

Introducing Technology Using LEGOs to At-Risk and Minority Elementary Students

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Abstract

Many at-risk and minority elementary students are not introduced to the “fun” of technology. In addition, they often lack good role models that utilize technology in their careers. To the students, there is no connection between technology and the devices and machines that they see or use everyday.

Certainly, technology is not always considered “fun” and is often not considered as a potential career. In fact, girls are often discouraged from seeking careers in technology or they simply feel their math and science skills are not suitable for technology careers. And, too often, these misconceptions originate at young ages, preventing knowledgeable and capable people from pursuing personally rewarding and satisfying careers.

This program aims to use very simple tools – LEGOs- that nearly all elementary school students have experienced and enjoyed. A LEGO set called **Pneumatics I: Introduction to Air Power Set** is provided for each student. Several simple machines using pneumatics, like a vertical press, are constructed by each student. The fundamentals of pneumatics and hydraulics are evident in these simple machines using LEGOs. A videotape, *Discovering Fluid Power: Hydraulics and Pneumatics at Work in Your World*, also is shown to the students to allow them to relate the simple machines and principles demonstrated in the LEGOs to the larger, more complex machines they see in their world.

This project is done in conjunction with the Center for Teaching & Learning, an initiative of the Community Education Coalition, in Columbus, Indiana, which has recently received a grant to bring educational opportunities to at-risk children.

While this idea may be simple in thought and execution, it introduces some at-risk youth to technology and to positive role models that may help them to build constructive and satisfying lives.

Introduction

Much has been written recently about the loss of manufacturing jobs in the United States. The *Indiana Business Review*¹, a quarterly publication of the Indiana Business Research Center, Kelley School of Business, at Indiana University, discussed these issues in its 2004 outlook for Columbus, Indiana and Bartholomew County. In the outlook, the jobs lost are considered “structural” employment, which typically do not return when the economy improves. Some losses were due to increased productivity and to jobs moving overseas. According to the report, “Ten years ago, more than 40 percent of all jobs in Bartholomew County were in manufacturing. Today that figure is about 35 percent.”¹ A related issue is that, although the percentage of the workforce holding a BS degree has increased from 17 to 22 percent, based on data from the 1990 and 2000 censuses, Bartholomew County fell in its ranking with other nearby counties. The articles states that “There is a clear link between educational attainment and income. Keeping the Bartholomew County workforce competitive in education is important for future prosperity”¹. Clearly, lower skilled jobs are permanently leaving the county and a well-educated populace is critical to the economic well-being of a community.

With these issues in mind, a program called *Learning with LEGOs* has been developed by the Purdue University School of Technology in Columbus/Southeast Indiana to introduce technology and teamwork to at-risk and minority elementary school students in the third to fifth grades. At-risk participants are identified as those elementary students who are eligible for reduced or free lunch at their school. This segment of the population is often not exposed to post-secondary education, including technology education and its benefits. Numerous sources have also discussed the low representation of women in the engineering and technology work force. The reasons for this low representation are discussed in a paper by Phillips and Wilson-Head². Other sources³ indicate that this third through fifth grade age group is when girls are deciding they don’t like science and engineering. This project aims to keep girls interested in engineering and technology at the time they begin to feel the pressure to shy away from these fields as well as expose at-risk students to technology careers and role models.

Role modeling and mentoring are also key aspects of the program. Many minority and/or at-risk youth have no role models in science, engineering and technology fields and can benefit greatly from such a relationship. Indeed, at this campus, many students are the first members of their family to pursue post-secondary education. Burtner⁴ describes in her work the very effective mentoring program at their summer camp for girls. Again, at-risk and minority youth are targeted in this project to expose them to adults and college students in the engineering and technology fields to allow them to see the benefits of higher education, especially technology education. To that end, representatives from local industries as well as students from Purdue University will assist the students during the workshops.

Concept

The genesis for this project was derived somewhat from the PRIME coalition in Southwest Pennsylvania. This coalition (**P**artnership for **R**egional **I**nnovation in **M**anufacturing **E**ducation)

“is an industry-driven, five college system delivering innovative manufacturing education and career development in Southwest Pennsylvania.”⁵ The goals of the coalition are

1. Build regional support for the engineering industry and increase awareness of the vast array of employment opportunities in the region's manufacturing sector.
2. Develop innovative manufacturing programs that emphasize real world experiences and provide students with hands-on learning with industrial-grade equipment.
3. Develop a feeder system for individuals who will access the seven new degree programs that will be offered by PRIME's educational partners.⁵

These goals could easily apply to the greater Columbus, Indiana area as well as all of Indiana. Students are often ill-prepared to enter technology and engineering programs at the post-secondary level. Additionally, many are unaware of the high-technology careers available in manufacturing. The PRIME coalition aims to address these problems from nearly all levels with programs developed for middle school, high school, and post-secondary students. Of particular interest are the outreach programs developed for middle and high-school students. Each of these programs use the LEGO Mindstorms robotics set as part of the program and is typically done on Saturdays and includes a tour of a local manufacturing facility. The program described herein is not nearly as mature as those of the PRIME coalition.

The *Learning with LEGOs* workshop also uses LEGOs to introduce technology and develop skills such as measuring distances in both the English and metric unit systems while employing simple math skills. In addition, an exercise emphasizing people or soft skills is also included. Engineering technology accreditation as defined by the Technology Accreditation Commission (TAC) of the Accreditation Board of Engineering and Technology (ABET) emphasizes teamwork in their Technology Accreditation 2000 criteria⁶. Additionally, most industrial organizations now require employees to work in cross-functional teams, whose effectiveness depends on soft skills and teamwork. This team-building exercise will be used at the beginning of the workshop to allow the participants to be more comfortable with each other.

Financial Support

The LEGO sets for both the pilot workshop and the first workshop with at-risk and minority students were purchased by the Center for Teaching & Learning, an initiative of the Community Education Coalition, in Columbus, Indiana. The Community Education Coalition is a “community-led initiative of education, business, and community leaders committed to development, implementation, and support of a seamless learning system that provides quality education for learners of all ages and those who teach them.” Bringing “integrative leadership and resources together to improve the community learning system” is the mission of the CEC⁷. The CTL has recently received a grant to assist in offering educational opportunities to at-risk children and they graciously agreed to fund the pilot workshop and the first workshop for minority and at-risk youth. It is our hope that ongoing financial assistance will come from the local business community as they recognize the long term benefits of this program to themselves and the entire community.

Workshop Organization

The goal for the workshop is to limit the number of elementary students to ten. Some students may have difficulty assembling the LEGOs and, in order to keep them from getting frustrated, a faculty member or community volunteer may assist the student. Ideally, there would be a single volunteer for each elementary student. While ensuring that the student successfully builds the simple machines, the volunteer also instructs the student on the fundamental principles involved. The volunteer may also offer several “What If” scenarios to the student to investigate how small changes in the machine affect its function.

The agenda for the workshop is as follows:

1. Introductions
2. Teambuilding Exercise
3. Video- Discovering Fluid Power: Hydraulics and Pneumatics at Work in Your World
4. Assembling the LEGOs
5. Visiting the website: howstuffworks.com
6. Summarize the day

The team building exercise consists of two teams of students each forming a circle. Each team will hold hands, while a hula hoop is placed on top of the hands of two students. The students will be asked to send the hula hoop around the circle without breaking the chain. They will then be asked to complete this activity again, but besides sending the hula hoop around the circle, they will also have to send it backwards. This activity shows the students that by working together, teamwork, they can accomplish their goal (sending the hula hoop around the circle and back). Without teamwork, they will not be successful.

Also contained within the Air Power set is a 12 minute video on pneumatics and hydraulics in use in our world today. The basic fundamental principles of pneumatics are explained and examples are very age-appropriate, including construction and farm equipment and dinosaurs seen in movies. Force multiplication is emphasized in an example showing a mouse lifting an elephant and is contrasted by showing the long length required for a mouse to lift an elephant on a teeter-totter.

The LEGO set used for the workshop is the **Pneumatics I: Introduction to Air Power Set** and is priced at \$32 per set. Three instruction cards are provided with the set that lead the participants to build first, second and third class levers; a vertical press; and a scissors lift. The teacher’s guide for this set contains copy masters with instructions, diagrams, and questions for the students to answer. The instructions and questions focus on making small changes to the model and discovering the differences that those changes make.

Initially, the students simply construct the hydraulic circuit consisting of the pump, valve and actuator. Several questions they answer lead them hopefully to understand how the valve operates and how the air works to move the piston and the actuator.

After constructing the circuit, the students continue building the first, second, and third class lever. Several questions relate to the direction and magnitude of displacement of certain points on the lever. This allows students to recognize that the different levers can be used for different applications, depending on what's needed.

Another instruction card enables students to assemble a vertical press similar to that shown in the video. A second configuration of the vertical press demonstrates that it can also be used in a horizontal position. Among the tasks performed by the students is to measure with a ruler the displacement of the press in both inches and centimeters. This is certainly good exposure to the two unit systems of our unit-challenged country. Finally, students are asked to put something soft like a piece of paper and something rigid like a LEGO brick in the press and record their observations while actuating the press.

The final model built during the workshop is a scissors lift, also highlighted in the video. Again, a slight configuration change demonstrates to the students that the lift could go to different heights depending on the application. As with the vertical press, the students are asked to measure with a ruler the height attained by the lift in both inches and centimeters.

Conclusion

The genesis, funding, and plan for a workshop for minority and at-risk third to fifth grade elementary students are described. The Center for Teaching and Learning, an initiative of the Community Education Coalition, in Columbus, Indiana, has funded the first workshop. Positive acceptance of the workshop by the community will hopefully attract continued funding for the program. Although the program incorporates the use of LEGOs, which is not a new idea, additional elements include team building exercises that introduce students to the complicated aspects of working together.

By demonstrating engineering and technology concepts using simple toys, the workshop hopefully serves to interest students in engineering and technology careers they hadn't previously considered. The authors also believe the interaction with an adult mentor will allow the students to see the benefits of education in general and motivate them to obtain a high school diploma and continue their education in a post-secondary institution. Regardless of the type of education received, a more educated population will certainly benefit Columbus, Bartholomew County, the state of Indiana and the country.

The pilot workshop and the first workshop are scheduled to occur during the spring semester of 2004. Observations of both of these will be shared during the presentation at the conference. Grants from community organizations as well as potential corporate sponsors will be aggressively pursued to continue the program locally and possibly within the extended region

surrounding Columbus, Indiana. The authors' plan is to report in a future paper observations of the currently scheduled workshops and results of the fund raising efforts.

References

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