Using Robolab Software and Lego Hardware to Teach Computing Concepts to Deaf and Hard-of-Hearing High School Students

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Abstract: Each summer NTID offers a one-week workshop for approximately 200 deaf and hard-of-hearing high school students, called Explore Your Future (EYF). These students (17-20 years of age) sample a variety of activities that are designed to educate them on different career possibilities. The Holland model is used to help students understand the various career areas and skill requirements. One of the author's of this paper was responsible for the "Investigative" Holland category and was charged to set up a technology activity which taught basic concepts of computer technology, including software, hardware, programming and interfacing. The first year the male and female participants were combined, the second year they were separated to see if the learning or the interest level changed among each gender. The authors' implemented an outcome assessment to see if the students gained both an understanding of what the Investigative type of career was and to see what technical concepts were learned during this 45-minute activity. The outcomes are derived from 394 deaf and hard-of-hearing high school students during a two-year time period. Both female and male participants showed similar gains in hardware and software knowledge. However, regardless of knowledge growth and female role models (i.e., female instructors), the high school female students' interest in this career area remained relatively unchanged and even declined. The technical activity and outcomes are discussed in detail.

Introduction

Technical educators of the deaf often wonder if and how quickly deaf and hard-of-hearing students can learn concepts pertaining to computer hardware and computer software/programming. During the summers of 2001 and 2002, the authors developed a 45-minute activity for deaf and hard of hearing high school students enrolled in the Explore Your Future (EYF) program. This activity was developed around Robolab™ software programs in conjunction with Lego™ toys equipped with motors, lights, touch and infrared sensor peripherals interfaced to the Lego RCX controller. The authors also developed a 10-question assessment that tested the students' knowledge before and after the 45-minute activity.

Although students enjoyed these types of activities in years past, nobody really knew if and how much information they learned about the career area and about the specific content being taught or whether students' interest in these types of careers increased or decreased. This activity needed an assessment in place to measure the outcomes that showed how much the students actually learned about the career type, about the technical content being taught, and how their interest in this career category increased or decreased. The current study was an attempt to implement an evaluation process for this EYF technology activity.

The Study

A total of one hour was allotted to this technology activity. The one hour included the assessment and explanation time, which required about 10 minutes before and five minutes after the activity. The learning activity itself was 45 minutes, with only five minutes of explanation and 40 minutes of hands-on activities.

For the 2001 activity, male and female students were combined, with one female teacher and one male teacher and one male student assistant. For the 2002 activity, the male and female students were separated into separate groups, with the female students having two female instructors and the male groups having male instructors.

During the 45 minute activity, students had to: set up and connect the hardware input and output devices, including touch and light sensors; set up and connect output devices, such as lights and motors; interface the input and output devices to the RCX controller; select a correct Robolab software program to run their hardware configuration; download the correct Robolab program to the RCX; run the hardware using the software program which they downloaded to the RCX.

Figure 1. *Example of RCX Controller, Lego Hardware and RoboLab Interfacing*

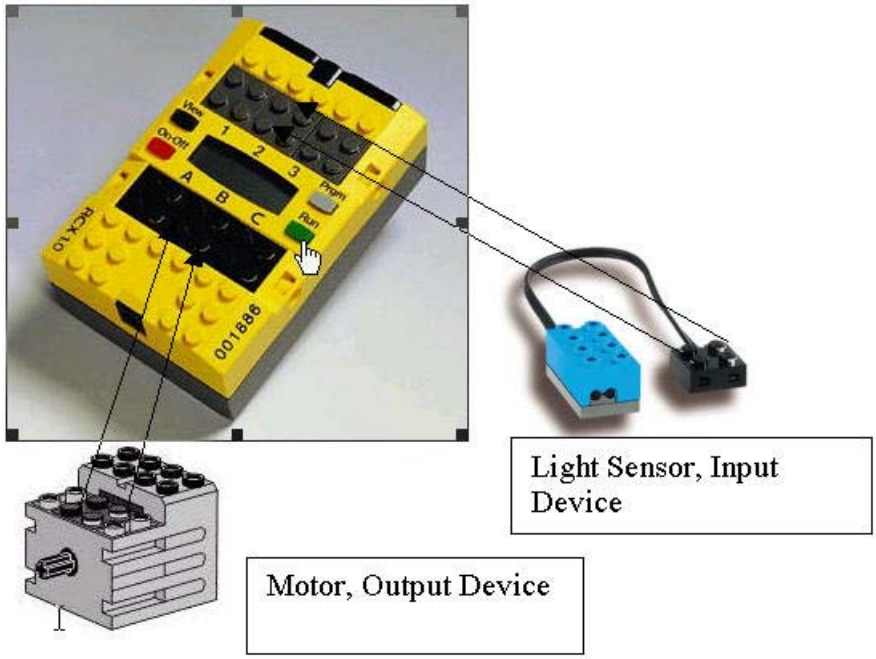
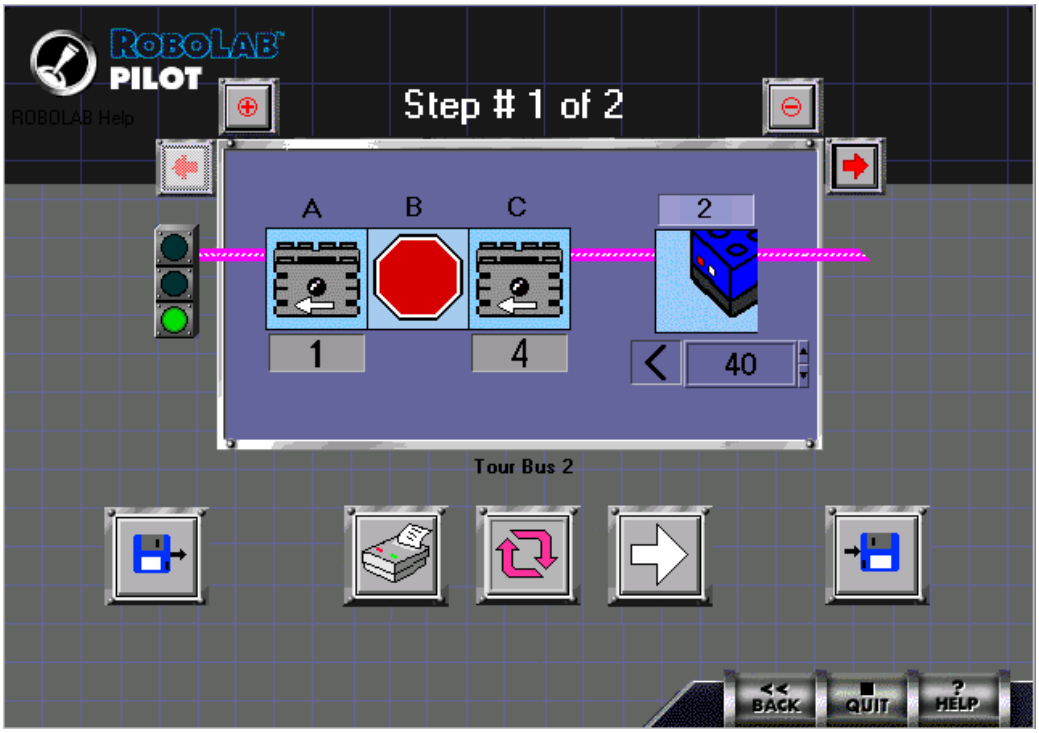
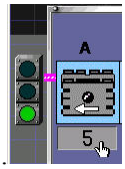


Figure 2. *Partial Robolab Software Program for EYF Activity*



Two questionnaires were developed, one pre and one post activity that consisted of 10 questions on the actual programming activity plus 4 other questions to find out about student demographics. The questionnaire had to be very brief due to the limited time available for students to fill it out. The 10 activity questions dealt with specific technical details, two about input and output hardware, four about the software and two questions about the interfacing aspects of the activity. The interfacing was included in the hardware group of questions when the data analysis was performed. *Figure 3*. shows a sample software type of question. The questions had various degrees of difficulty, some fairly obvious and some were quite difficult. The entire class of students for each EYF session was asked to fill out the pre and post activity questionnaire.

Figure 3. *Sample of One EYF Software Question on the Questionnaire*

7. 

What do these 2 software commands do?

- ☐ I don't know.
- ☐ Start the program, turn the motor connected at Port A on so that it rotates in this direction shown at a speed of 5.
- ☐ Start the program, turn 5 motors on until the program tells it to stop at point A.
- ☐ Go when the motor 5 starts to turn.
- ☐ Turn port A item on 5 times

Findings

There were 394 deaf and hard-of-hearing students (183 females and 211 males) who participated in the described "Explore Your Future" activity during 2001(n = 215) and 2002 (n = 179). The average age for females (17.4) and males (17.5) was statistically similar.

In 2002, the increase in learning for both females (blue) and males (red) from pre to post activity was statistically significant as shown in Chart 1 on Hardware concepts, F (1, 177) = 334.88, p = .0001 and Figure 5 on Software concepts, F (1, 177) = 569.5, p = .0001. This indicates students of both genders learned the desired concepts equally well during the 45-minute activity for both hardware and software concepts. Software concepts were more easily learned, especially by the female population. The authors assumed that this was due to the frequent student exposure to computers and other software concepts during their lifetime as compared to the reduced exposure they would have had to hands-on hardware types of activities.

Figure 4. *EYF 2002 pre and post learning for hardware concepts*

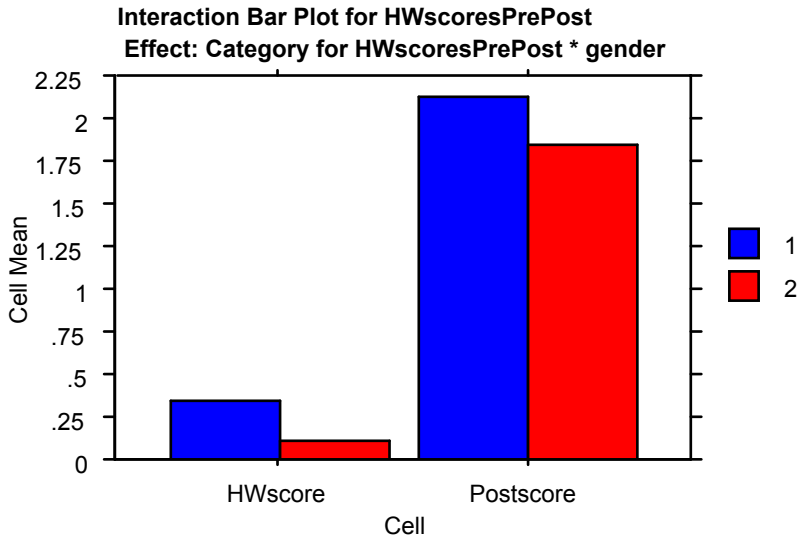


Figure 5. *EYF 2002 pre and post learning for software concepts*

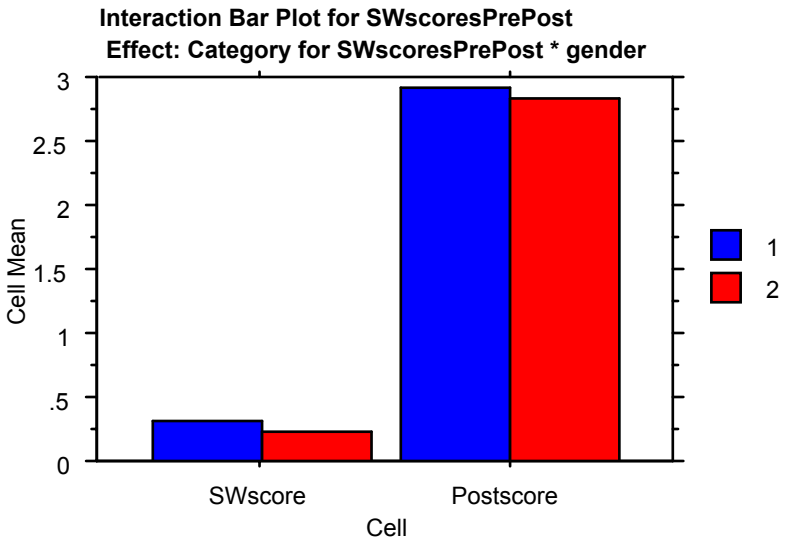


Table 1. Pre and Post Mean Scores for Students' Learning of Software and Hardware Knowledge

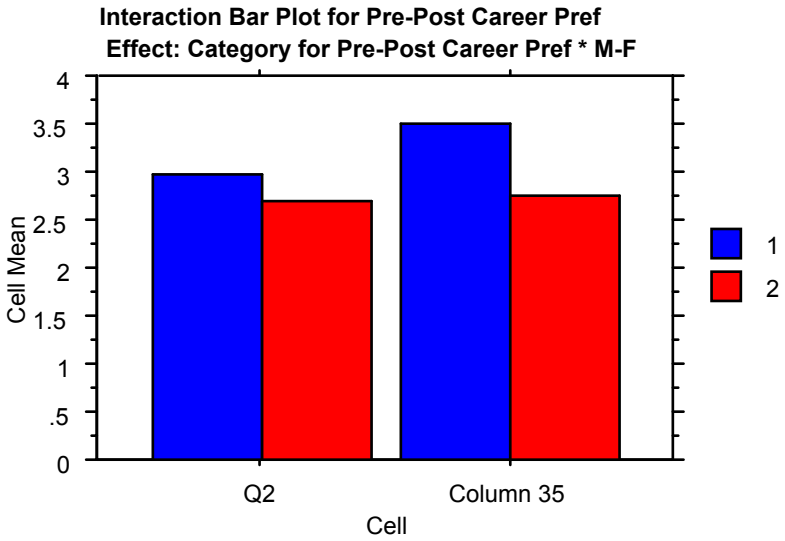
	2002		2001	
Hardware knowledge	Pre-EYF Survey	Post-EYF Survey	Pre-EYF Survey	Post-EYF Survey
Male	.34 (.67)	2.1 (1.2)	.40 (.7)	1.7 (1.3)
Female	.11 (.35)	1.8 (1.3)	.31 (.7)	1.5 (1.2)
Software knowledge				
Male	.31 (.68)	2.9 (1.2)	.43 (1.8)	2.6 (1.2)
Female	.23 (.58)	2.8 (1.4)	.3 (.6)	2.9 (1.2)

Table 1. above shows the mean growth in test scores representing the learning outcomes for the 2001 and 2002 activities for both male and female students on software and hardware topics.

As far as career preferences, it was found that males in general had an interest in Investigative types of careers prior to their EYF experience compared to their female counterparts. The interest on the part of the males increased significantly

from the 45-minute activity as indicated in Figure 6 below during the first year 2001 of assessing this EYF activity. In contrast, the female students had less interest in this activity and their interest remained basically flat with no change.

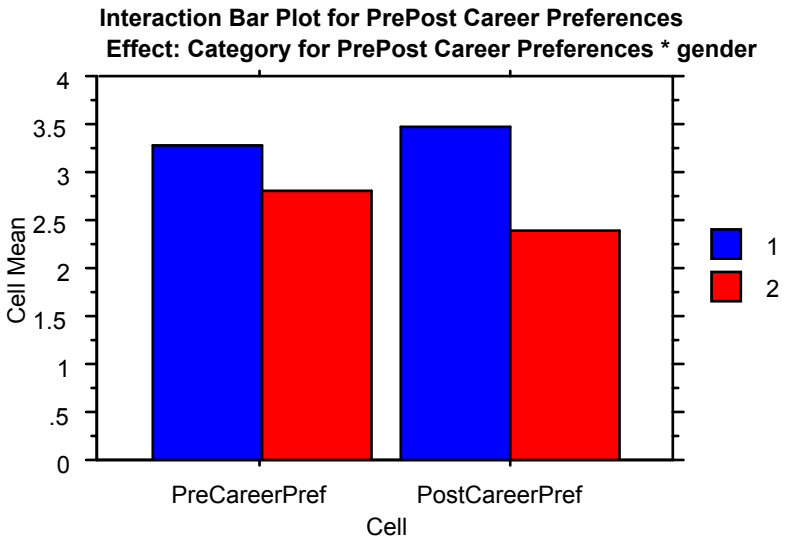
Figure 6. EYF 2001 Pre-Post Career Preferences with Gender Combined



Combined

In order to increase the interest among the female population, for the 2002 year's activity we separated the males and females and had the females work with two female instructors and the males work with the male instructors. The preactivity interest as shown in *Figure 7.* showed similar results to the year before. The interest in the male students increased similar to the previous year. However, to the authors' surprise, the post activity interest in Investigative types of careers on behalf of the females actually decreased when the they were taught by female instructors as can be seen in *Figure 7*.

Figure 7. EYF 2002 PrePost Career Preferences with Gender Separated



Conclusions

The students' pre and post EYF responses during a two year time period showed that a 45-minute activity using a Lego RCX controller and the related input and output hardware along with Robolab software can be an effective way to introduce computer software and hardware concepts to deaf and hard-of-hearing high school students. Such an activity can also help clarify deaf students' understanding of an "investigative type of career," in addition to giving them a deeper informational basis for career decision-making when planning their college studies.

There was a statistically significant increase in pre and post activity results relating to the understanding of the investigative career category, regardless of gender. Prior to the EYF activity in 2001, 44% of the students stated that they "did not know" what an investigative type of career was compared to only 9% after the activity. Similarly, 35% knew that computer programming was an investigative type of career prior to participating in EYF, while 75% correctly indicated this after the activity. In 2002, the results were similar where 25% stated that they did not know what an investigative type of career was pre-EYF activity, compared to only 7% after the activity. Similarly, 60% indicated they knew what it was prior to this EYF activity compared to 87% after the learning experiences.

The findings also showed a statistically significant increase in pre and post activity understanding of hardware and software computer concepts, regardless of gender. In 2001 for hardware input devices, for example, 83% of the students indicated that "they did not know" what an input device was, with only 8% getting the answer correct, whereas after the activity 5% of the students "did not know" with 59% showing a correct response.

This study uncovered some rather interesting gender differences among deaf and hard-of-hearing high school students. Prior to the EYF activity in 2001, only 4% of the females had programming experience compared to 17% of the males. There were also gender differences with respect to students' interests in pursuing an investigative type of career. Males increased their interest in investigative programming from pre to post EYF. In contrast, females showed no statistically no change in interest from pre to post EYF activity in 2001 and were even less interested in this type of activity when they were separated from their male counter parts in 2002. These findings indicate that in spite of having female role models providing the instruction and leading these types of activities, the high school female students' interest in these investigative types of fields does not appear to be influenced.

Acknowledgements

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