trek, an immersive experience for girls that have completed 7th grade, was conducted July 20-25, 2014. Surveys conducted at the beginning of camp, at the end of the camp, and six months after the completion of camp show that girls' confidence can be increased by the experience with significant effect remaining after the euphoria of camp has dissipated. Quantitative and qualitative data speak to increased self-efficacy in STEM fields and increased interest in pursuing a career in science or technology. Additionally, girls participating nationally in Tech Trek camps report large increases in comfort, enjoyment and interest in pursuing a career in programming as a result of taking core classes in mobile app development using App Inventor from MIT.

1.0   Introduction

The American Association of University Women (AAUW) research report "*Why So Few? Women in Science, Technology, Engineering, and Mathematics* (STEM)"[1] found that women are vastly underrepresented in STEM majors and fields compared with their male peers. But "*Why So Few?*" also showed that those numbers can change when girls realize their potential in STEM at an early age. In 2012, AAUW decided to provide girls across the country the opportunity to immerse themselves in hands-on exploration of STEM topics in order to encourage them to take more advanced STEM classes in high school and go on to major in STEM fields in college. A survey of California Tech Trek alumnae has shown that they surpass the national average in advanced math and science classes [2]. Using the model developed in California, AAUW brought Tech Trek to four national sites in 2013, these sites being Oklahoma, Washington, Florida and Ohio. Tech Trek is a weeklong summer camp for rising eighth-grade girls that is designed to develop interest, excitement, and self-confidence in STEM through classes, workshops, hands-on activities, and field trips. Camps are awarded from AAUW through a competitive grant process.

In 2014, Alabama, New Mexico and Oregon were awarded camps. The Alabama Trek camp, a partnership between the local AAUW branch and Institution followed the national pilot of core classes, workshops, a field trip and professional women's night. The girls spent 14.5 hours in core classes, choosing from robotics, app development, and life science. They also gained exposure to additional areas of STEM through 14 hours of workshops. Technical workshops included instant challenges conducted by trained appraisers from Destination Imagination, rocket building and the engineering design process led by NASA Education personnel, making slime, and DNA extraction at the Hudson Alpha Institute for Biotechnology. Non-technical presentations included communicating your big idea, STEAM, and stress release. The campers also toured a prototyping facility at Dynetics, Inc. and took the Ultimate Math Field Trip challenge at the US Space and Rocket Center. The highlight of the week was the Professional Women's Night, an event that involved professionals rotating among groups of

girls, speed dating style. In addition to meeting professional women, the girls watched a TED video and had Tedx personnel lead a panel discussion with two of the camp counselors, one an undergraduate STEM student, and one a graduate student in a STEM field. The goal of the camp is to immerse the girls in experiential exploration of STEM fields in an all-female environment so that the girls become more confident in their ability to pursue STEM subjects. A key element of the camp is Professional Women's Night where the girls encounter working professionals so that they see role models who look like them.

2.0   Methodology

At the beginning of camp, the girls took a survey designed by the national office of AAUW to gauge the girls' perceptions regarding STEM subjects and careers. At the end of the camp, they retook the survey. In some cases, the post survey showed that attitudes had changed based upon their experience at Tech Trek. The questions can be divided into perception questions and intention questions. The perceptions questions are listed in Table 1 and the intention questions are listed in Table 2. The girls were instructed to mark the box that best indicates how much you agree or disagree with the statement. The possible answers were Stongly Agree, Agree, Neutral, Disagree, and Strongly Agree.

Table 1. STEM Perception Questions

Pre, Post and Six Month Surveys	I like science I am interested in a career in science I am confident that I can learn science Women are not welcome in scientific jobs My parents encoursage me to pursue a career in science My teachers encourage me to pursue a career in science I plan to take advanced science classes in high school Scientists help protect the environment. Girls are as good as boys at science. Science can help me to make better choices about various things in my life (e.g., food to eat, cars to buy). Being nominated to go to Tech Trek camp means a lot to me.
	I like technology I am interested in a career in technology. Women are not welcome in technology jobs Girls are as good as boys at technology. My parents encourage me to pursue a career in technology. My teachers pursue me to pursue a career in technology. Knowledge of technology will help me protect the environment. My parents encourage me to learn about and use technology. I am confident that I can learn technology. I am interested in learning about what engineers do.

	I like mathematics. Girls are as good as boys in mathematics. I want to develop my mathematical skills. High school math courses would be very helpful no matter what I decide to study. I can think of many ways that I use math outside of school. I am confident that I can learn mathematics. I expect to take calculus in high school.

Table 2. STEM Intention Questions

Pre, Post, and Six Month Surveys	I plan to take advanced Science and Math courses in high school. I plan to attend college. I'm thinking of having a career in science or technology.
Post and Six Month Surveys Only	As a result of attending Tech Trek, I will take more advanced Science and Math courses. I will participate more in my STEM classes as a result of attending Tech Trek. I plan to major in a science, technology, engineering or math field in college. I would recommend Tech Trek to others.

Additionally, the girls were asked the four outcome questions given in Table 3 about their Tech Trek experience.

Table 3. Camp Outcome Questions

Post and Six Month Surveys Only	Opportunities to learn about real world applications of STEM. Opportunities to build your skills in critical thinking, problem solving and creativity. Opportunities to build your skills in collaboration and team work. Opportunity to learn about STEM fields.

They were asked to rate these opportunities as Excellent, Good, Fair or Poor

The 16 girls that participated in the App Development core course were given an additional AAUW designed survey regarding their comfort and enjoyment of computer programming and interest in pursuing a career in computer programing. These questions can also be divided into perception and intention questions. The perception questions are listed in Table 4 and the intention questions are listed in Table 5. The girls were instructed were to mark the answer that best indicated how much they agreed or disagreed with the perception questions with the choices being Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree.

Table 4. App Inventor Perception Questions

Pre and Post Survey Questions	Women can have successful careers in computer programming. I know what a mobile app is. I am confident that I can learn app development Computer apps can solve real world problems in my community. I am comfortable with programming. I enjoy programming. I would enjoy a career in computer programming or application development. Apps can help people live better lives.

For the intention questions, the girls were instructed to mark the answer that best indicated how likely they were to … and the choices were Very Likely, Likely, A Little Likely, Not At All Likely, and Not Sure.

Table 5. App Inventor Intention Questions

Pre and Post Survey Questions	Take more advanced Science and Math courses in high school. Take classes in graphic design/art. Take classes in business. Enroll in a free app development on-line course. Look for videos on You Tube about app development. Explore a career as an App Developer. Explore a career as a Video Game Designer. Explore a career as a Computer Programmer/Engineer.
Additional Post Survey Question	Try to solve problems in your community using technology.

The campers were also asked open ended questions in the survey, most notably, "How did your camp experience impact how you feel about yourself and STEM classes?" Six months after the camp, an email survey was sent to the 48 campers asking the same questions as the post camp survey to see whether the camp experience still had an effect on the girls and their perceptions and intentions regarding STEM. 23 of the 48 campers, 48 %, responded to the survey.

2.1 Limitations

It should be noted that the sample size for this study is small and there is significant participant attrition. For future work, we will attempt to get data from all the camps to increase the significance of this work.

3.0   Results

The race/ethnicity of the respondents is given in Table 6.

Table 6. Race and Ethnicity (n=46)

Hispanic or Latina	4.35 %
Black or African American	23.91 %
Asian	4.35 %
Caucasian/White	65.22 %
American Indian or Alaska Native	0.00 %
Native Hawaiian or Other Pacific Islander	4.35 %

The results for the STEM perception questions are given in Table 7. The percentage of girls that answered Strongly Agree or Agree is given for the pre camp survey, the post camp survey, and the survey conducted six months after the conclusion of camp. The number of girls answering each survey is given in the cell at the top of the column. In some cases, some questions were not answered and the number of answers is shown in that particular cell. The percentage of girls answering Strongly Agree or Agree to "I am interested in a career in science" increased 50 % from pre camp to post camp and remained up 42.86 % even six months after camp. The percentage of girls answering Strongly Agree or Agree to "I am confident that I can learn science" did not improve pre to post camp but did improve 4.55 % six months later. This is a small but notable percentage. The percentage of girls answering Strongly Agree or Agree to "I plan to take advanced science classes in high school" increased 5.26 from pre to post camp and 15.79 % from pre camp to six months after camp. The percentage of girls answering Strongly Agree or Agree to "I am confident that I can learn technology" decreased 2.33 % from pre to post camp but increased 6.98 % from pre camp to six months after camp. The percentage of girls answering Strongly Agree or Agree to "I am interested in learning about what engineers do." increased 2.63 % from pre to post camp but decreased 5.26 % from pre camp to six months after camp. The percentage of girls answering Strongly Agree or Agree to "I am confident that I can learn mathematics" did not improve from pre to post camp but did improve 6.98 % from pre camp to six months after camp. The percentage of girls answering Strongly Agree or Agree to "I expect to take calculus in high school." improved 2.94 % from pre to post camp and 31.43 % from pre camp to six months after camp. These results are promising but more work needs to be done to assess their statistical significance.

Table 7. STEM Perception Results (% Strongly Agree or Agree)

	Pre SA or A(n=46)	Post SA or A(n=46)	Six SA or A(n=23)	% Change Pre to Post	% Change Pre to Six
I like science	95.65	97.83	95.65	2.27	0.00
I am interested in a career in science	60.87	91.30	86.96	50.00	42.86
I am confident that I can learn science	95.65	95.65	100.00	0.00	4.55
Women are not welcome in scientific jobs	6.52	4.35	0.00	-33.33	-100.00
My parents encourage me to pursue a career in science	58.70	67.39	91.30	14.81	55.56
My teachers encourage me to pursue a career in science	67.39	60.87	47.83	-9.68	-29.03
I plan to take advanced science classes in high school	82.61	86.96	95.65	5.26	15.79
Scientists help protect the environment.	93.48	95.65	95.65	2.33	2.33
Girls are as good as boys at science.	97.83	97.83	100.00	0.00	2.22
Science can help me to make better choices about various things in my life (e.g., food to eat, cars to buy).	93.48	91.30	95.65	-2.33	2.33
Being nominated to go to Tech Trek camp means a lot to me.	93.48	97.83	100.00	4.65	6.98
I like technology	91.30	91.30	91.30	0.00	0.00
I am interested in a career in technology.	58.70	65.22	43.48	11.11	-25.93
Women are not welcome in technology jobs	4.35	4.35	4.35	0.00	0.00
Girls are as good as boys at technology.	93.48	95.65	100.00	2.33	6.98
My parents encourage me to pursue a career in technology.	50.00	67.39	69.57	34.78	39.13
My teachers pursue me to pursue a career in technology.	39.13	47.83	52.17	22.22	33.33
Knowledge of technology will help me protect the environment.	54.35	73.91	65.22	36.00	20.00
My parents encourage me to learn about and use technology.	78.26	80.43	73.91	2.78	-5.56
I am confident that I can learn technology.	93.48	91.30	100.00	-2.33	6.98
I am interested in learning about what engineers do.	82.61	84.78	78.26	2.63	-5.26
I like mathematics.	73.91	69.57	91.30	-5.88	31.25
Girls are as good as boys in mathematics.	97.83	97.83	100.00	0.00	2.22
I want to develop my mathematical skills.	93.48	97.83	100.00(n=22)	4.65	2.22

High school math courses would be very helpful no matter what I decide to study.	93.48	97.83	100.00	4.65	2.22
I can think of many ways that I use math outside of school.	91.30	93.48	86.96	2.38	-6.98
I am confident that I can learn mathematics.	93.48	93.48	100.00	0.00	6.98
I expect to take calculus in high school.	73.91	76.09	100.00	2.94	31.43

The results for the STEM intention questions are given in Table 8. The percentage of girls answering Strongly Agree or Agree to the statement "I'm thinking of having a career in science or technology" increased 9.76 % from the pre to post camp survey and increased 12.2 % from the pre camp survey to the six months after survey. The effect of Tech Trek on girls intentions to take advanced Science and Math courses did seem to decline six months after the camp as indicated by the fact that 86.96 % of the girls answered Strongly Agree or Agree to "As a result of attending Tech Trek, I will take more advanced Science and Math courses" in the post camp survey but that percentage declined to 78.26 % in the six month survey. The fact that 95.65 % of the girls answered Strongly Agree or Agree to "I will participate more in my STEM classes as a result of attending Tech Trek" in the six month survey as compared to 86.96 % in the post camp survey is another indication of increased self-efficacy in the girls attending Tech Trek.

Table 8. STEM Intention Question Results (% Strongly Agree or Agree)

	Pre(n=46)	Post(n=46)	Six Months(n=23)	% Change Pre to Post	% Change Pre to Six
I plan to take advanced Science and Math courses in high school.	97.83	95.65	100.00	-2.22	2.22
I plan to attend college.	100.00	100.00	100.00	0.00	0.00
I'm thinking of having a career in science or technology.	89.13	97.83	100.00	9.76	12.20
As a result of attending Tech Trek, I will take more advanced Science and Math courses.		86.96	78.26		
I will participate more in my STEM classes as a result of attending Tech Trek.		86.96	95.65		
I plan to major in a science, technology, engineering or math field in college.		91.30	91.30		

The results for the camp outcome questions are given in Table 9. These results show that the impressions of the ability of the camp to provide exposure to real world applications and to build skills in critical thinking, problem solving and creativity faded somewhat after camp. They also show that impressions of the camp to build collaborative skills and learn about STEM fields remained vivid even six months after the camp.

Table 9. Camp Outcome Question Results (% Strongly Agree or Agree)

	Post(n=46)	Six Months (n=23)	
Opportunities to learn about real world applications of STEM.	97.83	91.30	-6.67
Opportunities to build your skills in critical thinking, problem solving and creativity.	97.83	95.65	-2.22
Opportunities to build your skills in collaboration and team work.	100.00	100.00	0.00
Opportunity to learn about STEM fields.	100.00	100.00	0.00

All of the results presented up to this point are responses from girls attending the Tech Trek Alabama camp only. The App Inventor population is somewhat different. A grant from Verizon Wireless was the impetus for the inclusion of App Inventor in camps. Tech Trek Alabama was selected for a pilot along with girls attending Tech Trek Oklahoma at Southwestern Oklahoma State University, and Tech Trek California at Santa Barbara. The girls in Oklahoma were rising 8th graders but the population in California was student counselors entering 10th or 11th grade. The App Inventor class was added in California after plans had already been made for the core classes so the decision was made to go forward with the student counselors (Tech Trek alumnae) rather than the campers themselves. The responses to the App Inventor perception questions "I am comfortable with programming", "I enjoy programming", "I would enjoy a career in computer programming or application development." showed large increases from pre camp to post camp of at least 23.49 % of the girls answering Strongly Agree or Agree. No six month survey was sent about App Inventor since the number of Alabama girls was only 16 and access to the other girls was not available. The responses to the questions "I know what a mobile app" and "I am confident that I can learn app development" showed small increases of 2.38 % and 4.88 %, respectively of the girls answering Strongly Agree or Agree. The only question to which the percentage of the girls answering Strongly Agree or Agree decreased from pre camp to post camp was "Apps can help people live better lives" with a decrease of 4.12 %.

Table 10. App Inventor Perception Question Results (% Strongly Agree or Agree)

	Pre (n=43)	Post SA or A(n=40)	%Change Pre to Post
Women can have successful careers in computer programming.	100.00	100.00	0.00
I know what a mobile app is.	97.67	100.00(n=39)	2.38
I am confident that I can learn app development	95.35	100.00	4.88
Computer apps can solve real world problems in my community.	86.05	82.50	-4.12
I am comfortable with programming.	60.47	90.00	48.85

I enjoy programming.	62.79	92.50	47.31
I would enjoy a career in computer programming or application development.	35.71(n=42)	58.97(n=39)	65.13
Apps can help people live better lives.	58.14	71.79(n=39)	23.49

The results for the App Inventor intention questions are given in Table 11. For these questions, the girls were instructed to mark the answer that best indicated how likely they were to … and the choices were Very Likely, Likely, A Little Likely, Not At All Likely, and Not Sure. The responses to the App Inventor intention questions I am likely to "Take classes in graphic design/art", "Take classes in business", "Enroll in a free app development on-line course", "Look for videos on You Tube about app development", "Explore a career as an App Developer", "Explore a career as a Video Game Designer", "Explore a career as a Computer Programmer/Engineer" showed large increases from pre camp to post camp of at least 26.00 % of the girls answering Very Likely or Likely.

Table 11. App Inventor Intention Question Results (% Very Likely or Likely)

	Pre VL or L or A(n=43)	Post SA or A(n=40)	%Change Pre to Post
Take more advanced Science and Math courses in high school.	95.35	97.50	2.26
Take classes in graphic design/art.	47.62(n=42)	60.00	26.00
Take classes in business.	44.19	62.50	41.45
Enroll in a free app development on-line course.	32.56	60.00	84.29
Look for videos on You Tube about app development.	44.19	67.50	52.76
Explore a career as an App Developer.	27.91	50.00	79.17
Explore a career as a Video Game Designer.	27.91	37.50	34.38
Explore a career as a Computer Programmer/Engineer.	40.00(n=40)	57.50	43.75
Try to solve problems in your community using technology.		76.92(n=39)	

When asked the open ended question "How did your camp experience impact how you feel about yourself and STEM classes", 9 of the 46 respondents (19.6%) in the post camp survey mentioned the word "confident" or confidence". One respondent also used the word "empowered". Intriguingly, 11 of the 23 respondents (47.8%) to the six months later survey used the words "confident" or "confidence" with one respondent using "capable". The effect had grown, not abated.

4.0 Conclusions and Future Work

Bringing girls together in an immersive environment with strong female role models as counselors, teachers, workshop leaders, and professionals, engaging them with hands on projects and exposing them to multiple aspects of STEM can have a profound effect that lasts well beyond the euphoric experience of camp. Anecdotally, the girls responded most positively to the professional women's night. Future work includes a deep, rather than cursory, qualitative analysis of the girls open ended responses. It would also be interesting to continue to keep in touch with the girls on an extended basis to see whether they translate intention into action. When contacted for the survey, the girls were offered the opportunity to volunteer at this year's camp, 13 of the 23 respondents have responded affirmatively. A focus group of these girls could be conducted in conjunction with their volunteer experience. Additional questions could be added to the surveys to identify which particular aspects of camp are most effective.

[1]   Hill, Catherine, "Why so Few? Women in Science, Technology, Engineering, and Mathematics, 2010, http://eric.ed.gov/?id=ED509653 .

[2]   AAUW, Igniting the Spark: Tech Trek STEM Camps for Girl. 2013 Evaluation of Tech Trek, 2013, http://www.aauw.org/files/2014/05/2013-Evaluation-of-Tech-Trek-nsa.pdf.