AC 2009-1227: DID IT WORK? - ANALYSIS OF WAYS TO MEASURE THE IMPACT OF AN AFTER SCHOOL ROBOTICS OUTREACH PROGRAM.

Austin Talley, University of Texas, Austin

AUSTIN TALLEY is a graduate student in the Mechanical Engineering Department at The University of Texas at Austin. His research focus is in design methodology and engineering education. He received his B.S. from Texas A&M University and M.S.E. from The University of Texas at Austin. Contact: Austin@talleyweb.com.

Marilyn Fowler, Austin Children's Museum

MARILYN L. FOWLER is a science educator with over 35 years experience with schoolchildren. Her years in education include classroom teaching at the elementary and college levels, science curriculum specialist, consultant, science coach, and currently, as a teacher of robotics and science. In 1991 she completed her Ph.D. research in problem solving strategies that led to adolescent girls' success on a mechanical design problem, and that interest led her to collaborate with engineers at UT Austin to create the award-winning DTEACh teacher education program (1995 Fred Merryfield Award, ASEE), which continues today. She leads afterschool classes in LEGO Mindstorms Robotics for the Austin Children's Museum in Austin-area schools. Contact: mlfowler@austin.rr.com

Christina Soontornvat, Austin Children's Museum

CHRISTINA SOONTORNVAT obtained her BS in Mechanical Engineering from Trinity University in 2002 and her MS in Science Education from the University of Texas at Austin in 2007. She has worked at the Austin Children's Museum since 2006 and now serves as the Science Content Developer. She has taught ACM's robotics after-school programs and currently coordinates the Museum's outreach classes in local elementary schools. Christina's other duties at the Museum include developing the science content for exhibits and programs, and assisting in the planning for the new Museum. Contact: csoontornvat@austinkids.org

Kathy Schmidt, University of Texas, Austin

KATHY J. SCHMIDT is the Director of the Faculty Innovation Center for the College of Engineering at the University of Texas at Austin. In this position, she promotes the College of Engineering's commitment to finding ways to enrich teaching and learning. She works in all aspects of education including design and development, faculty training, learner support, and evaluation. Contact k.schmidt@mail.utexas.edu

Did it Work? - Analysis of Ways to Measure the Impact of an Afterschool Robotics Outreach Program

1. Abstract

All over the nation afterschool programs are implemented to assist children. This paper focuses on the challenge of evaluating the outcomes of an afterschool robotics program that is an outreach program of the Austin Children's Museum. Students use LEGO Mindstorms to explore robotics. The program works with third through fifth grade students at inner-city elementary schools in weekly afterschool sessions for eight weeks at each school. The goals of the program include: enhanced academic skills such as graphing and visual discrimination; increased interest and motivation for future experiences and positive attitudes towards mathematics, science and technology; and greater awareness of technology/teamwork processes such as brainstorming, planning teamwork and troubleshooting. This paper presents the effort to assess the impact the program has on the students in the area of interest. The goals of the program are outside the scope of traditional classroom goals and therefore require assessment different from standardized tests. The assessment is brief due to the short program (eight sessions), the age of the students (third through fifth grade), and the voluntary nature of the program. It was essential to minimize time assessment to maximize the children's experience. Due to these young students' written comprehension level, traditional assessment techniques were not appropriate. These challenges led to an assessment that includes a short pre and post written quiz of the students' comprehension of content areas, pre and post verbal interview of the students, and in-session records of students' abilities to demonstrate understanding of the content discussed. This paper discusses the success and shortcoming of the different ways of implementing the assessment. The analysis focuses on the ability of the assessment to measure a change in students' skills or attitudes. The analysis also discusses how each of the assessment techniques impacted the program and provides insight in an area that many programs find challenging.

2. Robotic Background

The materials used for the after-school robotics program were the LEGO® MINDSTORMS® NXT Robotics system. The LEGO® MINDSTORMS® Robotics allows an individual to create autonomous electromechanical inventions that are based on the LEGO building systems. The system features an automatic programmable control unit (NXT brick) that has four inputs and three outputs. Outputs for the NXT brick are motors and lamps (lights). Inputs for the NXT brick are light, sound, rotation, distance, touch and other custom sensors. The robots are built from LEGO Technic components and other craft materials. Programs to control the robots are written on computers with the NXT software and then transferred to the robots. An example of an NXT robotics project is shown in Figure 1.

Figure 1: LEGO NXT Robotics Example

In the robotics program the students explore concepts about automated devices with active learning principles. The robotics program uses active learning materials that were developed by the Design Technology and Engineering for America's Children (DTEACh) program. The curriculum for the robotics program is based on the DTEACh 5-Step teaching model shown in Figure 2.

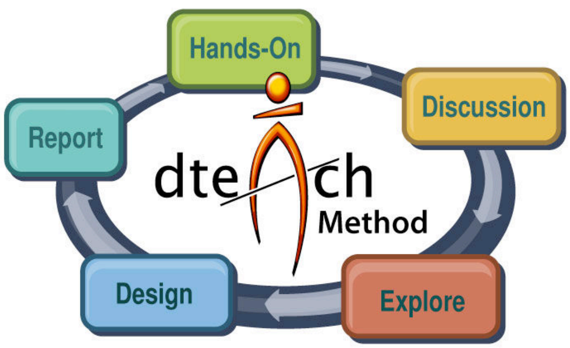

Figure 2: DTEACh 5-Step Visual Representation[i]

The DTEACh 5-step model is influenced by the Kolb's Learning Cycle model and Bloom's Taxonomy[ii]. The Kolb Cycle is based on learning experientially through four stages of a learning cycle[iii]. Bloom's taxonomy has six levels of cognitive understanding of a subject. Starting with the lowest level, knowledge, each level of the subject must be understood by the individual before moving to the next level of cognitive understanding[iv].

3. Brief Introduction to the Austin Children's Museum

The Austin Children's Museum (ACM) is a nonprofit organization whose mission is "to create innovative learning experiences for children and their families that equip and inspire the next generation of creative problem solvers." Through well-crafted exhibits and educational programs, the Museum helps lead young children towards the life-long learning modes of questioning, reflecting, informed decision-making, critical thinking, and multidimensional thinking. There have been significant advancements in the understanding of how young minds develop and are inspired before starting grade school. For the last 25 years, the Austin Children's

Museum has been a leader in applying those advancements to help children learn and grow, and has become a vital complement to our public education system. The Museum welcomes more than 200,000 visitors annually and serves a primary audience of children (ages 0 to 11) and the adults in their lives[v].

4. Robotics Program

The Austin Children's Museum has been incorporating LEGO robotics into its program offerings since 2005. Serving an informal audience has several customer-driven challenges: Every child must have a good time and enjoy free choice activities, yet must also stretch his or her capabilities as much as possible. The first robotics summer camps filled to capacity with children from our science/technology-passionate public, and we now offer afterschool programs funded by local foundations at Title One campuses. In this way, the robotics program has served well over 200 children ages 7 to 12 with fun yet challenging activities with programmable LEGOs.

This research focuses on the assessment of the afterschool program. The robotics program is eight two-hour sessions held weekly, depending on the hosting school schedule. The students are voluntarily participating in the program, and are selected by the hosting school. The students vary from second through sixth grade. The sessions are offered on site at host schools to twelve participating students. The students are a mixture of males and females. Figure 3 shows some of the students and instructor of the ACM robotics program.

Figure 3: Students and instructor of the ACM robotics program

5. Assessment Goals and Limitations

The ACM robotics program's goals are to enhance students' academic skills, increase student motivation towards STEM subjects, and increase the students' conceptual understanding of technology processes. To assess the goals three different methods of assessment were used. The goal of the assessment is twofold: to get a better understanding of the students and to evaluate the assessment approaches.

6. Assessment Tools

The assessment of the program focused on three methods. The methods are intended to assess the students with minimal impact on the students. The program is a voluntary afterschool program. The program was assessed with a "Pretest" on the first day and a "Post" assessment at the end of the program (a minimum of seven weeks apart). Because the program consists of a total of sixteen hours, a major concern was the minimizing of the time the assessment took during the program. The assessment also needed to evaluate students in a range of grade levels.

6a Visual Discrimination and Graphing Skills

This written assessment instrument focused on academic skills and contained four visual discrimination questions asking the student to identify the item on the page that was different from the rest, and two questions about reading graphs. Two versions of the evaluation were created and alternatively used during the assessment. The first page of the written assessment is shown in Figure 4.

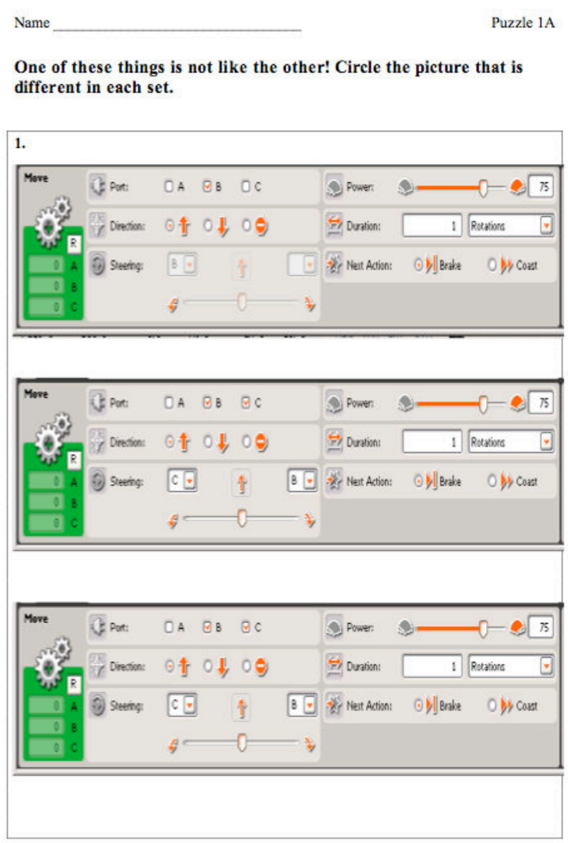

Figure 4: Written Assessment Page One

6b Interview

To assess the student's interest and motivation, a structured interview of three questions was given to each student. The interview format was used to minimize the effects of the students' reading comprehension and writing skill on the assessment. The interview consisted of three questions shown in Figure 5.

Name ________________________________ Date ________________

1. Would you like to do an activity like this again? Why or why not?

2. Would you rather have a video game to play at home or have one of these NXT kits to play with at home? Why?

3. If Dr. Fowler gave you a challenge do you think you could get it right on the first try? Why or why not?

Figure 5: Interview Questions

6c Activity - Conceptual Understanding

Assessment of the conceptual understanding technological process focused on the students' understanding of automatic devices. During the first and last days of the program, the students were asked as a group to name automatic devices. The devices were listed on a poster as they are called out. The number of unique devices listed was recorded for each session. An example of a poster list is shown in Figure 6.

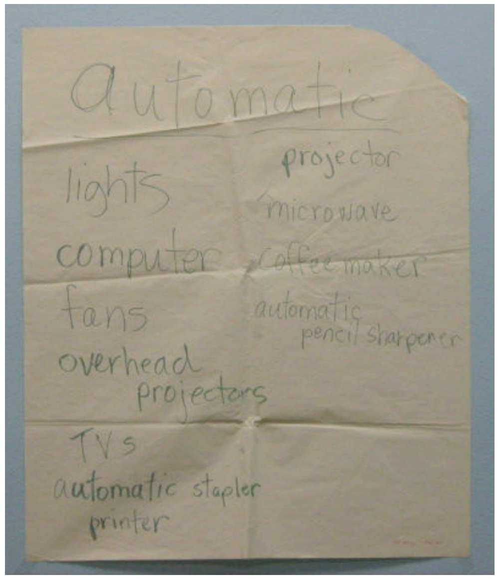

Figure 6: Automatic Devices Poster

7. Assessment Results

Overall, the interview demonstrated the students are excited about the program and would like to participate in a future robotics program. At the end of the program, the students stated they would prefer playing with NXT at home over playing with a video game. We found that interview question number two produced a male/female bias; none of the females preferred a video game to the NXT LEGO robotics kit.

The interview was a success in gathering written comments on the program for use with program sponsors and marketing of the project. This form of assessment required an additional individual to perform the interview but was minimally invasive. The first interview question results indicate that all students would like to participate in a similar program in the future but many of the students made the same statements at the start of the program. Careful analysis of the interview questions is needed. The interview process was conducted while the students were working on building or demonstrating the robots. This method of interviewing allowed the interviewer to interact with the students one on one during the program time. This method appears to be well received by the students and worked well with the program instructor. Due to this interview style a maximum of three questions are recommended due to the time it took. A representative sample of the interview comments from the students is shown in Table 1.

Table 1: Sample Interview Comments from Students

“I like to make stuff.”
“You get experience to create something yourself.”
“You have to use your imagination and when you finish it and do a contest you feel really proud of yourself.”

For the written evaluation, the study had difficulty attempting to assess all students with the same tool due to the students' different ages and abilities. Our research demonstrated that the evaluation could be too simple and or too complex for the students. The visual discrimination test that was given was overall too easy for the students. The majority of the students to correctly answered the questions both before and after the program. The graphing section of the evaluation was based on the program module being implemented in the program. A lesson learned in this evaluation was that the skill assessment tool needs to be individualized for the skill level of the students.

The assessment tool for conceptual understanding was successful. The program's instructor felt it was easy to implement the program and the results indicate that students were able to name significantly more items as the end of the program. This lends support to the belief that the students are grasping the conceptual understanding of automatic devices as seen in Figure 7.

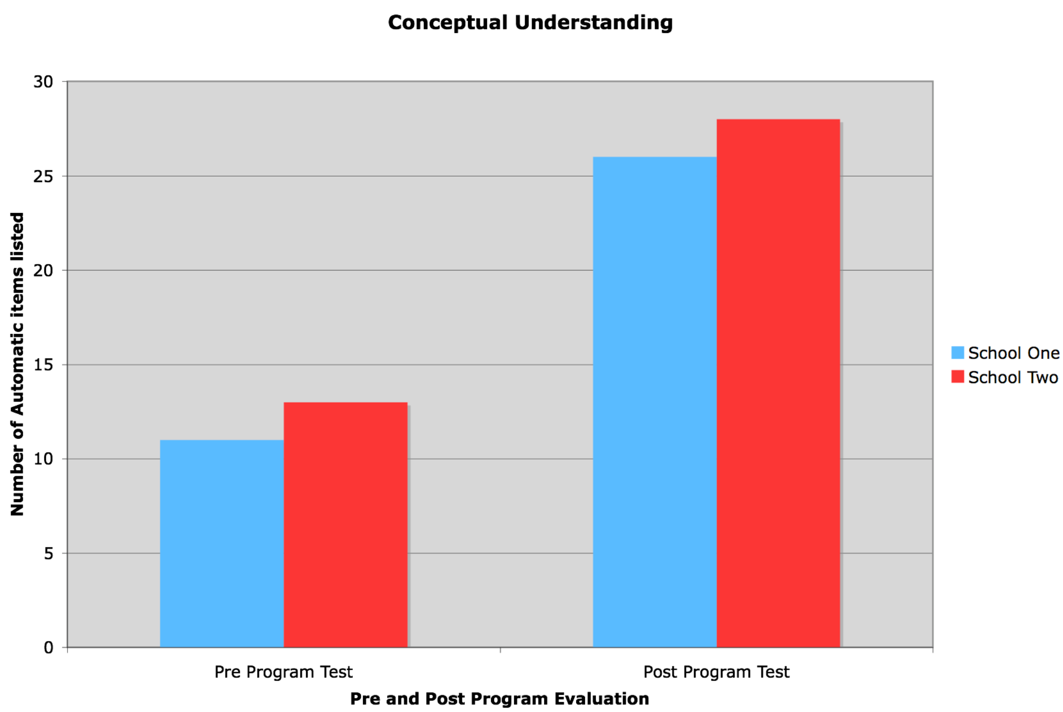

Figure 7: Conceptual Understanding Assessment

8. Conclusions

Overall, the three assessment methods allowed the researcher to analyze the students' skill, conceptual understanding of the content, and perception of the program. Conceptual understanding integrated into the program has demonstrated success as an assessment method and appears likely to be integrated into all future ACM robotics programs. Future use of the conceptual anlysis might be directed at using Concept Maps[vi]. The written assessment has showed that the students were able to visually discriminate among the concepts presented to them. Careful consideration of age-appropriate assessment questions will be needed for future analysis. The structured interview takes active involvement for successful implementation but in this study demonstrated some insight into the students' attitudes toward the program. Continued analysis of student assessment methods is needed to refine and maximize the gathering of information with minimal interference in the program.

References

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