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Program Evaluation • Consultation • Market Research

Final Evaluation Report: *Technology @ Crossroads*

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INTRODUCTION

The Girls Get Connected Collaborative (GGCC), in partnership with Simmons College, received a three-year award in 2004 from the National Science Foundation's Information Technology Experiences for Students and Teachers (ITEST) division to develop *Technology at the Crossroads*, a youth-based project serving middle school students in Boston, Massachusetts. Girls and students from racial/ethnic groups that are under-represented in STEM (science, technology, engineering, and math) fields were of particular interest to the project.

As with all youth-based ITEST projects, *Technology at the Crossroads* was developed to provide students with a minimum of 120 hours of experience with technology and IT-intensive STEM subject areas. The majority of this time (75 hours) was to be part of a three-week Summer Camp experience, hosted at Simmons College, which provided intensive hands-on learning with both technology and urban ecology science content. The remaining 45 hours were to be completed in an after-school setting, as students completed a year-long community-oriented project that incorporated the technology and science from the Summer Camp.

Goodman Research Group, Inc. (GRG), a research firm specializing in the evaluation of educational programs, materials, and services was contracted by GGCC to conduct both formative and summative evaluation of *Technology at the Crossroads*. GRG submitted an annual report at the end of both the first and second years of this project to describe the formative and early summative results.

The purpose of the current report is to present the results from the final year of the project. These responses are described as responses to the following research questions. What did *Technology at the Crossroads* students experience as part of the program?

- Who are *Technology at the Crossroads* students?
- What feedback did students share about the *Technology at the Crossroads* program?
- What did students learn about urban ecology and science from the *Technology at the Crossroads* program?
- What did students learn about Geographical Information Systems (GIS) from the *Technology at the Crossroads* program?
- What did students learn about Global Positioning Systems (GPS) from the *Technology at the Crossroads* program?
- Were students' attitudes about science and technology changed as a result of *Technology at the Crossroads*?
- What decisions are *Technology at the Crossroads* students making about their futures?

The next section presents a general description of the methods used for the *Technology at the Crossroads* evaluation. Next, we present results from the evaluation, followed by a final section of this report that provides a summary of the program overall, and presents GRG's conclusions and recommendations about the program.

METHODS

The evaluation of the *Technology at the Crossroads* program used a multiple-method design that included a combination of traditional methodologies such as surveys and observations, as well as authentic assessment measures.

The surveys used for the evaluation included a Pre-Program Survey that students completed on the first day of Summer Camp, a Mid-Year Survey that they completed as part of an after school meeting, and an End-of-Year Survey that was completed at the final project meeting. The Pre-Program survey was designed to gather basic demographic information and to document students' science and technology experiences prior to beginning the program (see Appendix A). Both the Mid-Year and End-of-Year Surveys gathered feedback about the program, as well as information on student's perceived proficiency with technology and their educational and career aspirations (see Appendix B and Appendix C, respectively).

To document the work that students completed during the school year, GRG administered an online tracking sheet that groups completed at the end of each meeting. GRG also conducted at least two site visits to each group to observe after school meetings in person.

In addition to these more traditional methodologies, GRG conducted a number of authentic assessments throughout the year to measure student learning and skill development. GRG worked in close collaboration with *Technology at the Crossroads* staff to create a number of performance-based, authentic assessments that were embedded into the Summer Camp. They were designed to provide either individual- or group-level data to demonstrate the science knowledge or technology skills gained as a result of attending Camp.

The majority of the Summer Camp authentic assessments consisted of competitions designed to take advantage of the Camp's organization. Students are divided into six learning groups based on the school they attend. Most of the authentic assessments were designed as competitions between these six groups (referred to as Tree Houses), and the majority were conducted as part of field day events that included both the authentic assessments as well as more traditional events such as a water balloon toss and a three-legged race.

Three authentic assessments were also conducted during the school year. Two of these, a GIS assessment and a reflection piece, were conducted as part of students' after school groups. A final authentic assessment was conducted at Simmons College in the summer of 2008.

The specific authentic assessments used are described throughout the report, as the results are reported. For an assessment-by-assessment description, see Appendix D.

RESULTS

WHAT DID *TECHNOLOGY AT THE CROSSROADS* STUDENTS EXPERIENCE DURING THE PROGRAM?

Student's experiences with the *Technology at the Crossroads* program can be divided into two primary offerings, the Summer Camp and the after school program. The program was originally designed to serve the same group of students throughout the year; however, a sub-set of students participated in only one of these two program components.

Summer Camp 2006

The *Technology at the Crossroads* Summer Camp is a three-week experience in which students work in groups consisting of a teacher, other students from their middle school, and an undergraduate student. Given the urban ecology theme of the Camp, these groups were referred to as Tree Houses, and each group was assigned a particular tree that is commonly found in the Boston area. For the 2006 Summer Camp, the Tree Houses included Dogwood, Hawthorn, Judas, Paw Paw, Pine, and Plum. These names will be used later in the report to discuss the projects completed by specific groups.

The Technology at the Crossroads team worked with an external curriculum developer during the spring of 2006 to revise and formalize the curriculum that was used during the 2005 Summer Camp. The full curriculum was then implemented during the 2006 Summer Camp.

GRG used the *Technology at the Crossroads* curriculum and the Camp schedule to create a profile of the content and experiences that students received as part of the program. Curriculum activities were categorized according to key content areas and the amount of time devoted to each was estimated.

Overall, the Summer Camp focused heavily on urban ecology and science process activities and skills. The program also served as an introduction to GIS and GPS technology, and it included several sessions for students to begin working together to plan their year-long projects.

The *Technology at the Crossroads* Summer Camp included science activities in a number of contexts. Students gathered data in their real world as part of the Greater Boston Tree Inventory (6 hours) and as they gathered water samples to analyze in the science lab. Students spent a minimum of 4.5 hours conducting science lab work, including the creation of a Winogradsky Column with their water samples, extracting orange oil from a peel, and conducting a DNA sampling activity.

Science process skills were also featured in the Summer Camp. Four activities were devoted to helping students develop process skills in the 2006 Summer Camp. Students then put these skills to use as they began working together to plan their year-long projects (minimum of 4.5 hours). The process skills featured were: brainstorming, background research, creating a project plan, data collection, analysis, and project completion.

Students were introduced to GPS by working with paper maps and learning about latitude and longitude. This knowledge served as a basis for then transitioned into an explanation of GPS and how it works. Students completed two GPS learning activities as part of the Summer Camp. In addition, they used those skills during GPS scavenger hunts and geocache activities that took place during the Summer Camp schedule and field trips.

Three sessions at the Summer Camp were designed to introduce students to GIS. Students spent between three and four and half hours in the computer lab learning how to use the different features of GIS.

2006-2007 After-School Program Projects

As stated earlier in this report, by the end of the Summer Camp, each Tree House had selected a community project that they planned to continue throughout the following academic year. Projects were expected to provide students with the opportunity to continue using the skills and knowledge they had learned during the Summer Camp. More specifically, each year-long project was required to include:

- A question/hypothesis that the Tree House wanted to explore,
- Use of GIS in the analysis of their question,
- Use of GPS in some aspect of the project,
- A timeline for data collection,
- An implementation plan for the year that included dates and deliverables,
- Quarterly reports on the project presented in PowerPoint, and
- A community forum.

Finally, each Tree House was required to conduct an interview with a professional who was working in a field related to their project. *The Technology at the Crossroads* team worked with the teacher from each Tree House to make arrangements for each group of students to conduct their interview. Once conducted, each Tree House was expected to summarize what they learned from the interview by creating a PowerPoint presentation.

Each Tree House was also responsible for helping keep track of their group's progress on each of these items by completing an online tracking sheet at the end of each after school meeting (see Appendix E). The tracking sheet recorded attendance at the meeting, the length of each meeting, and a brief description of what happened during the meeting.

Tree Houses worked on their project throughout the year in anticipation of the Mid-Year and End-of-Year events, during which all of the Tree Houses were reunited to watch presentations of each group's project work to date. The *Technology at the Crossroads* staff continued to work with each group throughout the year to help them meet the goals of the project, to provide students with new technology skills, and to help support each project. They also helped remind the Tree Houses to use the tracking sheet.

To provide a description of each after school project, GRG synthesized the data gathered through the tracking sheets and after-school observations. The work conducted by each Tree House is summarized below, with a focus on describing each community project and the time and skills students devoted to completing it.

The Hawthorn Tree House

Hawthorn began participating in the program with four girls who attended the Summer Camp; nine additional girls joined them during the school year to work on their project. This group chose to meet according to a modified schedule so they could complete their entire project by early January 2007. They met regularly for three months, for a total of eight after-school meetings. Between 12 and 13 students attended each meeting, and after school sessions were 120 minutes long, on average.

The Hawthorn girls chose to work on a project that focused on gangs, crime, and graffiti in their neighborhood. They hypothesized that *"eighty-five percent of their environment was affected by Gangs, Crimes, and Graffiti (GCG),"* and they tested this hypothesis by gathering data on GCG in their community. They noted incidences of graffiti, picked up trash, and interviewed a police officer about GCG in their area. They accomplished these tasks using a combination of technology, including PowerPoint, Excel, and GIS.

The Plum Tree House

Plum decided to work on a project that measured air quality in relation to asthma prevalence. Their research question was "*How are asthma rates different from places with more or less trees?*" To answer this question, the girls researched asthma prevalence in their community, as well as how trees affect air quality and the number of asthma cases. They also spoke with a scientist who studies air quality, called the EPA to find out how they could measure air quality for the purposes of their data collection, wrote to staff at Boston Public Works, and emailed a nurse about asthma.

This group met on a regular basis throughout the school year (at least 22 times). Meetings lasted an average of 85 minutes, and between three and seven girls attended each (average attendance = five girls).

Plum used different types of technology throughout the school year. They entered data into Excel and used GIS software at least three times to plot and analyze their data. Additionally, they worked on PowerPoint presentations during a minimum of six meetings. They also used skills from the Summer Camp such as measuring and inventorying trees to collect their data.

The Dogwood/Paw Paw Tree House

During the school year, two Tree Houses were combined to form one after-school group. This decision was based on two factors: one of the two teachers was transferred to another school and could no longer work with his group on a regular basis, and both groups experienced a drop in student attendance making it unnecessary to have two teachers. The fact that these two Tree Houses were from the same school also made it easy to form one after-school team.

The Dogwood/Paw Paw Tree House conducted a project to learn how different cars affected their neighborhood. Their hypothesis was that "adding trees to an urban environment will increase oxygen and the quality of life and decrease daily pollution." Students tried to answer this question by collecting data on the trees in their community and the emission rates around their school. They also tested solar panel and hydrogen cell cars, and researched how using these types of cars would significantly decrease carbon emissions in their community.

Dogwood and Paw Paw used a range of technologies to complete their school year project including PowerPoint, Microsoft Excel, digital cameras, and GIS. Additionally, they used skills from the Summer Camp to inventory trees.

There were four students who attended Dogwood/Paw Paw's meetings throughout the school year; however the number of students who attended meetings ranged from one to four, with an average of two students attending each meeting. The average length of the meetings was 123 minutes and this group met at least 12 times during the school year.

The Judas Tree House

The Judas Tree House decided to collect data to answer the broad question, "*How do trees affect the community?*" Their yearlong plan was to collect data on three communities around their school, and infer the health of the community by studying the health of each neighborhood's trees. Judas gathered tree data, entered it into Excel, and created maps in GIS to plot tree locations. They then used these data to make conclusions about their research question.

Judas reported using Excel and PowerPoint during the school year. They also used GIS in their projects as well as PDAs to gather data on trees. Students from the Judas Tree House met at least 13 times during the school year. On average, three students attended each of Judas' 90 minute after-school meetings, with the range of students in attendance being two to four.

The Pine Tree House

The Pine Tree House completed a community project designed to determine which of three Boston neighborhoods was most polluted. This group collected data on trees in each area, and then used those data to determine the health of the trees as a way to measure pollution.

Pine used different forms of technology throughout their project. For example, GPS was used to navigate around each neighborhood to collect data, Microsoft Excel was used to analyze data, GIS was used to display data in a map format, and they used Microsoft PowerPoint to create presentations. On average, three students attended Pine's after-school meetings on a regular basis. Meetings were 85 minutes in length, on average, and this Tree House met on at least 11 occasions during the school year.

WHO ARE *TECHNOLOGY AT THE CROSSROADS* STUDENTS?

Two groups of students participated in the *Technology at the Crossroads* Summer Camp in 2006. The larger of these two groups included students who were participating in the Summer Camp for the first time (N=36). The second group consisted of students who had participated in the 2005 Summer Camp and who returned in 2006 to serve as peer leaders/Ambassadors (N=15).

The simplest way to answer the question "Who participated?" is through the demographic profile presented in Table 1. As shown, far more females (83%) than males participated in the program. Students included rising 6^{th} graders through rising 8^{th} graders, with half (50%) entering grade 7. About half the students (51%) identified themselves as Hispanic or Latino and 53% identified as African American. This profile provides compelling evidence that *Technology at the Crossroads* was successful at serving its target audience of female and under-represented minority middle school students.

Table 1
Demographic Profile of Students Who Attended Summer Camp

		% Students	% Ambassadors
Gender	Female	83%	71%
	Male	17%	29%
Grade	6^{th}	8%	0%
	7^{th}	50%	0%
	8^{th}	42%	33%
	9th	0%	64%
Race/Ethnicity	African American	53%	13%
	American Indian	15%	0%
	Asian	--	7%
	Hispanic	51%	60%
	Native Hawaiian	3%	0%
	White	12%	0%

Number of Students ranged from 34-36 across questions.
Number of Ambassadors ranged from 14-15 across questions.

Perhaps a more interesting way to describe *Technology at the Crossroads* students is by examining at their past experiences prior to attending the Camp. These data provide an indication of prior interest in the topics featured in the Camp and may also demonstrate the need for future programs such as *Technology at the Crossroads*.
Technology at the Crossroads students, for example, had quite a bit of experience using computers before attending the Summer Camp, but they had little experience with the specific technologies featured in the program.

- Students reported using a computer at school between four and five days per week, on average. Similarly, almost all students reported that they had played computer games (97%), surfed the Internet (94%), and used email (94%) in the past.

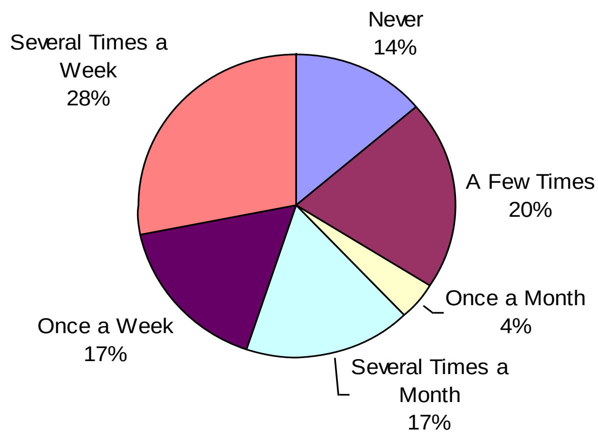
- Technology featured in *Technology at the Crossroads* was used much less frequently, if at all. For example, 44% had used a Personal Digital Assistant (PDA), 18% had used GPS, and none had used GIS software prior to attending the Summer Camp.

Because the curriculum focused on using maps and mapping software, students were also asked questions about their past experiences with these technologies. Approximately half of the students brought relevant prior experiences to the program.

- Just under half of the students (47%) had used a map to navigate around their hometown of Boston, MA, and a similar percentage (46%) had also used a map to navigate around another city.
- 58% of the students had used mapping Web sites such as mapquest.com or Google Maps prior to coming to Summer Camp.

Students also arrived at the Summer Camp with a range of science-related experiences. As seen in Figure 1, around half of the students had participated in science labs on a fairly frequent, regular basis during the past school year, and thus had much experience with science process and lab skills. A slightly smaller portion, however, were on the opposite end of the spectrum and had the opportunity to experience science labs only a few times during the year, if at all.

Figure 1
Students' Reports of How Often They Completed Science Labs During the School Year



Similarly, some students (47%) had had the opportunity to study science outside of the classroom in the past school year by going on a science-related field trip, while others had not. Of those who reported going on a science field trip, over half went to a science museum, and three reported going on a science-related trip outdoors to a park or a farm. Five students did not report their science field trip destination.

As with the technology data presented above, students reported that their past science experiences were not related to those featured in the *Technology at the Crossroads* program.

- Only 11% reported that they had previously done at least one of the three primary science labs featured in the program.
- Students also reported that they were unfamiliar with the urban ecology content featured in the GBTI; when presented with a list of five trees and asked if they could identify them, students predicted that they could identify between zero and one of the five, on average (mean score = .4).

WHAT FEEDBACK DID STUDENTS SHARE ABOUT THE *TECHNOLOGY AT THE CROSSROADS* PROGRAM?

Throughout the project, GRG gathered student feedback on *Technology at the Crossroads*. For example, the Mid-Year Survey asked students to describe the Summer Camp and then provide feedback on specific Camp experiences. Toward the end of the school year, students were asked to reflect on these experiences again.

The Summer Camp's focus on science content and students' positive perceptions of the program were evident in their descriptions of the Camp. Of the 16 responses, nine focused on science experiences. Three focused on their technology experiences and two provided general statements about learning. Nine students provided positive feedback about the Summer Camp and one provided negative feedback, saying the program was *"boring."* Positive responses included:

> *"A program for girls to connect with technology, science, and nature."*
>
> *"T@C is a camp where you learn about trees and things* [in] *your neighborhood like air and other things. And you get to measure trees and have fun learning too."*
>
> *"It is a good way to learn about new technology while you are spending time and having fun with your friends."*
>
> *"It was fun, but not only fun but also educational. We have a lot of fun activities also."*

Students' choices on an end of year reflection exercise also indicated the wide appeal of the science and technology featured in the Summer Camp. When asked to write their favorite thing about the Camp, four students named technology, with three focusing on the GPS scavenger hunt and one focusing on general computer use.[1] One student named the science labs as her favorite part of the Camp, and two others focused on what they learned about the environment and/or trees. Students wrote:

> *"This is a picture of the* [GPS] *Scavenger hunt that we did. We put in coordinates in the* [GPS] *and we followed it to find the box. This is my*

[1] Two of the three students who chose the GPS scavenger hunt as the favorite thing incorrectly identified this activity by saying it involved the use of GIS instead of GPS.

favorite thing from Summer Camp because we had lots of fun looking for the box and then going to the beach afterwards."

"The reason why I pick[ed] *this picture is because* [it] *was fun using the computer.*

"This picture shows that we didn't only use tree materials we also used technology to help."

"The picture I pick[ed] *was a science lab experiment…it shows us grinding bananas and sand to extract an alcohol substance."*

"This is a picture of trash in the pond that people throw and don't take care of the[ir] *community around them. It shows that it is my favorite thing at camp because I learned so much about not doing a mess because it can cause real damages to the world."*

"This picture shows the type of animals that live in the trees that we can help save."

The environment and trees were also key features included in students' descriptions of their year-long projects. Ten of the 16 students who described their project as part of the Mid-Year Survey indicated the interaction between the environment and people or the community as part of their response. Responses included:

"We are trying to find out about how the number of trees affect the air quality. Then we want to see how the air quality affects the asthma rates."

"My project that I was working on was how do different cars affect the quality of air that we live in."

"We are working on how the environment [affects] *the community and how the community* [affects] *the environment."*

The End-of-Year Survey challenged students to think specifically about the science and/or technology featured in their project and then report what they had learned. Of the 12 students who answered this question:

- Half (n=6) mentioned something related to science or the environment, with some focused on the tree content featured in the program and others focused on topics such as "*environmental racism*" that were related to their year-long projects.
- Four students focused on technology in their responses. Two mentioned GPS and a third said "[mapping] *coordinates*;" the final student mentioned "*AEJEE,*" the GIS program.

Each group's yearlong project also provided a unique opportunity for students to learn how to work as a team. At the end of the year, students were asked to reflect on their experiences by sharing the most important thing they learned about teamwork and what they would do differently if they were doing the project again.

- Nine of the 12 students who responded to this question mentioned learning how to cooperate with others as the most important thing they learned about working with a team. Responses focused on sharing, listening to others, and trying to come to an agreement as a group.
- When asked what they would do differently, 7 of 12 students said they would devote more resources to their project by "*working harder and faster*," attending the after school group more often, and being more "*focused*."

Finally, students were also asked to report their favorite thing about working on their team projects. Several (n=5) enjoyed having the chance "*to go outside and do activities.*" Three students mentioned technology as their favorite thing about the program, including "*using iMovie*," doing "*a lot of things on the computer*," and "*recording audio and videos on the laptop*." Two said the favorite thing about their project was using "*dry ice*."

WHAT DID STUDENTS LEARN ABOUT URBAN ECOLOGY AND SCIENCE FROM THE *TECHNOLOGY AT THE CROSSROADS* PROGRAM?

To answer this question, GRG gathered both short-term and longer-term data from students. Short-term data were gathered throughout the Summer Camp using a number of authentic assessments. Longer-term perception data were also gathered from students.

During the first week of Summer Camp, students began learning about the 25 trees included in the Greater Boston Tree Inventory (GBTI) project. Because they were expected to be able to identify and inventory trees and their characteristics during the coming weeks as part of the GBTI, Tree Houses worked together to learn in detail about each of these trees.

To gauge their short-term learning of this material, GRG conducted an authentic assessment called Name that Tree at the end of the first week of Camp. To play, students worked with their Tree House to correctly identify five trees that had been tagged in a one-acre area. Data were collected on whether each Tree House could correctly identify the five trees and the amount of time it took to do so. Results indicated that *Technology at the Crossroads* was quite effective at teaching students to identify trees in a short amount of time.

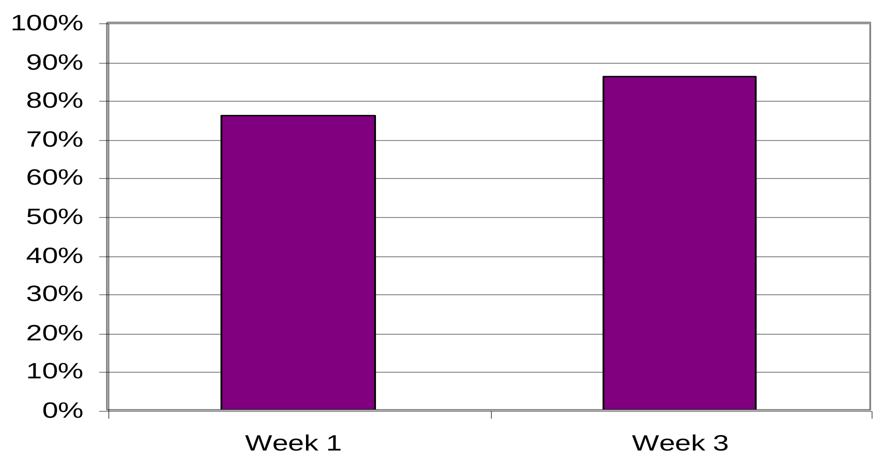
- All six teams identified the five trees correctly; two teams got all five trees right on their first attempt, three took two tries to identify all five, and one team got all five correct on their third attempt.
- All teams completed this game in a relatively short period of time. One group finished in just over one minute and the group that took the longest amount of time finished in less than eight minutes.

In addition to learning about the trees themselves, students also learned how to record the identifying characteristics of trees using the ArcPad GIS program on a PDA. Successful completion of this task required a number of skills. Students had to know how to take 14 different measurements of a tree and they had to understand how to use both the ArcPad program and the PDA.

On two occasions during the Summer Camp GRG measured the accuracy and speed with which students could inventory a tree – once at the end of the first week and then again during the third week, after students had completed their work on the GBTI project. The results from these two assessments demonstrate students' increased competency with this technology across the Summer Camp.

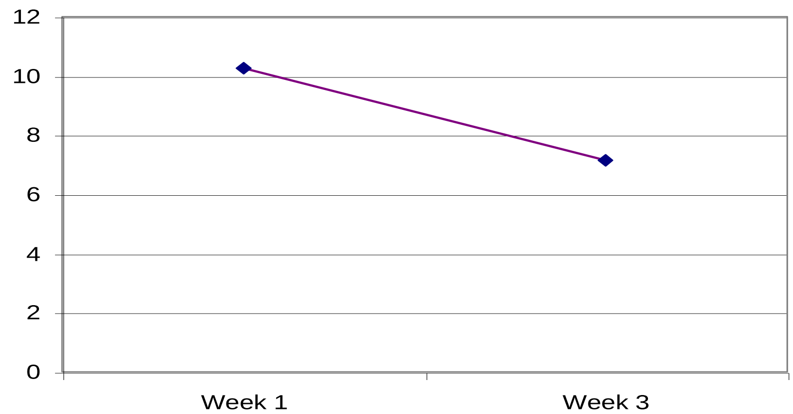
As seen in Figure 2, the results demonstrate that students were already proficient in using the technology to record GBTI data by the end of the first week of Camp, with 76% of the data recorded proving accurate. Results from the third week of Camp showed that students' skills continued to progress across the Summer Camp, with accuracy ratings increasing to 86%, a statistically significant increase ($p<.01$).

Figure 2
Students' Accuracy in Recording Tree Inventory Data



The time it took students to record these data also demonstrated their progress. Figure 3 shows that students needed just over ten minutes to inventory a tree inventory at the end of the first week of Summer Camp. By the end of Summer Camp, the time it took to record these data had decreased to seven minutes, on average, which was a statistically significant difference ($p<.05$).

Figure 3
Number of Minutes Needed to Complete Tree Inventory



These data, in combination with those regarding a degree of learning and accuracy provide a compelling picture of students' increased proficiency across the Summer Camp. Students were able to record data more accurately and in less time as the Camp progressed.

GRG also measured students' knowledge of trees and their characteristics. Throughout the Summer Camp, students used a PowerPoint presentation created by *Technology at the Crossroads* staff to learn about the 25 trees included in the GBTI. Each PowerPoint slide featured a picture of a tree (that showed the tree's height and crown shape), as well as close-up shots of specific tree features such as the branch, fruit, or bark.

In the second week of the Summer Camp, GRG used a modified version of the PowerPoint presentation to assess students' knowledge of the trees. Using a projection system, GRG played the presentation as a slideshow, allowing students one minute to look at and identify each tree. Students wrote their answers on a handout and noted the specific feature used to identify the tree (crown, bark, fruit, etc.). At the end of the second week of Camp, students correctly identified 19 trees (75% of the total 25), on average, with a range of 0 – 25 trees identified.

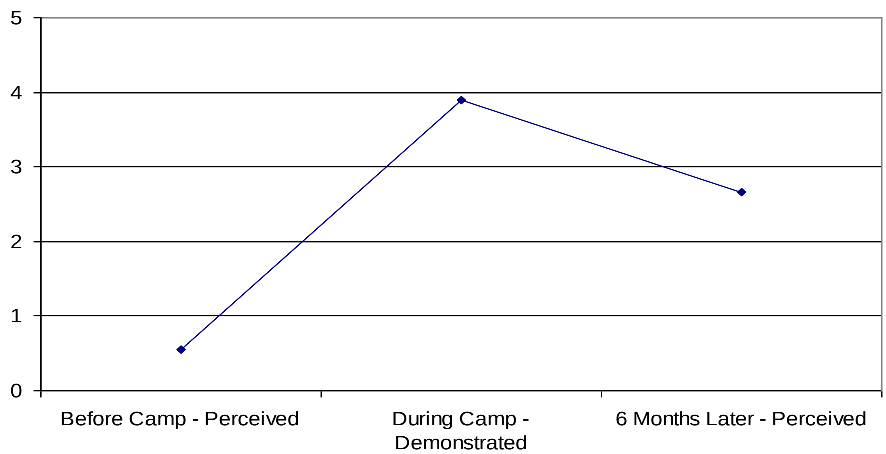
Students used between zero and seven characteristics to help distinguish between and correctly identify the 25 trees. More specifically:

- 94% of students correctly identified at least one of the 25 trees based on its leaf,
- 74% used both the bark and the tree's fruit to successfully identify a tree,
- 62% used the flower to recognize a tree,
- 21% used the tree's crown shape or height, and the same percentage used metaphors to help distinguish trees (e.g., it looks like a heart).
- 13% identified a tree based on personal experiences with that type of tree.

GRG also used these data to make comparisons between student's perceived ability to identify trees before and six months after the Summer Camp. Recall that students provided their perceptions of whether they could identify five particular trees on both the Pre- and Mid-Year Surveys.

Nine students had complete data for all three of these time points; Figure 4 shows the pattern of data for these students across time. Knowledge of trees increased sharply between students' perceived knowledge before the Summer Camp and their demonstrated knowledge through the PowerPoint assessment. Students' perceptions of their abilities remained fairly high, even six months after Camp.

Figure 4
Students' Perceived and Demonstrated Knowledge of Trees, Across Time



While we do not have data to demonstrate the extent to which these perceptions are accurate, the majority of students (11 of 16) did report that they had continued to identify trees in the Boston area after the Camp ended. In late Winter 2007, students were asked to indicate the last time they remembered walking around Boston and identifying a tree that they had learned about in Camp.

- Five students admitted that they had not identified a tree since the Summer.
- Four had identified a tree four to five months prior, but not since.
- Two had identified within the past two or three months, and
- Five had identified a tree within the last month.

What did students learn about the importance of trees to the city?

As part of a reflection activity conducted toward the end of the school year, students were asked to explain what they had learned about the importance of trees to their city. Nine students responded to this question, and most focused on the topic they were investigating as part of their year-long project. For example, several of the students who worked on the asthma project focused on air quality in their responses. Similarly, students who conducted their project on the association between the health of trees and their surrounding community focused on this interaction in their responses. The girls wrote:

"Technology at the Crossroads helped me understand the idea that trees are very important to us because they give us oxygen and a very nice environment to live. Trees keep us healthy since they keep up the good air quality in your area and they give you oxygen. We learned how to appreciate this in the summer camp."

"The summer program has helped me realize why trees are important because without trees we can't breathe good air and trees also make our communities look beautiful and pretty. Also the summer program taught us how to help save trees in Boston and to keep them healthy."

"Technology at the Crossroads showed me a understanding of trees because I didn't really care about the trees around us, except the fact that it made shade but now I know that it's one big thing that keeps us alive. If we didn't have them it would be difficult to breathe… there would be more CO2."

"It gives us shade and they could die without the right protection from us. We can also help from watering them."

"This has showed me the meaning of how important trees are because before I never knew what trees do for you and how it helps everyone. So now I think that [I'll] *be more careful of where I through my trash or harm nature."*

"This program showed me many things about the environment and trees. The program basically taught me that people are cutting down the trees and putting artificial trees there. People do not notice how this [affects] *us and our breathing habits but it* [affects] *us in a major way. This program also taught me that there are many different trees and many different diameter's and wide span's and conditions."*

"The oxygen helps us breathe and it also helps people with asthma. This is related to tress because they support us with there bark."

*"That there is so much things about trees that not a lot of people know about that help make oxygen and that we **need** to stop polluting our community because it's stopping the trees from making a lot of oxygen."*

"It helped me understand that it is absolutely a wrong thing to throw things on the floor and use a lot of gases like to smoke or have a car, its not a bad thing but sometimes it can effect you and it will effect trees which will harm you and give you asthma because trees take in Carbon dioxide so it can help us."

WHAT DID STUDENTS LEARN ABOUT GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FROM THE *TECHNOLOGY AT THE CROSSROADS* PROGRAM?

GRG gathered data from students throughout the Summer Camp and school year to measure their understanding of maps and GIS software. Two authentic assessments were used during the Summer Camp, including a team-based map game and a GIS scavenger hunt.

In the first week of the Summer Camp, an assessment was conducted to measure the extent to which students were learning about maps and map features. Students were challenged to work as a team to find specific locations on a number of maps by using particular map features. Student teams were given clues that required them to identify the appropriate map to use, and then use legend symbols (e.g. time zone, mileage, ruins, and population density), country capitals, latitude and longitude, regions, topography, and/or land features to find the correct location.

Ten questions were included on this assessment, and the number of questions answered correctly ranged from seven to ten across Tree Houses.[2] Each team correctly answered questions that required them to identify the population density of an area, locate a capital, use latitude and longitude, and identify a topographical map.

During the second week of Camp, students built on these skills by beginning to work with Geographical Information Systems (GIS) software on the computer. A second authentic assessment, a GIS scavenger hunt, was developed by the project team as a measure of students' ability to follow directions in order to use the Open Spaces and layer functions in GIS.

To complete this task, students used clues to search through a GIS map as they answered a series of six questions. The answers to the questions were then used to solve a puzzle. GRG scored the six questions as correct or incorrect, and these results were used as a measure of short-term GIS learning. Overall, the results indicated that the program was effective at teaching students how to use these GIS functions; students got five of the six questions correct, on average.

In Spring 2007, a second scavenger hunt was conducted. As with the first scavenger hunt, students were challenged to use the layer functions in GIS. The difference with this new assessment was that students were not always given clues about which functions to use; that is, they had to recognize the need to use particular GIS functions (e.g., layers, Attribute Tables, Query Builder) on their own.

This assessment proved a challenge for students. Though it was developed as a half-hour task, six out of fourteen students were unable to complete the activity

[2] One team got all ten questions correct. Of the remaining teams, two got nine questions correct, two got eight correct, and one answered seven of the ten questions correctly.

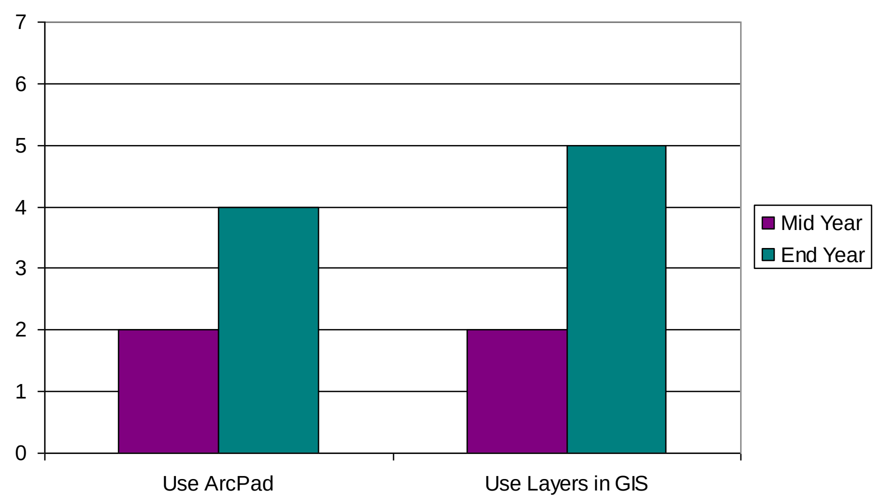
in less than an hour. The results from those who did complete the task were mixed.

- Eleven of the 14 students were able to use the layer function of GIS without prompting to correctly answer a question.
- Eleven of 14 could use either the Attribute Table or Query Builder function to answer a general question, but none of the students were able to use these functions to answer a more nuanced question that required a deeper understanding of these functions.
- Most students (9 of 14) understood that the Attribute Table and Query Builder are different functions in GIS that can be used to answer the same question.
- Most students (9 of 10) understood that GIS allows you to continue adding new data to a GIS map, but only one of nine knew the first step that you need to take to begin this process.

While the data presented above provide a mixed picture of students' GIS skills, their perceptions of their skills in GIS did increase across the program. Students reported whether they had used GIS before the Camp and then, six and twelve months after Camp, they rated their proficiency with using ArcPad GIS as well as the layer function in AEJEE, the desktop version of GIS used by the *Technology at the Crossroads* program. Students were considered proficient if they believed they could teach a friend to perform these skills.

Seven students provided data across these three time points. As mentioned previously, none of the students had used GIS prior to *Technology at the Crossroads*. Six months after Camp, two students considered themselves proficient with ArcPad and GIS layers. By the end of the year, the number of students who considered themselves proficient in these areas had doubled (see Figure 5).

Figure 5
Students Perceived Proficiency with GIS Six Months and One Year After Camp



WHAT DID STUDENTS LEARN ABOUT GLOBAL POSITIONING SYSTEMS (GPS) FROM THE *TECHNOLOGY AT THE CROSSROADS* PROGRAM?

To test students' ability to use a GPS unit to navigate an urban area, GRG created a race in which students worked with their team to complete a GPS-based scavenger hunt (referred to as a multicache) as quickly as possible. The multicache consisted of three sets of coordinates. To begin the game, a Teaching Team member shared the first set of coordinates with the team. Students programmed the first set of coordinates and followed their GPS to the first cache. The first cache contained coordinates for the second cache and the second cache contained coordinates for the finish line.

This game was a race in which up to three teams completed their own multicache course at the same time. Each team was timed as they completed the course so that all six teams could compete against each other. The objective of this game was to demonstrate that teams could use a GPS unit to navigate an urban area.

Prior to camp, 18% of students had used GPS technology. At the end of the first week, all students had spent some time using a GPS unit, and each team was able to work together to navigate the multicache successfully. More specifically, each of the six teams correctly entered the coordinates into their GPS unit and, working together, the teams took between 10 and 20 minutes to complete the entire multicache course.

Individual data were also collected on students' GPS skills as part of the Summer Camp. During the final week of Camp, individual students were challenged to create their own geocache by hiding a plastic jellybean in a local park and marking the coordinates of their cache. A teammate was then given the task of using those coordinates to find their peer's geocache. A researcher followed the students and asked questions to learn how students were using the GPS unit and their understanding of how GPS actually works. This assessment yielded an individual-level skill score and knowledge score for each student.

- Just under two-thirds of the students (64%) were able to mark the location of their geocache and use GPS to find a geocache.
- Almost all students (96%) were able to provide a basic explanation of GPS; definitions included between two and four unique statements about the technology and its capabilities.
- The majority were able to provide a full explanation of the steps you take to use GPS.[3] Students listed five steps, on average, and 74% of the students were able to provide a full explanation of the steps needed to use GPS.
- A smaller percentage of students (42%) could identify ways that GPS is used in the real world (other than those done in Camp). Uses identified include "to get directions" or "*to help find someone who is lost.*" Students also believed GPS is used by "*planes*," "*ships*," and "*travelers.*"

[3] Students' descriptions were considered to be full explanations if they included steps to encompass the full experience of using GPS, from turning it on and programming a waypoint, to finding a coordinate's physical location.

At the end of the project year, a similar geocache activity was conducted with students to learn the extent to which they had retained their GPS knowledge and skills. Students were asked to write instructions for a friend who was trying to use GPS for the first time. They also created and located a geocache.

The results from these assessments were mixed. Nine students completed the assessment. Five of the nine were able to use a GPS unit effectively.

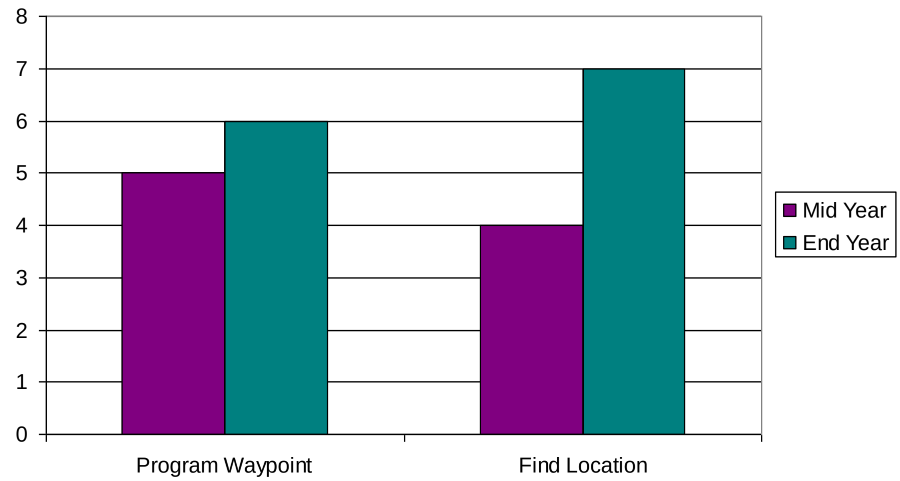
- Five out of the nine students were able to both program a waypoint correctly and use a coordinate to find a geocache during the end of year assessment.
- One student was able to program a waypoint but she was not able to find her peer's geocache; it is unclear whether this was due to an error on her part or whether the geocache was hidden too well for anyone to find.
- Three students could not perform either of these skills in GPS.

A comparison of students' written GPS instructions from the end of the program and their verbal instructions provided during the Summer Camp indicated that students were less fluent at explaining the technology at the end of the program. Students provided a short list of written instructions at the end of the Summer Camp. Five students included fewer steps in their end-of-year instructions compared to those given at the Summer Camp. Two students provided more instructions at the end of the program, and two provided the same number of instructions in both assessments.

In addition to the data collected through these authentic assessments, survey data were gathered to ascertain students' perceived proficiency with GPS. Students reported whether they had used GPS before the Camp and then, six and twelve months after Camp, they rated their proficiency with programming a waypoint and finding a location using the technology. Students were considered proficient if they believed they could teach a friend to use GPS.

Eight students provided data across these three time points. As shown in Figure 6, one had experience with GPS prior to attending Camp, and the number of students who considered themselves proficient increased across time for both GPS skills measured. Increases were greater for students' perceptions of their ability to find a location compared to the increases associated with programming a waypoint.

Figure 6
Students Use of GPS Before Camp and Perceived Proficiency Across Time



WERE STUDENTS' ATTITUDES ABOUT SCIENCE AND TECHNOLOGY CHANGED AS A RESULT OF *TECHNOLOGY AT THE CROSSROADS*?

To answer this question, GRG conducted a pre-post analysis of two sets of questions. The first set, which measure science attitudes, were taken from the National Assessment of Educational Progress (NAEP). These items were then modeled to create a similar set of questions about technology.

Table 2 shows students' ratings of each science attitude statement before beginning the *Technology at the Crossroads* program. These results indicate that students had positive attitudes about science prior to attending Camp, and thus indicate that the program serves students who are already inclined toward science.

Table 2
Students' Attitudes about Science Prior to *Technology at the Crossroads*

	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
I like science. mean=4.09	0%	0%	20%	51%	29%
I enjoy learning science. mean=4.14	0%	0%	14%	57%	29%
Science is boring. mean=2.03	24%	50%	27%	0%	0%
I am good in science. mean=3.74	3%	6%	23%	51%	17%

Number of respondents ranged from 34-35 across questions.

Students also had quite positive attitudes toward technology prior to *Technology at the Crossroads* (See Table 3). It is interesting to note that while students' opinions of technology were positive, their perceptions of their own abilities at using technology were rated lower. This trend was also found for the science items rated above.

Table 3
Students' Attitudes about Technology Prior to *Technology at the Crossroads*

	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
I like learning about technology. mean=4.51	0%	0%	3%	43%	54%
I like using new technology. mean=4.46	0%	0%	6%	43%	51%
I am good at using technology. mean=3.88	0%	3%	27%	50%	21%
Learning about technology is boring. mean=1.80	49%	27%	23%	3%	0%

Number of respondents ranged from 34-35 across questions.

Of the students who completed the Pre-Program Survey, ten also provided ratings of their science and technology attitudes on the Mid-Year Survey six months into the program. While this sample size is not large enough for GRG to a conduct statistical analysis to determine whether the program affected students' attitudes, the mean ratings are presented in Table 4 for descriptive purposes.[4]

Overall, attitudes about science were slightly lower at the mid-point in the program, while attitudes about technology were slightly higher. Interestingly, the greatest gains in each area were associated with student's perceptions of their own abilities, which were the areas that received the lowest ratings before the program. By the end of the program, these items were rated as highly as or higher than the other positive items assessed.

Table 4
Students' Science Attitudes Before and During *Technology at the Crossroads*

		Before the Program	Six Months into the Program
Science Attitudes	I like science.	3.90	3.50
	I enjoy learning science.	4.00	3.40
	Science is boring.	2.10	3.00
	I am good in science.	3.60	3.70
Technology Attitudes	I like learning about technology.	4.50	4.30
	I like using new technology.	4.30	4.50
	I am good at using technology.	3.60	4.20
	Learning about technology is boring.	2.00	1.60

N=10

[4] Note that the means presented in Table 4 are not the same as those presented in Table 2 and Table 3. The means presented in Table 4 are only for the sub-set of students (N=10) who completed both the Pre-Program and the Mid-Year Surveys.

WHAT DECISIONS ARE *TECHNOLOGY AT THE CROSSROADS* STUDENTS MAKING ABOUT THEIR FUTURES?

Of the 16 students who completed the End-of-Year Survey, four entered 7th grade in the 2007-2008 academic year, 10 entered 8th grade, and one started high school. In the Boston Public School (BPS) system, students have the opportunity to choose the high school they would like to attend, including those that focus on college preparation and/or schools with a specialty focus such as technology, arts, or science and math.

GRG asked students to share the factors they will consider when choosing a high school. First, students were asked to select the most important factor they will consider, from a list of 11 options. Students indicated safety and academics as their top concerns (see Table 5). Three students chose to write in an answer instead of using one of the 11 options provided; these students planned to attend the school that their siblings attended or reported that schools that offer assistance in paying for college were primary factors for consideration.

Table 5
Reasons Students Chose Their High School

	Most Important Factor	Other Factors Considered
Considered safe	5	8
Strong academics overall but not a specialty school	3	5
Strong sports program	2	5
Close to my home	2	3
Where my friends go	1	7
A language/international specialty school	0	5
An arts specialty school	0	4
A college-prep school but not a specialty school	0	3
A math/science specialty school	0	3
A technology specialty school	0	3
An ACC program	0	0

N=16

After choosing the factor that was most important, students were asked to select all the factors that they will consider when choosing a high school. Students chose two additional factors, on average, with a range of zero to eight factors selected. As shown in Table 5, the largest group of students indicated that school safety is an important factor. The academic and athletic programs at schools were also important factors for several students.

- Three students indicated that they will look for a school that specializes in math/science.
- Three students, including two of those who reported an interest in math/science specialty schools, reported that they will consider schools with a technology focus.

In addition to reporting their plans for high school, students were also asked to name the job they want to have when they are 30 years old. Five of the 14 students who answered the End-of-Year Survey indicated that they would like to have a STEM-related job when they grow up. All of these students wanted to be a doctor or a veterinarian.

A total of eight students reported their desired career on both the Pre-Program and End-of-Year Surveys. Overall, these students were quite consistent in their career choices. Five students reported an interest in a STEM-related job at both time points. One student changed her mind from a non-STEM job on the Pre-Program Survey to "*doctor*" on the End-of-Year Survey. A second student changed her mind in the opposite direction, reporting first that she wanted to be a *"doctor"* then later a *"lawyer"*.

Regardless of the job selected, students reported an interest in using technology featured in *Technology at the Crossroads* as part of their work. Nine of the 14 students who answered these questions reported that they might be interested in using at least one of these technologies in their future job pursuits. In particular,

- 8 students said they might like to use map-based Web sites in a future job,
- 5 said they might like to use GPS, and
- 3 said they might like to use GIS software.

SUMMARY OF PROJECT OVERALL

Looking back over the evaluation reports generated during the three years of the *Technology at the Crossroads* project, a consistent picture of the program emerges. Many of the program's successes have been achieved consistently throughout the project. For example, throughout its history, *Technology at the Crossroads* has served its intended audience by providing new and effective science and technology learning experiences.

Each year, many students have indicated that, prior to *Technology at the Crossroads,* they have not had the opportunity to participate in science labs and/or science field trips on a regular basis, and few have reported studying urban ecology prior to beginning the program. Similarly, the GIS and GPS technology featured in the program were new to almost all participants each year.

Importantly, the program has not only introduced students to these new content areas, it has been effective at teaching them new science knowledge and technology skills. Each year students learned the distinguishing characteristics of 25 trees featured in the program. Their performance on authentic assessment also indicated that the Summer Camp was effective at providing them with data collection skills, and the use of GIS and GPS technology.

The feedback gathered from students each year has also been an indicator of success. They have provided positive comments about both the social and educational aspects of the program. The fact that several students have continued with the program year after year also demonstrates their positive regard for *Technology at the Crossroads.*

Past reports and presentations for *Technology at the Crossroads* also provide evidence of the strong collaborative relationship between the project and evaluation teams. The project team, for example, has been responsive to evaluation results and recommendations throughout the three-year project, often using results to make decisions about the continued development of the project. Similarly, the evaluation plan and methods were revised over time in response to feedback from the project team. The collaborative approach used to develop authentic assessments for this project, in particular, has benefited both the project and the evaluation, resulting in a contribution to the ITEST community in particular and the field of evaluation in general.

Though the reach of the *Technology at the Crossroads* program has been modest to date, we believe the strengths of the program, the evaluation, and the collaborative relationship between the project and evaluation teams provide a strong case for scaling up the program. The conclusions and recommendations below are written with this scale-up in mind.

CONCLUSIONS AND RECOMMENDATIONS

The current evaluation report includes findings from the 2006-2007 implementation of the *Technology at the Crossroads* program. Given these findings and the overall profile of data gathered throughout the three-year project, we make the following conclusions and recommendations for continuing and scaling up the *Technology at the Crossroads* program.

First, the results from this program indicate that *Technology at the Crossroads* was successful at serving girls and other under-represented minority students in the 2006-2007 project year. This profile of students was consistent for both the group of students who continued with the program, as well as those who were new. **Based on this success, GRG recommends that *Technology at the Crossroads* continue using similar networks to recruit students to participate in future programming.** If possible, we also recommend adding new schools and programs to the network in an effort to increase the number of program participants.

Related to recruitment is the retention of students once they have started the program. *Technology at the Crossroads* has experienced both successes and challenges in this area. An indicator of success for this project is the number of students who have remained part of the program from year to year; fifteen students have participated in the program for two years, and 11 have participated in all three years of the project. On the other hand, only a portion of the students were retained from the Summer Camp into the academic year. **GRG recommends that *Technology at the Crossroads* continue to use the overall two-component model for the program. Further, we recommend that staff pursue ways to increase the retention of students from the Summer Camp to the after school program.** Continuing to maintain contact with students and their parents between these program components and/or having students continue work on their yearlong projects by continuing to work with their Tree House throughout the remainder of the summer might be ways to increase retention. Because there are many demands on students' time after school, changing the after school component to a Saturday-based offering might be another possibility for retaining a greater number of students throughout the school year.

The results from this evaluation indicate that students who do participate in the program tend to be predisposed to science and technology. Even still, the evaluation results also demonstrate that *Technology at the Crossroads* has been successful at offering students new science and technology experiences. Completing science lab work, attending science field trips, and the use of specific technology were program features that were new to many students.

Importantly, the program has demonstrated its capacity to teach students in each of these content areas. Students from the Summer Camp showed positive short-term gains in the following areas: understanding and ability to apply urban ecology content, proficiency in conducting a tree inventory, use of GPS in group and individual contexts, and basic understanding of how to navigate in GIS.

The results for students' long-term retention of this content were mixed. Students' perceptions of their GIS and GPS skills indicated a belief that they had either maintained or increased their proficiency with both these technologies during the academic year; however, those perceptions were not validated through authentic assessments that required students to use those skills.[5] One explanation for this trend is that students may not have had the chance to practice these skills as much during the academic year as they did during the Summer Camp. **To ensure that students continue to learn about and use technology throughout the program, GRG recommends that the *Technology at the Crossroads* team develop and implement a series of year-long lessons focused on each content area.**

In addition to rating themselves as proficient with GIS and GPS, *Technology at the Crossroads* students also showed increases in their perceived science and technology abilities overall after completing the program. Though the sample was too small to conduct significance tests, these data may indicate that the program is increasing students' self efficacy in these areas. **GRG recommends that future evaluation efforts add more explicit measures of self efficacy to capture the influence that the program might be having on students in this domain.** Demonstrating that the program increased students' self confidence in science and technology and/or their appreciation of the importance of developments in these fields would each be meaningful outcomes to the project.

The evaluation plan used for the final project year assessed students' technology skills and knowledge at times scheduled by the project and evaluation team. **In**

[5] Note that for the longer-term results, the sample size for the project and evaluation are a limitation. While data were gathered from most students who continued with the after school program, the number of students involved was too small to make broad claims about the programs effectiveness in this area.

future project years, GRG recommends using a student-centered approach whereby students determine when they are ready to demonstrate their proficiency. Using this model, the project and evaluation teams could share the proficiencies of interest with students and then have students work toward the goal of demonstrating those proficiencies when they are ready. This strategy would provide students with greater autonomy, while at the same time making the learning goals of the program clear. The sense of competition that might arise as peers begin demonstrating their proficiency levels might also serve as an extra motivator for students.

Another project component that influenced students was their year-long project. This *Technology at the Crossroads* component seems to have been successful at helping students understand the importance of ecology to their urban environment. Many students chose to focus on projects that investigated the interaction of human behavior and urban ecology, and students were able to articulate the important lessons learned from this component. The year-long projects also provided valuable experience working as a team, and provided the opportunity to continue working with the technology featured during the Summer Camp.

Both the Summer Camp and the year-long projects for *Technology at the Crossroads* were designed to use technology to gather scientific data. Students' statements and feedback about the program indicate their view that the program has a stronger science than to technology focus. **Depending on the interests of the project team, GRG recommends that the program become more balanced in its science and technology delivery in future years.** Teaching about the multiple uses of each technology and providing students with different types of tasks to accomplish using the technology (i.e., examples that do not feature science) might be ways to increase the balance of how each of these domains are presented. That said, the students in the program this year were more interested in science compared to technology careers, and so the science focus likely served them well in those pursuits.

In summary, this report has demonstrated the successes of the *Technology at the Crossroads* project in its third project year. These findings – and those generated through previous evaluations of the program – have provided valuable information that project staff can use as they continue to refine and implement the program in the years to come.

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