

Tech Camp 101: Assessment

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Introduction:

Studies have shown that middle school is a decisive time for either promoting or dissuading student interest in the areas of mathematics and science (1). Students who are not engaged in learning these subjects in the critical middle school years often lose interest and motivation by the time they reach high school. Use of technology and hands-on activities has been shown to engage middle school students and encourage their interest in these subjects (9).

Summer technology camps provide a fun environment for children to learn about many subjects that are not offered in a traditional middle school curriculum. Today's leading technology camps offer subjects that involve mathematics and computer science such as Global Positioning Systems (give the full name, not abbreviation), programming, robotics, three dimensional modeling, web design, and digital video creation. Of course, the knowledge acquired at these technology camps does not come free. Typically, these camps cost at least \$600 per child for one week (3, 4). In other words, the valuable information presented at technology camps is often restricted to children from affluent backgrounds. (2)

The vast majority of technology camp attendees are Caucasian males. In computer science and technology, there continues to be a great deal of discussion and concern over the low numbers of women and minorities involved. National Science Foundation studies show that in 2001, only 27.5% of computer science bachelor degrees were awarded to women and only 5.9% and 10.8% of the degrees were awarded to Hispanics and African Americans, respectively (5, 6). These statistics are alarming for several reasons. Diversity in the workplace often leads to innovation; currently, the technological fields lack both gender and ethnic diversity. Additionally, technological fields often offer higher rewards in the form of income and benefits than do other fields (2). These statistics motivated the creation of a free, one week technology camp designed specifically for middle school students, to cultivate interest in these students and encourage their pursuit of technological fields of study.

Motivation:

The implementation of the No Child Left Behind Act motivated educators nationwide to initiate programs aimed at assisting K-12 teachers in reaching the goal of 100% student proficiency by the year 2014. The *GK-12 Learning Partnerships* program (GK-12), a grant supported by the National Science Foundation (Award #DGE 0231611), is one of several such programs implemented at the Colorado School of Mines (CSM). Through this program, graduate students were partnered with middle school teachers at three schools in Adams County District 50 (Adams 50), a partner district of CSM, located in the Denver metropolitan area. Adams 50 is an economically disadvantaged district, with 67.5% of middle school students qualifying for free or reduced price lunch. Adams 50 is

also a very diverse district in terms of demographics: 54.4% of students are Hispanic, 34.1% are Caucasian, 8.2% are Asian and 2.2% are African American.

During their experiences in Adams 50 middle school classrooms, two graduate students realized that the middle school students they were working with do not have the same opportunities as students in schools with a primarily Caucasian population and affluent background. This realization motivated these graduate students to investigate the possibility of offering a free technology camp specifically for Adams 50 middle school students. Tech Camp 101 was the result of this investigation.

Tech Camp 101:

Tech Camp 101 is a free one week camp at CSM aimed at introducing concepts in technology to middle school students. The target audience is primarily female and minority students in grades 6, 7 and 8.

In the summer of 2004, Tech Camp 101 was offered at CSM for the first time (8). Graduate student stipends were paid from the GK-12 grant and additional funds were raised from various organizations both on and off campus. Fifteen students, of which six were female, attended the first camp. All students were from one of three middle schools (Hodgkins Middle School, Clear Lake Middle School or Shaw heights Middle School) in Adams 50. During the camp, students learned concepts such as Flash animation, web design, robotics and GPS navigation.

In the summer of 2005, two camps were offered: one to a mixed gender group of students and the other to an all-girl group. As in the previous year, the participants were all students in Adams 50. The content of both camps was identical: students learned Alice 3D programming, video game programming, cryptography, Lego Mindstorms robotics, water bottle rockets, and also examined the inside of a computer. Once again, four graduate students provided instruction for the camp. As part of an academic course, undergraduate students joined the Tech Camp 101 instructors as evaluators. Based on the camp goals, they developed and implemented an assessment instrument and analyzed the resulting data. This paper summarizes the results of this assessment effort.

Assessment Development:

The assessment instrument was designed to measure four student constructs: personal interest, skills, image of a computer scientist, and technical ability. Personal interest was measured through a series of questions that addressed the extent to which the student was interested in computers and computing. Skills were addressed through questions concerning the students' prior experiences with computers. Students were also asked questions concerning their perceptions of the personal characteristics of a computer scientist. This included a request for the students to draw a picture of a computer scientist. Sample questions from these first three assessment categories are

displayed in Table 1. The fourth and final section, technical ability, consisted of eight questions, two from each instructional lesson taught during Tech Camp 101.

Table 1. Example questions within each attitude assessment category

Personal Interest	Skills	Image of a Computer Scientist
<ul style="list-style-type: none"> • Do you want to go to college after high school? • I want to be a computer scientist when I grow up. 	<ul style="list-style-type: none"> • Do you think computer programming will help you in college? • I am good at using a computer. 	<ul style="list-style-type: none"> • Computer scientists are nerdy. • Most computer scientists work by themselves all day.

All of the questions were in a multiple choice format, with the exception of the one that requested that the students draw a picture of a computer scientist. Some of the questions, such as those in the technical ability category, had only one correct answer. Other questions asked students for their opinions, and possible answers were based on a Likert scale, ranging from “strongly disagree” to “strongly agree.” The entire assessment consisted of 26 multiple choice questions and one paper-and-pencil drawing. These 26 questions were randomized to avoid subconsciously leading the students toward a specific answer.

Assessment Implementation:

The assessment questions were administered at the beginning of Tech Camp 101, immediately before instruction, and again at the end of the camp, immediately following instruction. A Personal Response System, commonly called “clickers”, was used for administration purposes. Each question was read aloud to the students and the students selected a button on a hand held device to indicate their response remotely. An infrared beam transmitted the students’ responses to the instructor’s computer. In order to ensure proper use of the clickers, the students were asked a series of practice questions before the first administration of the assessment.

Figure 1. Students Using “Clickers” For Assessment Activity at Mixed Gender Camp



Data Analysis:

As was discussed earlier, some of the questions had a correct answer. For these questions, one point was assigned for a correct answer and zero points were assigned

for an incorrect answer. For opinion questions, where students indicated the extent to which they agreed with a given response, positive attitudes were assigned higher scores. For example, for the question, "I like working with computers," five points were assigned if students entered "strongly agree," three points for "neutral," and one for "strongly disagree." Mean scores among all students were calculated for each of the four categories for the pre- and post-assessments. If a student did not respond to both the pre- and post-assessment, that student's response was not included in the final analysis.

Assessment Results:

It should be noted that there were 16 students at both camps in 2005. In the first camp, three of the students had attended Tech Camp the previous summer; in the all-girl camp, two of the students had attended the previous summer. These students may have contributed to higher scores in the Technical Ability category than if none of the students had attended Tech Camp 101 in the past. Since student responses were not associated with their names, it was impossible to separate out the students who had attended Tech Camp in the past and analyze only the new students' responses.

Figures 2 and 3 display the results of the assessment questions for the mixed gender camp and the all-girl camp, respectively. The results displayed are the ratios of the student scores to the total possible number of points; in other words, the percentage of correct answers. As these figures suggest, almost all of the categories displayed an increase in mean scores from pre- to post- assessment. The only exception is that the all-girl camp's mean for the "image of a computer scientist" section remained unchanged from pre- to post-assessment. A paired t-test was used to determine whether any of the categories displayed a statistically significant increase. Only one was found and this was with respect to the all-girl camp for technical ability. Although the mean pre-assessment score for technical ability was lower in the all-girl camp than the co-ed camp, the mean post-assessment score for the all-girl camp was higher than the co-ed camp. Although not statistically significant, it is interesting to note that the students in the all-girl camp had a higher opinion of computer scientists overall than the co-ed camp, even though there was no change from pre- to post-assessment. Table 1 summarizes these findings.

Figure 2. Assessment Results from Mixed Gender Camp

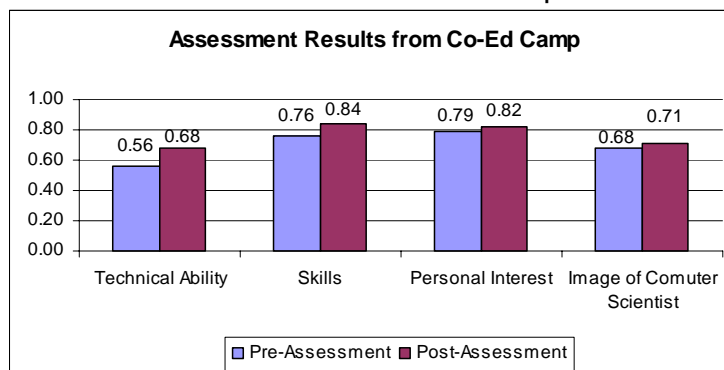


Figure 3. Assessment Results from Mixed Gender Camp

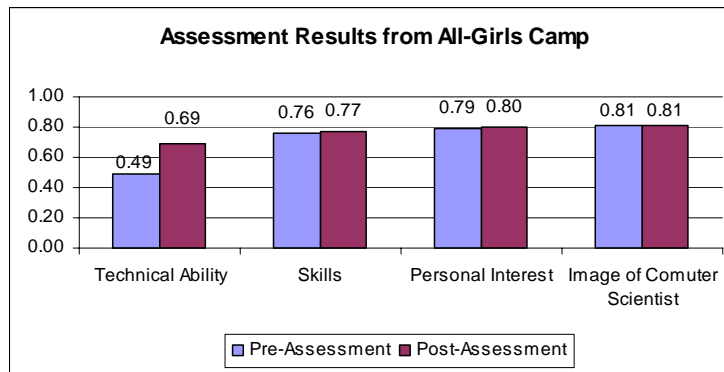


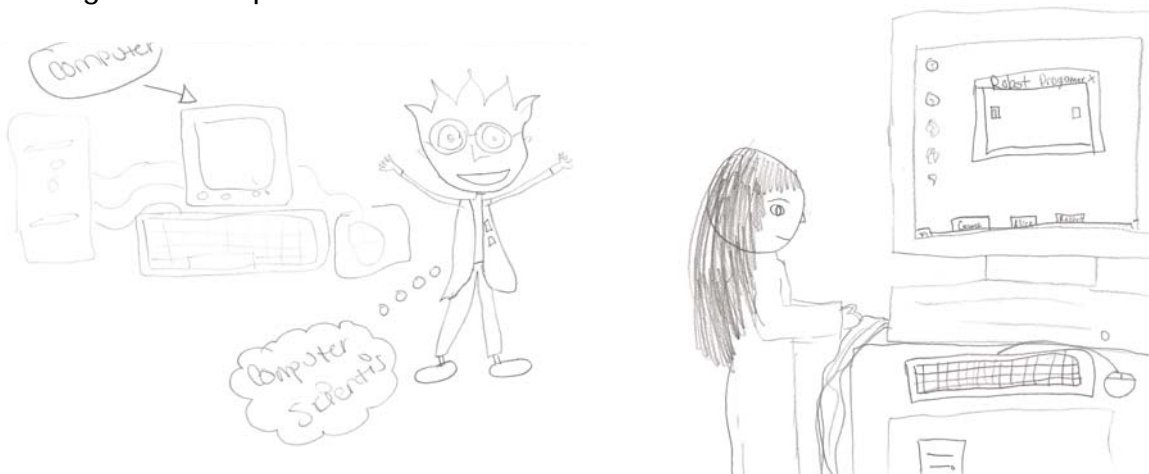
Table 1. Summary of Results from both Camps

	Co-Ed Camp			All-Girl Camp		
	μ_{pre}	μ_{post}	p-value	μ_{pre}	μ_{post}	p-value
Technical Ability	0.56	0.68	0.1754	0.49	0.69	0.0026*
Skills	0.76	0.84	0.2863	0.76	0.77	0.9086
Personal Interest	0.79	0.82	0.8636	0.79	0.80	0.6440
Image of a Computer Scientist	0.68	0.71	0.6340	0.81	0.81	1.0000

*designates a statistically significant difference from pre- to post-assessment

In addition to the quantitative results gathered from the assessment, the drawings that students made were also collected and examined. In general, student drawings from the pre-assessment illustrated computer scientists as stereotypically “crazy” and “nerdy” people. In the post-assessment, several students drew themselves as computer scientists, and their drawings were decidedly more “normal.” Figure 4 shows a comparison of pre- and post-assessment drawings.

Figure 4. Examples of Pre-Assessment (left) and Post-Assessment (right) student drawings of a Computer Scientist



Discussion:

It is interesting to note that the only statistically significant change that was observed was with respect to technical ability in the all-girl camp. In other words, the students in the all-girl camp appeared to have greater gains in knowledge as a result of attending the summer camp than did the students in the mixed gender camp. This is consistent with the literature that suggests that females do not have the same experience with computers as do their male counterparts. Therefore, camps such as Tech Camp 101 may be more critical for encouraging female participation in computer science than they are for encouraging male participation. It is somewhat disappointing that Tech Camp 101 did not have a significant impact on either group's personal interests in computing.

On a qualitative level, camp instructors noticed that students in the all-girl camp were receptive and attentive to learning the various concepts taught. The students in the mixed gender camp, although they were also eager to learn, were more likely to spend their "free time" surfing the Internet or playing games rather than working on their projects. This was visible during the assessment activities as well – during the mixed gender camp, students quickly realized that they could enter multiple answers, race to see who entered an answer first, or who could wait until the timer was just about to run out. In the all-girl camp, students did not play such games during the assessment. It is interesting to note, also, that the girls in the co-ed camp acted more like the boys in the same camp than like the girls in the all-girl camp. This may be due to the influence that the boys have on girls.

Finally, the drawings of the computer scientists show that the students' perceptions of how a computer scientist looks and acts did change slightly during the course of the camp. At the beginning, most students in both camps drew more stereotypical images of computer scientists. By the end of the camp, the majority of the students realized that computer scientists are "normal" people and that they could become computer scientists too. Having computer science graduate students as instructors may have contributed to this positive influence.

Future Plans:

Tech Camp 101 instructors have secured funding to continue offering this program in future years (sponsors are acknowledged in the following section). In June of 2006, two camps will again be offered to Adams County District 50 middle school students. The first camp will be an all-boy camp; the second will be an all-girl camp. An assessment similar to the one used in the summer of 2005 camps will be administered at both camps. Assessment statistics will be analyzed to further investigate the differences resulting from camps serving either gender.

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The *GK-12 Learning Partnerships* project investigators, Drs. Barb Moskal and Cathy Skokan, were instrumental in making Tech Camp 101 successful. They ensured that graduate students would be compensated for their time in developing and implementing the camps. Additionally, they provided opportunities for quantitatively evaluating the effects of the program in hopes of securing future funding.

Finally, Tech Camp 101 sponsors also deserve acknowledgement. The Mathematical and Computer Sciences department at the Colorado School of Mines provided a computer lab and 16 computers for two week-long camps. Adams County School District 50 provided buses for transporting students to and from the camp each day. Grants from Lexis Nexis, Sigma Xi, and the Mathematical Association of America's Tensor Foundation provided funding for camp software and lunches for students. Finally, the Women in Science, Engineering and Mathematics program and CSM provided funding for the all-girl camp.

References:

- (1) Clewell, B.C. and Braddock, J.H. (2000). "Influences on minority participation in mathematics, science, and engineering." In G. Campbell Jr., R. Denes, and C. Morrison (eds.), *Access Denied; Race, Ethnicity, and the Scientific Enterprise* (pp.89-137). New York: Oxford.
- (2) Dean, A., Miller, L., Ewing, M., Moskal, B. & Fairweather, G., Tech Camp 101, Mathematical Association of America, Tensor Foundation grant proposal, March 2006.
- (3) <http://www.cybercamps.com>
- (4) <http://www.internaldrive.com>
- (5) <http://www.nsf.gov/statistics/wmpd/pdf/tabc-4.pdf>
- (6) <http://www.nsf.gov/statistics/wmpd/pdf/tabc-7.pdf>
- (7) Moskal, B., The Next Generation of Outreach Mathematicians (and the Generation after that): Technology Camp 101, *National Council of Teachers of Mathematics* magazine, February, 2006.
- (8) Miller, L., Shearer, S., & Moskal, B. Technology Camp 101: Stimulating Underprivileged Students' Interests in Technology, Proceedings of the *Frontiers in Education Conference*, Indianapolis, Indiana, 2005.
- (9) Staten, Mary E., A Framework to Help Move Teachers Toward an Inquiry-Based Science Teaching Approach, p. 8, 1998