Teaching the Way of Using Computers with Autonomous Robots for Junior-High Students

HK Ho-Kyeong Ra
Computer Engineering & System
Institute of Technology
University of Washington, Tacoma
hkr88@uw.edu

Sam Chung
Computing & Software Systems
Information Technology & Systems
Institute of Technology
University of Washington, Tacoma
chungs@uw.edu

Jie Sheng
Computer Engineering & System
Institute of Technology
University of Washington, Tacoma
shengj2@uw.edu

ABSTRACT

Computers can be used more effectively for constructive work instead of just chatting and games. This paper talks about our efforts in introducing computers to junior high school students (eighth grades) as more creative learning tools in a fun way. A visual programming curriculum utilizing an autonomous robot was developed. Both the course design and the teaching materials are discussed in the paper. Moreover, the before and after difference in taking the course is shown by conducting survey and data analysis on them. The results show that after taking the course, most junior high school students were able to experience the broad view of usage of computer other than just thinking of computer as tools for recreational activities such as gaming and chatting.

Keywords: computer, robot, junior high school students, survey, correlation

1. INTRODUCTION

The range of computer usage is very broad throughout all of age groups. However, many of elementary students in the USA are addicted to computer games and chatting [2]. Statistics in [3] shows that 97% of teenagers used computers for games; 54% of them used computers for internet web surfing purpose. People in education area have been looking for ways to use computers more effectively for constructive work, although it is very hard to let young children to see how a computer can be used as a useful tool instead of chatting and games.

In other studies, the robots have been used for various purposes. In [1], authors showed how teaching programming with robot can develop technology literacy in Japan. During study, they developed a robot that could understand programming language "Dolittle". Other than developing robot and conducting survey, they had to develop the teaching contents. The study result showed considerable improvements in understanding technology articles by the group of students who were 11 years old. In [4], RCX robot was used to introduce idea of how computer can be a fun tool to use and to play with. The age group was between 9 to 12 years old, and the class was held for two days. As a result, students enjoyed playing with computer much more than before. In addition to these two given related works, there also exist lots of studies where robots were used for educational purposes. Most of these studies aimed mainly at training students as future computer scientists or computer engineers. Moreover, each study had different teaching contents; different types of robot have been used for their studies, respectively.

The purpose of this research is to introduce computers to junior high school students (eighth grades) as a creative learning tool in a fun way. For this purpose, we developed a visual programming curriculum utilizing autonomous robots. Since the kids are familiar with robot toys, they were expected to pay more attention to assembling and controlling the robots. In order to control behaviors of the robots, they had to learn how to program the robots. They started with assembling a robot with three servo motors, and then visually programmed a robot application to use its motors. The program was then downloaded onto the robot and tested. The procedure was repeated for four other sensors including a light sensor, a sonic wave sensor, a touch sensor, and a voice recognition sensor. Toward the end of the robot programming class session, the kids were required to solve several problems by using their robots and computers. The problem solving test indicated how the kids approached the problem in order to solve it, and how they used their computer to solve a certain type of given problems. The combination of a

robot and a computer delivered an important message to junior students: in addition to games or chatting, their computers can do more constructive things for them. Before and after the class surveys were administrated among the kids; survey results were used to tell how much they like or dislike computer programming with an autonomous robot compared to just playing video games or chatting.

NXT robot was chosen in our research to approach in a playful manner the solution for teaching a variety of ways of using a computer constructively. We also developed teaching materials using NXT robot, and survey questions to evaluate the difference between the ways of using computer by students. The survey result was not just for comparing data; it also served for computing correlation coefficient.

The paper is organized as follows. In Section 2, programming tools as well as the teaching materials are discussed. In Section 3, surveys used to measure the before and after differences in taking the course are presented. In Section 4, survey results are analyzed by conducting comparison as well as correlations. Finally, in Section 5, conclusions are given.

2. DESIGNING CLASSROOM

Choosing programming tool

Every computer programming classes requires Integrated Development Environment (IDE). Through this particular research, LEGO MINDSTORMS NXT and ROBOLAB 2.5.4 were chosen. Each IDE features visual drag and drop programming. The other reason for using LEGO MINDSTORMS NXT and ROBOLAB 2.5.4 IDEs was that our purpose is to teach students how a useful tool a computer can be, but not to teach them how to do programming strictly. However, both software tools contain very basic structures of programming, such as for loop, while loop, if statements, and so on. Therefore, all participants had a chance to get a taste of the basic programming. By using the chosen IDE, it was much easier for training teachers to learn NXT or RCX robot, because LEGO MINDSTORMS NXT and ROBOLAB 2.5.4 are visual programming tool. From students' points of view, the program itself was not interesting at all; instead, they were more interested in seeing what their robot's sensor is read through computer monitor. The other thing attracted them was that they were able to control robots to do the exact task or jobs as they desired by just giving certain commands.

Teaching contents

In our course preparation, we found it was very hard to get help from both the Internet and the school library the exact teaching materials relevant to our robotic class using existing IDEs for NXT or RCX. Therefore, we had to come up with our own teaching materials and lecture contents. The curriculum can be summed up to in total four different chapters, with each chapter comprising subchapters with instructions for all the students to follow. Among these four chapters, the first two described how to set up NXT software and how to use software, respectively. And the remaining two explained how to use the hardware, i.e., the robot. Since the software/hardware set up part was basically done before we started the course, we simply skipped the first two chapters to expedite the learning experience; instead, the students used them for reference. After going through all the chapters, all the students learned about sensors. Each sensor was taught explicitly to give the students a very strong basic idea about its functionality as well as how to use it. In the last chapter, students were asked to solve certain given problems individually by using any sensors they wanted to use.

3. CONDUCTING SURVEY

To measure the before and the after differences in taking class, we designed two different surveys with each question rated on the scale from 1 through 5 (1 as weak, 5 as strong). We named the first survey as "Entrance survey", which is given in Figure 1. In this survey, each question was asking the student how he/she used computer before taking the class. Half of the questions were about positive way of using computer, such as for research purpose, or studying and seeking for unknown knowledge. The other half were asking about the student's leisurely way of using computer (we call this as negative). Examples include gaming, chatting, watching movies, etc. On the "Entrance survey," the first question asked the student whether he/she had ever used any kind of robots before. The purpose of putting this question there was to open up students' minds toward class and get everyone ready to get involved with robotic studies. Except the first one, all the other questions were counted and used for data comparison and analysis, as we will talk about soon.

Accordingly, on the second survey named as "Exit survey," each question was asking the student how he/she used computer after taking the class, see Figure 2. Other than the first one, all the remaining questions were identical as those on the "Entrance survey." The first question on the "Exit survey" asked whether or not the student enjoyed studying robotic class, and if yes, to what extent he/she enjoyed (rated on the scale from 1 through 5, 1 as weak, and 5 as strong). We note that the first question on "Exit survey" would be used to calculate correlation between itself and all the other questions on "Exit survey".

4. DATA ANALYSIS

Data comparison

After conducting classes and surveys, answers to questions on both Entrance and Exit surveys that have the same numbers were compared. Significant difference was noticed in answers to questions about negative ways of using computer, see Figure 3, where before and after data are given for "Question 3: Do you use a messenger for chatting (not related to work or homework)?" and "Question 4: Do you use social networks to communicate with your friends?" As we expected, there were students who chose not to use messenger after taking the class. The result also showed that students tended to use computer toward its positive side. For questions about positive ways of using computer, such as using computer to work on homework, searching for unknown knowledge, learning special topics and learning more about robots, students' answers revealed that taking the course had helped them seeing more in using computer as an educational tool. Together with these positive results, something unexpected also showed up; some students became to play more computer games after taking the course, see Figure 4. Fortunately, in general, 70% of survey data indicated that students tend to use computer as an educational tool instead of a recreational tool, after taking our class, as shown in Figure 5.

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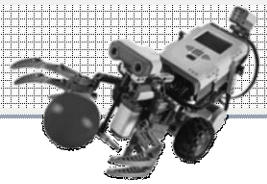


Entrance Survey

My name is HK Ra. I am doing a summer research with Dr. Sam Chung to analyze how a robot education program affects the use of a computer of a teenager. No private information is required for this survey. Your participation will receive our special thanks.

1) Have you played with robots before? Yes ( ) No ( )
   If you did, what was your robot?
   Robot name: _____ (EX. LEGO MINDSTORM)

2) Have you ever played role playing games (For example: level up by experience) or other computer games? Yes ( ) No ( )
   If you do, how do you play each day?
   Played too much ( ) Played Somewhat ( ) Played ( ) Played a little bit ( ) Not at all ( )

3) Do you use a messenger for chatting (which is nothing do with your homework)? (For example: MSN, Yahoo Messenger, AIM, etc.)? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

4) Do you use social networks to communicate with your friends? (Ex. Facebook, MySpace, LinkedIn, Twitter, etc.)? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

5) Do you use a computer for work on homework? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

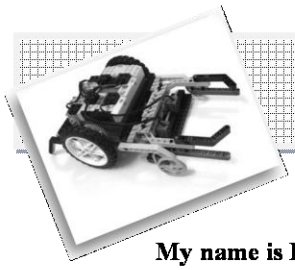
6) Do you use a computer for searching unknown knowledge? (For example: Google, Wikipedia, etc.) Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

7) Do you use a computer for listening to music? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

8) Do you use a computer for learning special topics? (For example: learning robots, programming, math, etc.) Yes ( ) No ( )
   If you do how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

9) Do you use a computer for watching movies? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

Fig.1 Entrance Survey



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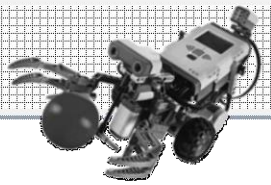


Exit Survey

My name is HK Ra. I am doing a summer research with Dr. Sam Chung to analyze how a robot education program affects the use of a computer of a teenager. No private information is required for this survey. Your participation will receive our special thanks.

1) Did you enjoy play with robots (Scale of 1 to 5)?
   Strongly enjoyed ( ) somewhat enjoyed ( ) enjoyed ( ) enjoyed a little bit ( ) Not at all ( )

2) Have you ever played role playing games (For example: level up by experience) or other computer games? Yes ( ) No ( )
   If you do, how do you play each day?
   Played too much ( ) Played Somewhat ( ) Played ( ) Played a little bit ( ) Not at all ( )

3) Do you use a messenger for chatting (which is nothing do with your homework)? (For example: MSN, Yahoo Messenger, AIM, etc.)? Yes ( ) No ( )
   If you do how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

4) Do you use social networks to communicate with your friends? (Ex. Facebook, MySpace, LinkedIn, Twitter, etc.)? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

5) Do you use a computer for work on homework? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

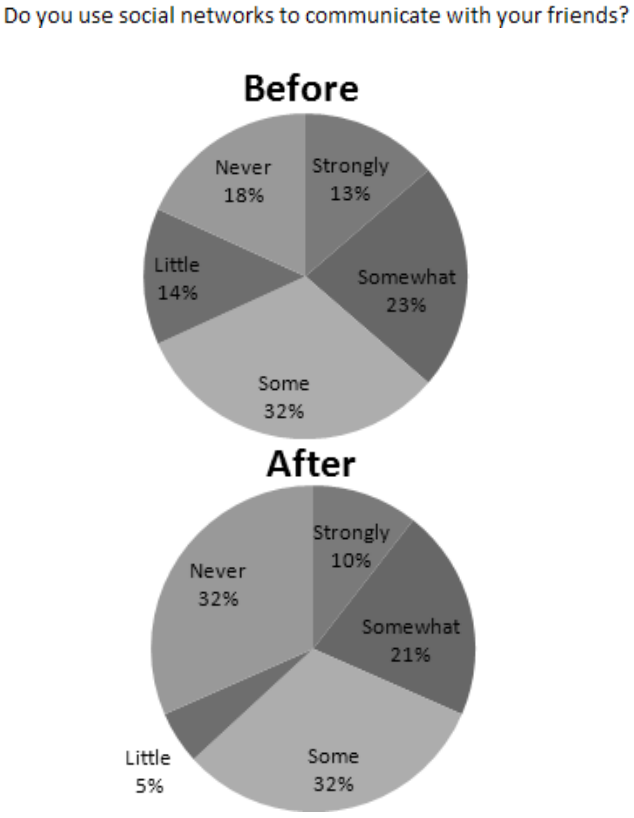
6) Do you use a computer for searching unknown knowledge? (For example: Google, Wikipedia, etc.) Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

7) Do you use a computer for listening to music? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

8) Do you use a computer for learning special topics? (For example: learning robots, programming, math, etc.) Yes ( ) No ( )
   If you do how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

9) Do you use a computer for watching movies? Yes ( ) No ( )
   If you do, how do you use it each day?
   Used too much ( ) Used Somewhat ( ) Used ( ) Used a little bit ( ) Not at all ( )

Fig.2 Exit Survey



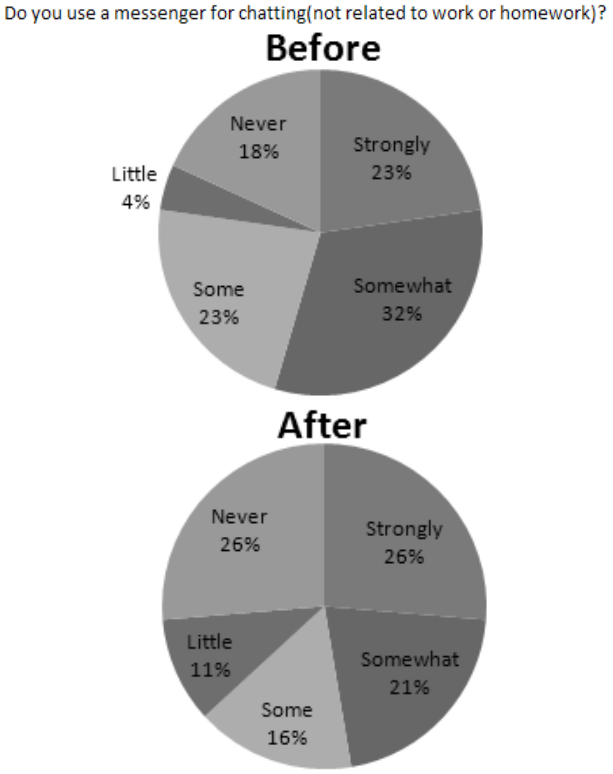


Fig. 3 Survey results for Question 3 and Question 4

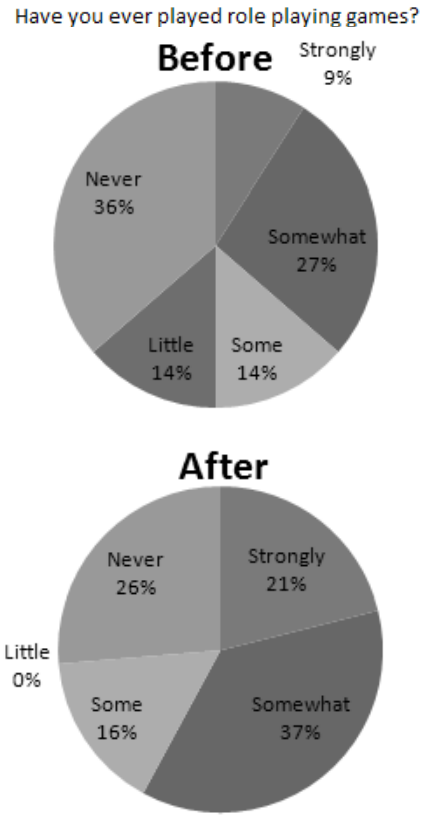


Fig. 4 Unexpected survey results

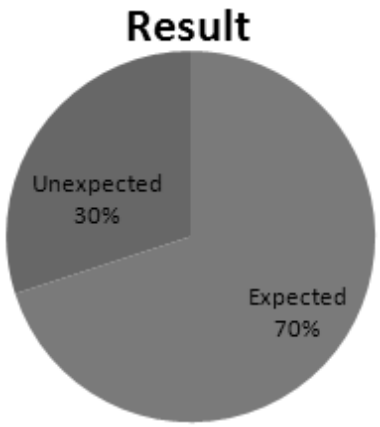


Fig. 5 General survey results

Correlation

After seeing the before and the after differences in taking our course, we took another data analysis on Exit survey itself, by calculating the correlation. Correlation, concept used extensively by scientists and engineers, is a single number that represents the degree of relationship between two different data sets [5]. On this particular research, the first data set was the first question in Exit survey - how each student enjoyed the class; and the second data

set was questions selected from the remaining ones in the same survey. As correlations disclose, if a correlation value is positive, the result has positive relationship. Reflected on this study, if the first data set is compared to positive aspect of using computer data set, the correlation should be a positive correlation value; and if the first data set is compared to negative aspect of using computer data set, the correlation should be a negative one. Moreover, if correlation value has a positive sign, it means the pair of data sets would tend to move in the same direction; and if correlation value has a negative sign, the pair of data sets would tend to move in opposite directions.

Table 1 exhibits our result where the first data set was correlated to the third Question: Do you use a messenger for chatting (not related to work or homework)? The calculated correlation value is -0.44359, a negative value as we expected. The reason is that the third question is about the negative way of using computer while the first data set is relevant to whether the student enjoyed taking robotic class. Thinking of our purpose to provide this course, if the student likes the way we showed in using computer, he/she should spend less time in front of a computer for chatting or gaming.

Table 1 Correlation between the first data set and the third question

Correlation Numerator	-190	Correlation Denominator P1	284
Correlation Denominator	428.327	Correlation Denominator P2	646
Correlation	-0.44359		

Before making any calculations, expectation for each question was made for later testing and comparison purposes, as shown in Table 2. After the calculation, 67% of the results have correlation values as we expected, and 33% of the values showed unexpected result, as given in Figure 6. We note that this is consistent with our observation and discussion in preceding subsection shown in Figure 5.

Table 2 Correlation between the first and second data sets

Q.	1	2	3	4	5	6	7	8	9	10
R	X	0.46	-0.44	-0.44	0.28	0.17	-0.25	0.11	0.25	-0.22
expectation		-	-	-	+	+	-	+	-	+
Result		+	-	-	+	+	-	+	+	-

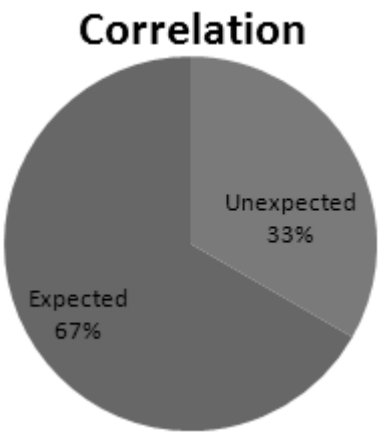


Fig. 6 Correlation results

5. CONCLUSIONS

According to the data analysis in Section 4, we concluded that after taking our course, most junior high school students were able to experience the broad view of usage of computer other than just recreational activities such as gaming and chatting. Although there were unexpected results showing that some students tended to play more games after taking our course, however, they were playing games requiring logical thinking or brain exercise with certain educational value. If computer game developers can come up with educational games that are fun but require students to concentrate more on learning, it will make even game playing a positive way of using computer.

6. REFERENCES

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