2006-1007: HOME SCHOOLERS IN AN ENGINEERING/EDUCATION K12 OUTREACH PROGRAM

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Abstract

The Toying With Technology[SM] program (TWT) has been offered to preservice elementary and secondary teachers for ten years. This program is designed to explain the principles behind many of the technological innovations in wide use today. This is accomplished through hands-on laboratory experiences. This includes, but is not limited to, experiences with programming, global positioning systems, and biomedical engineering. This program uses engineering as a basis to teach math, science, technology and problem solving concepts.

This paper will describe the twelve week experience of a home schooled group engaged in the TWT program. Home schooling is a growing trend in the United States and it is estimated that two million American children are home schooled each year with this number increasing by 15-20% per year[1]. The students' progress in this program was measured through specific reflection questions, as well as observations and reflections by the TWT facilitators and the cooperating home school representative and the parents of the home schooled students.

The Toying With Technology[SM] Program

The Toying With Technology[SM] Program at Iowa State University has been reported on many times in the literature[2-7]. This program includes an undergraduate and a graduate engineering class for education majors as well as a large K-12 outreach effort. The undergraduate course has enrolled hundreds of preservice teachers, the graduate class enrolls 15 – 20 per summer, and the outreach program touches over 2000 K-12 students per year. Included in the undergraduate class is a month-long field experience at which the preservice teachers become facilitators of engineering lessons with local K-12 students. In the fall 2005 semester this field experience was with a group of home-schooled students.

Home Schooling and TWT

Up until the 1850's, most children in the United States were educated at home.[8,9] Within the past twenty five years, the United States has seen a tremendous upswing in the number of children being home schooled. In 1999, there were an estimated 850,000 students being home schooled across the United States.[9,10] More recently in 2003, that number has grown to an estimated 1.1 million students.[8,9,10] It is estimated that this number will continue to steadily increase in the future.[10] Parents have decided to home school their children for a number of reasons. Recently it was reported by thirty-one percent of home schooling parents that the most important reason for home schooling was their concern about the environment of other schools.[11] Thirty percent said the most important reason was to provide religious or moral instruction not taught in schools.[11] The next greatest reason was that sixteen percent of home schooling parents said that they were "dissatisfied with the academic instruction available at other schools."[11]

To provide continuity for home school students, many parents network themselves by joining professional groups such as the National Homes Education Network, home schooling support groups, or form regional and area curriculum teams. Many times these teams are formed to unify the home schooling process, provide support for parents, and to enrich the children's education with outside programs such as the Toying with Technology[SM] program.[12] **"**While home schooling parents seek out these enrichment programs for many of the same reasons the teachers in a public school participate, the outcome is more drastic."[13] According to a representative from the Ames Home School Network, "home school students participate in the TWT program because many do not receive a rich technology experience at home and TWT provides a challenging but non-threatening environment to do so. TWT also provides a chance for students to work with their peers and collaborate in a group they may not have access to at home."[13]

During the fall, 2005 semester twenty home school students met on the Iowa State University campus once a week for twelve weeks. Three ISU pre-service teachers and one parent volunteer met with the students as support. Students were given a variety of projects to work on including; basic LEGO car programming, building and testing a LEGO egg drop creation (see Figure 1), building and testing a paper egg drop, and participating in a biotechnology engineering presentation. For the LEGO projects, students were allowed to use the materials supplied in the LEGO Mindstorms© kit. The home school students ranged in grade level from 4th through 10th grades and were paired according to their age. The main goal of this experience, along with all TWT experiences, is that students will learn to problem solve. Students were also to meet goals of the NSES (National Science Education Standards)[14], NCTM (National Council for Teachers of Mathematics)[15], ISTE (International Society for Technology in Education)[16], and the NSSC (National Social Studies Council)[17]. These goals are outlined in Table 1. Also, because the home school students were working collaboratively when they might work alone most days, a second goal was for the home school students to work with a partner in completing each of the tasks, this goal is also addressed in the NSSC standard.

Results

The students were successful with many of their projects. Due to the age range of the home school students and their lack of experience with computers, they spent 4-6 hours working with the basic LEGO Car and grasping the concepts of programming. While most students admittedly had trouble working with sensors at the beginning of the program, they slowly caught onto the idea. As for the LEGO egg drop, within three weeks each pair had completed a machine they envisioned would drop an egg from the top of the table to the ground without breaking it. As the home school students presented their projects to their parents, they addressed how they had worked as a team and what problems they had incurred. Although most of the eggs broke, the students were eager to redesign their machines and test them the following week. Those students who had successfully dropped an egg using LEGOs were allowed to then create a "paper egg drop" using 6 sheets of typing paper and a yard of tape. The students then dropped their paper egg drops from fifteen feet and the one group who's egg drop worked successfully from fifteen feet dropped the egg drop from the next level of thirty feet. Although the egg drop did not successfully reach the ground with a whole egg, the students were delighted they had progressed so far.

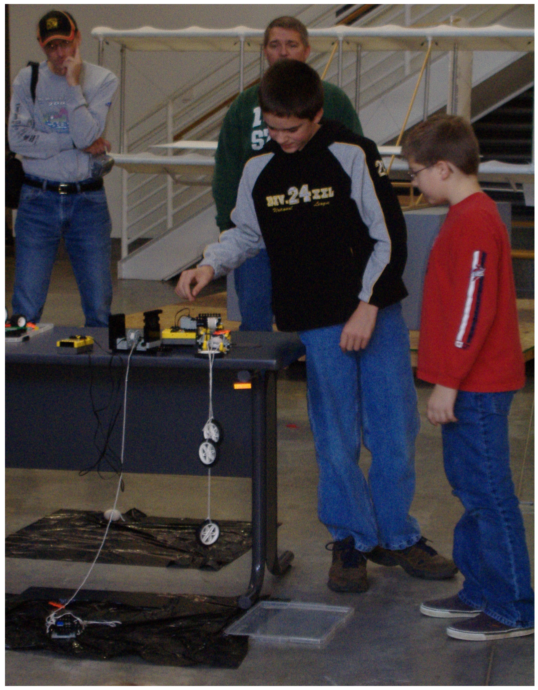

Figure 1: LEGO Egg Drop Presentation

All of the goals of the program were met (see Table 1) as measured by student achievement in prescribed national curriculum standards. Student achievement of these outcomes was based on both direct and indirect assessment. The direct assessment was provided by the parent-teacher and the preservice teachers who directed the sessions. In addition a couple of parents who weren't continually in the sessions were also interviewed about their perceptions of the program. Since all of the work was project-based, one direct measure was provided by observations performed by the parent-teacher and the preservice teachers. The teachers unanimously observed students using scientific inquiry to complete tasks, working with bodies in motion (their robots), applying design process strategies, performing problem solving on their robotic systems, and working collaboratively. The assessment measure used was to observe these behaviors being applied and to assess the successful (or not) completion of the assigned task. No attempt was made to rate the "level" of the attainment of a desired outcome, only that the behavior desired was applied and the project was successfully completed. These reflections were collected through interviews with the parent-teacher and written reflections as well as conversations with the preservice teachers. All of this data was collected by the co-author on this paper who is also a preservice teacher and supervised this event.

Indirect measures used were in reflections by the home-schooled children and by the preservice teachers. Again the supervisor of this project collected the reflections of the preservice teachers and, along with the preservice teachers, collected the data from the home-schooled students. Since the preservice teachers are also students in the TWT course, they were both assessed and assessors. The preservice teachers also had some experience facilitating similar exercises with in-school students. None of the preservice teachers had previous experience with home-schooling so they were anxious to learn about it and compare home-schooling to the in-school experience they knew more about. The reflections of the preservice teachers showed that they were surprised to find little difference in the abilities and scientific aptitudes between the two groups. The success rates for student projects are virtually identical. The preservice teachers learned more about what home-schooling is, how it is done and why it is chosen by some parents than about science as applied to the K12 populations since that appeared to be the same.

When the home-schooled students were asked to reflect on their experiences, Kim, 15, said that "I really like the way they (TWT pre-service teachers) let us figure out the problem ourselves. Other people can complain about that but I think I learned a lot by rethinking the problem and talking to my partner about it. I learned how to better compromise and make group decisions." Kim's response correlates directly to the constructivism and constructionism ideas of education that students create their own learning when they are taking an active role in their education.[2] When the parents were asked to reflect on the course, one said "I enrolled Sarah so she could receive the exposure to technology that isn't available in our home. However, she got much more out of it. Through TWT, Sarah had the opportunity to get involved with other kids which is so helpful to her social growth. By partnering up, she learned about teamwork at the same time she was learning about programming, math, and engineering."

Conclusion

Each semester the Toying With Technology[SM] course is offered to about 20 – 30 future K-12 teachers. The field experience described here, or one similar to it, has become a regular and important portion of the class. Providing future teachers the training necessary to make use of such engineering contexts is crucial to the success of curricular improvement.[18] This field experience is helping this course provide such practical training for future teachers. The particular field experience described in this paper dealt with home-schooled children and was, therefore, unique to this program. It showed that no significant difference appears to be present in the results of these exercises when performed with home-schooled or in-schooled children.

The home-schooled project was so successful that the TWT program intends to continue this outreach program in the future. Home schooling has grown rapidly in recent years and can provide another pipeline for prospective engineering professionals.

Table 1: Standards met by home school students

Standards		Engineering Context Activities		
Standards Used	Domain/topic/benchmark	Basic Programming	LEGO Egg Drop	Paper Egg Drop
NSES	A. Science as Inquiry · abilities necessary to do scientific inquiry	**X**	**X**	**X**
NSES	B Physical Science · motions and forces	**X**	**X**	**X**
NSES	E. Science and Technology · abilities of technological design · understandings about science and technology	**X**	**X**	**X**
NCTM	problem solving · solve problems in math and other contexts	**X**	**X**	**X**
NCTM	problem solving · apply/adapt a variety of appropriate strategies	**X**	**X**	**X**
ISTE	Standard 11: Students will develop abilities to apply the design process.	**X**	**X**	**X**
ISTE	Standard 13: Students will develop abilities to assess the impact of products and systems.	**X**	**X**	**X**
NSSC	IV. Individual Development and Identity · work independently and cooperatively to accomplish goals	**X**	**X**	**X**

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