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Using Practical Toys, Modified for Technical Learning

by ***Tracey Lynn Weisheit***

Introduction

Educators have used toys in the classroom for as long as toys have been in existence, especially in the field of elementary education. Toys can provide motivation as well as keep the students focused on a particular area of study for longer periods of time - something students at the elementary level often struggle with. These students need to obtain fundamental skills for creating, disseminating, retrieving, and evaluating information from electronic media [**10**]. Using robots as toys and teaching tools is a concept that has also been around for quite a while, and a great way to introduce these fundamental skills [**4**].

For most of our lifetime, however, economic constraints prohibited extensive use of robots in all but the rarest environments. LEGO has altered these constraints by creating a programmable add-on to the always fun LEGO building pieces. The RCX brick, along with the appropriate software and pieces, allows users to write their own programs and then communicate with the brick using an infrared tower [**5**]. The robots can then perform the tasks specified in the program. This technology is boundless and can be applied to a wide variety of disciplines, including computer science. However, until recently, such technology has been utilized largely in upper level high school and

undergraduate college curricula. Unfortunately, targeting students in that age range is not really effective for increasing interest in computer science as most students already have a general idea of what they wish to study. LEGO again comes through by creating more kid-friendly software interfaces such as ROBOLAB and LEGO Mindstorms for schools which help students learn a range of skills within the field of computing, including systems thinking, solutions design, basic problem-solving, and the use of computers [**5**]. Using what we know about the effectiveness of toys in the classroom and the inventive technology of LEGO, we can combine the two to create a powerful teaching tool for all ages, especially younger children.

In this project, we offer a hands-on approach for teaching and integrating robotics and computers into the elementary school classroom. The approach uses the LEGO Mindstorms Robotics Invention Kit and course curriculum, which we hope is effective in developing children's interest in computer science.

Related Works

Others have used LEGOs in camp-like settings to teach robotics. Specifically, other science camps, such as ones taught by Destination Science [**5**], Sci-Fi Engineering Summer Science Camps [**7**], Summer Science Day Camps, Inc [**9**], and Sci-Tech Ventures [**8**] have all taught camps dealing in robotics in order to accomplish different goals. All of these camps are day camps taught over a several hour span. But, these courses took place during summer break or a time when students were not in session for long periods of time and most of them take place over the course of an entire week. We wanted to see results that reflected how much students were learning and increasing their interest while also being asked to focus on regular class work during a normal school semester (or quarter) and in a shorter time frame.

The Sci-Tech camp and the Sci-Fi camp each use a curriculum-based on the LEGO Mindstorms, whereas the Summer Science Day camp uses the LEGO Mindstorms in combination with CyberKnex, another toy building set, in order to get missions accomplished. Each camp curriculum involves giving teams a problem to solve using their LEGO Mindstorms robot and the Robotic Inventions Software, or other toy kit. The camps are focused more on fun than education. Also, each of these camps emphasize robotics and related fields, ignore the programming or computing aspects.

Figure 1: The RCX Brick - Made by LEGO [**2**].

The Plan

In order to integrate the use of robots into an elementary curriculum, we held a camp focused on several areas of computer science. The camp was open to all students aged 8-12 and held over a two day period. Students from a local elementary school were invited.

Students in the computer science major at Hanover College taught and assisted in the classes with the help of a faculty advisor. Computer science majors were chosen as teachers to promote undergraduate community and improve instruction quality [**6**]. Each of the four sections of the camp were held on both days of the camp, which was scheduled over the fall break (Table 1). The days were divided into two sections with two classes being taught at each section and a one hour lunch break in between. Each section could support up to sixteen students, one or two instructors, and at least one assistant.

Computer Science Camps		
Time	*Thursday, Oct. 23*	*Friday, Oct. 24*
8:30 AM	Registration	Registration

9:00 AM	***Session 1*** Robotics Computer Hardware	***Session 1*** Robotics Computer Hardware
12:00 PM	LUNCH	LUNCH
1:00 PM	***Session 2*** Virtual Reality Web Programming	***Session 2*** Virtual Reality Web Programming

Table 1: Computer Science Camp schedule of events.

The Curriculum

Throughout the day, the campers were broken into teams of four and introduced to the Robotics Invention system software. Using this software, the teams completed tutorial missions and learned how to program their Linebots , which they were given instructions on how to build. The goal of the day was to have their robot solve a simple problem involving pushing soda cans out of a square drawn with black electrical tape on a table . The teams competed at the end of the day to see who could accomplish this task the fastest . During the course of the camp, surveys were also administered to be used for evaluation of the camp later on.

Evaluation

Surveys were used to determine whether or not children's interest level actually increased after taking the Robotics class. The surveys were anonymous but numbered so that each student's progress could be measured at the end of the camp without knowing personal information about the individual. The campers were given a short seven question survey at the beginning of each camp. The questions surveyed students about their current interest level in computing, if they had ever used LEGOs or Mindstorms before, and why they wanted to participate in the camp. Four of the questions were simple yes or no questions, two involved circling an answer based on a level of acceptance, and the final question concerning their reasons for attending camp had a written answer.

1st Survey QUESTIONS and RESULTS:				
Gender:	*Boy*	*Girl*		
	75%	25%		
Age:	*9*	*10*	*11*	*12*
	25%	50%	18.75%	6.25%
How much do you like computers?	*Not at all*	*A little Bit*	*A lot*	*I love them*
	0%	1.25%	31%	56.25%
How often do you used a computer?	*Never*	*Only at School*	*3 Days a Week*	*Every Day*
	0%	1.25%	50%	37.50%
	Yes	*No*		
Have you ever used a computer before?	100%	0%		
Have you ever used a robot before?	31.25%	68.75%		
Do you have a computer at home?	100%	0%		
Have you ever used LEGO Mindstorms before?	1.25%	87.50%		

Table 2: The first student survey questions and results.

These initial surveys (Table 2) were compiled and later checked against a second survey (Table 3) initiated during the last 5-10 minutes of the camp. Questions on the second survey were based upon the student's perception of whether they learned anything, whether they were more interested in computing after having taken the Robotics class, and if they would continue to pursue activities involving Robotics and computing. The second survey results were also compiled and checked against the corresponding numbered survey from the beginning of the camp. In the short time following the closure of the camp, a third survey was also instituted. This survey went to the instructors and assistants of the class. These results were used to evaluate whether the concept of a Robotics class was effective and whether the curriculum written for the class contributed or hurt the results of the student surveys. The results of the final two surveys are discussed below.

Results

The student and teacher/assistant surveys showed that using practical toys modified for technical learning does affect children's interest level in computing. In looking at the tables of the results below (Table 3 and Table 4), we learned that every student who attended the Robotics class of the computer science camp intends to use computers more often, and will enjoy doing so more now that they have learned that computing can be fun. Several student comments support these results when they provided their answers to the question, "What did you learn about robots and

computers today?" Some of these comments included, "You can program them [robots] to do everything", "That I can do it!", and "That they can be fun!" The teachers and assistants also supported this conclusion, with 100% responding "Yes" to the question, "Did the toys, or Lego Mindstorms, aid in teaching concepts of robotics and computing?" Other interesting survey results include the rise in student's intended usage of computers in the every day category from 37.50% to 56.25% indicating that students will use computers more often. Also notable, is the 56.25% that say they like computers more now that they believe programming can be fun. The results of the instructor surveys also indicate that the students enjoyed the class and that if taught in the future it could produce similar results shown below.

2nd Survey QUESTIONS and RESULTS:

Gender:	***Boy***	***Girl***		
	75%	25%		
Age:	***9***	***10***	***11***	***12***
	25%	50%	18.75%	6.25%
How much do you like computers?	***Not at all***	***A little Bit***	***A lot***	***I love them***
	0%	6.25%	50%	43.75%
How much do you like using computers more now that you know that computer programming can be fun?	0%	0%	3.75%	56.25%
How often will you use a computer after participating in this Robotics camp?	***Never***	***Only at School***	***3 Days a Week***	***Every Day***
	6%	0%	37.50%	56.25%
Did you have fun learning about robots and computers?	***No fun***	***A little fun***	***A lot of fun***	***The Best fun***
	0%	0%	43.75%	56.25%

Table 3: The second student survey questions and results.

Teacher/Assistant Survey QUESTIONS and RESULTS:

Classification:	*Teacher*	*Assistant*		
	75%	25%		
Did the students enjoy the class?	***Not at all***	***A little Bit***	***A lot***	***They loved it***
	0%	0%	20%	80%
Did the students learn anything about robots and computing?	***Not at all***	***A little Bit***	***A lot***	***Tons***
	0%	20%	60%	20%
Did the students seem more interested in computers?	***BEFORE***	***AFTER***		
	0%	100%		
Did the toys, or Lego Mindstorms, aid in teaching concepts of robotics and computing?	***YES***	***NO***		
	100%	0%		
If given the opportunity, should this class be utilized to teach computing concepts?	100%	0%		

Table 4: The teacher and assistant survey questions and results.

These combined results support our hypothesis that using toys, in this case LEGO Mindstorms, to aid in teaching important computer concepts such as basic programming, has a positive effect on raising student's interest levels in computing.

Conclusion

We believe that by using Robotics, namely LEGO Mindstorms, in an elementary school curriculum, it is possible to increase children's interest level in computing. Although the method chosen to demonstrate this, a computer science camp offering a Robotics class, may not be completely fail-proof in every situation, the idea to use the Mindstorms as teaching tools remains to be the point that needs to be clear. Computing is fast becoming a well known and respectable field, but without interest, it will quickly experience employee shortages again. By introducing younger children to the inventive technology of LEGO and basic programming concepts at an early age, we are hopefully ensuring the world of a bright future in computing.

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Biography

Tracey Lynn Weisheit (**weisheit@hanover.edu**) is a junior at Hanover College in Hanover, Indiana. She will be graduating in May of 2005 with a major in computer science and a minor in mathematics. Her research interests include peer to peer networking, desktop publishing using Adobe products, and user support for operating systems. In her leisure time, Tracey enjoys softball, outings with her sorority sisters in ADPi, ultimate Frisbee, and the TV show JAG.