Robotic Simulators to Develop Logic and Critical Thinking Skills in Under Served K-6 School Children

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Abstract

There are many ways children benefit from using and interacting with technology. Basic technical skills, logic and critical thinking are necessary for a child to be successful in school. Some children, depending on socio-economic background or other factors, will not get the same level of support in developing these skills as children with more assistance. The Robotic Simulator discussed in this paper will supply a tool for children in kindergarten through 6th grade to enhance their critical thinking skills. The effects of the simulator to increase neural plasticity and augment thinking skills will have potentially life long effects.

Introduction

There are many programs to generate interest in scientific and mathematical disciplines. Getting students interested in science is only one part of the equation, as we must also prepare them for logical thinking and problem solving. The *Robot Simulator Program's* primary goal is to provide a structured learning experience for children in grades K-6 to develop logical neural plasticity [2, 3] and thinking skills at an early age. As an example, it is commonly accepted that the best time for learning foreign languages is when children are young. The same can be said for logical thinking. It is beneficial to start solving logical problems as the brain is forming in order to develop the required neural plasticity that can be employed over a lifetime of logical thinking and problem solving. The program will employ a software-based robotic simulator that allows the student to build a simple sensor/effector robot, use that robot to create a series of logical programming challenges, with increasing levels of difficulty, and evaluate how the robot functions. Our experience with the Robot Roadshow Program [1] reveals that even kindergarten children can easily learn how to manipulate robots via sensors. We want to extend these experimental learning experiences to boost the critical and logical thinking skills in a great number of children.

The goal of many robotics programs is to expose school age children to technology and interest them in science. While the experiences of such programs are normally strong and worthwhile and complete the goal of creating interest, programs of this type are normally resource constrained. Our secondary goal is to provide a complete learning experience utilizing the interest that robots generate but to also remove barriers of resource constrained programs. The *Robotic Simulator Program* fills common gaps of current hardware-based robotic programs targeted at elementary and middle schools. With ventures such as Robocup events and Mindstorm programs, the schools must have funding to purchase hardware and software thus being resource limited whereas the Robot Simulator Program allows complete access due to its software based nature. This Robotic Simulator Program is freely downloadable to all students and others who would like to participate. There is no licensing or payment of any kind. This will eliminate the disqualification of any student, teacher or administrator who wants to participate in the program.

In this paper, we will discuss the goals of the program. An important area is the access to the technology and tool which will be discussed. The Robotic Simulator will be discussed in the next section, with a complete description and visual graphic to describe the tool. We finish our discussion with some preliminary results and a description of further work to complete the program.

Program Goals

There are many goals for this program with a core set that define the nature of the program. The core goals for this program are:

1. Develop logical and critical thinking skills at an early age.
2. Create opportunity for under served K-6 school children to have access to additional continuous and freely available educational resources.
3. Encourage students to develop an early appreciation for scientific, logical and technical disciplines.
4. Create a lesson-based reinforcement process to create a long term learning and enabling effect.

Access

This program is freely available to all schools and other interested organizations. The only minimal constraint is access to the internet. With access to the internet becoming a ubiquitous capability, it levels the playing field for access to our program. If students or schools do not have access to the internet, a CD mailing program will be available.

The Robotic Simulator fills a gap of the Robotic Roadshow. It allows complete access to the program. With the Robotic Roadshow, we are limited by physical resources of people to conduct the program and physical resources, such as robots. To conduct ventures such as Robocup events and Mindstorm programs, schools must have the funding to purchase hardware and software. The Robotic Simulator Program is free to all students and others who would like to participate. There is no licensing or payment of any kind. This will eliminate the disqualification of any student who wants to participate in the program or a teacher or administrator who desires to use the program within their school.

Robotic Simulator

Initial Idea Development

The general idea for the Robotic Simulator initiated from observing pre-kindergarten and young elementary school children interact with robots during the Robot Roadshow Program. Even though they conceptually did not understand the technology of the robotic sensors, they easily learned how to manipulate the robots using the sensors. We began to notice that young children learn very quickly when given a logical task to carry out.

Ideas from children that participated in the Robot Roadshow Program were used as one of the inputs to develop the robotic simulation program. They will also assist in testing the software and help us continually improve the software.

Program

The simulator will contain of a set of 20 lessons increasing in technical difficulty to challenge the student as they progress. Each lesson will be self-directed and interactive. The progression of lessons will form a challenging pattern of increased knowledge with each lesson reinforcing previous lessons and adding a new element of learning. A screen shot of the robotic simulator software tool is shown in Figure 1. The simulator consists of 3 main elements; building a robot, writing a program to control the robot and the play space or environment the robot works within. The challenge of each lesson will drive how a robot is built, the program to be written and the play space the robot will have to interact with.

Building the Robot

Each lesson will require the student to build a simple robot using simple available capabilities. The capabilities are sensors and effectors such as sonar, wheels, grippers and vision. The simulator will give tips to assist the student in what should be chosen to complete the task or lesson.

Writing a Program

The programs are based upon a very simple, English-language syntax with a limited vocabulary and grammar. The commands will move the robot, operate its sensors and effectors and allow it to interact with the environment.

Play Space

The *Play Space* is the environment in which the student built robot will live and work. For some lessons, the Play Space will be given from the simulator and for other lessons the student will have control over creating the *Play Space*. The environment will consist of walls, impediments, goals, people and other objects the robot will have to work with or around to complete its assigned task.

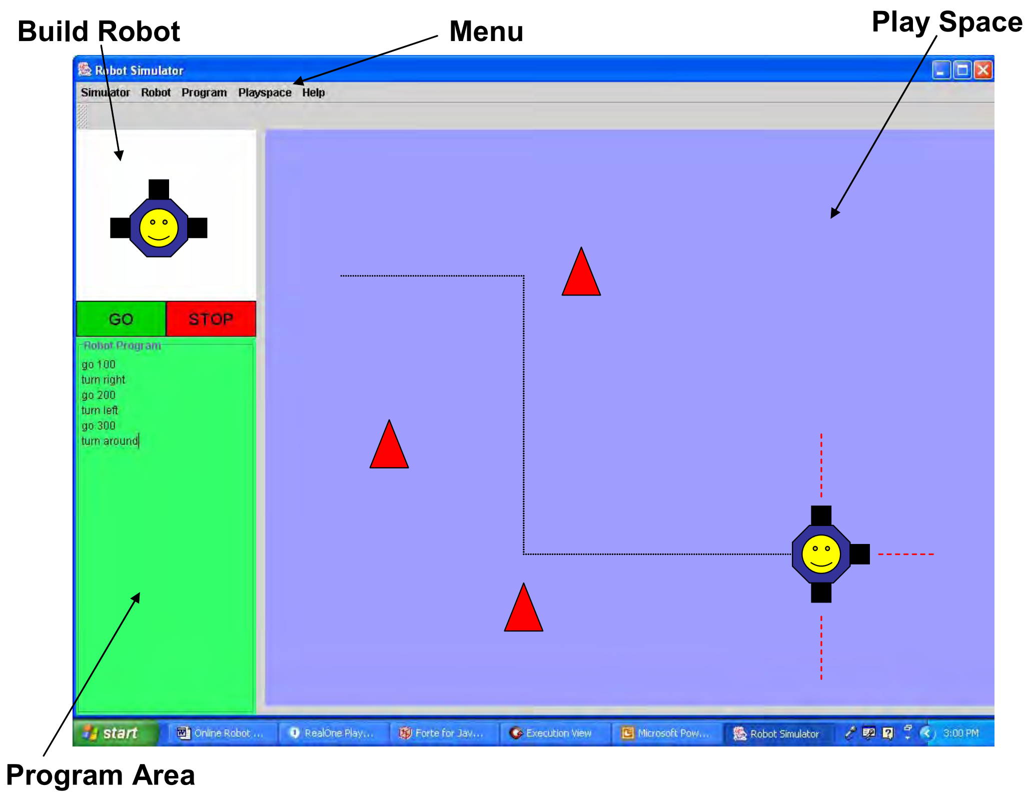

Figure 1: Robot Simulator

Results

Although results are very preliminary, due to the stage of current development, we hold that the program will be invaluable for developing critical thinking skills in young, school age children.

Although it is difficult to measure the long-term results for this type of outreach program due to the number of factors and variables, we will track the success of the users via an online web tracker program that students can voluntarily participate in. This will allow the easiest way to report back on the success of each student, school and group. This program feature will also allow us to factor in the relevance of each lesson and adjust them if necessary.

Further Work

As the program moves forward the most important effort will be to secure funding to provide the program a permanent operating basis. This will allow a consistent product for student involvement and achievement and create an environment of continuous improvement for the Robotic Simulator.

Lesson stratification will be introduced after evaluation of the appropriateness of the current lesson plans. Stratification will allow lessons to be targeted at a very specific age group, for example kindergarten. Developing different lesson plans will increase learning impact by providing the most direct experience for a particular age range.

A third future enhancement is to convert the simulator's environment and robots from two dimensional to three dimensional view spaces to enhance the student's visual experience and create a more realistic environment.

References

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Biographical Information

ERIC MATSON is currently a Ph.D. student in the Department of Computing and Information Sciences, College of Engineering at Kansas State University. His current research interests include organizational theory, cooperative robotics, multi-agent systems, and adaptive information systems. Prior to returning to academia full-time, Eric spent 13 years in industry working as a software engineer, project leader, manager and director for companies such as AT&T and Schneider Electric. Eric received his B.S. in Computer Science from Kansas State University in 1988, a M.B.A. in Operations Management from The Ohio State University in 1993, and a M.S.E. in Software Engineering from Kansas State University in 2002.

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