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# Developing Technology in Upward Bound Mathematics & Science Curriculum

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## 1. Abstract

This paper will examine the incorporation of technology into the curriculum for New Jersey Institute of Technology's Upward Bound Mathematics & Science Program (UBMS). UBMS provides high school participants with the opportunity to spend a fraction of their summer and academic school year studying in state-of- the-art science, mathematics, computer laboratories and smart classrooms. The program goal is to enhance the participants' academic ability and interest in technology by providing hands-on opportunities to work on research projects with university faculty and mentors.

We will also examine the influence of incorporation of Technology on bridging the Digital Divide and Computer Equity for groups under-represented in science, technology, engineering and mathematics. A review of the effects of technology on our participants in their educational attainment at the secondary and post-secondary levels is presented.

## 2. Introduction

The Center for Pre-College Programs at the New Jersey Institute of Technology houses an Upward Bound Program and Upward Bound Mathematics & Science Program which services one hundred and sixty-four students. The Upward Bound Program target area is comprised of six cities in New Jersey: the municipalities of Newark, East Orange, and Orange located in Essex County, and Jersey City, Hoboken and Union City located in Hudson County. The Upward Bound Mathematics & Science Program services students residing in New Jersey and New York. Both the programs provide participants with the opportunity to spend a part of their summer and academic school year studying in an environment equipped with the best science, mathematics, computer laboratories and smart classrooms in the state. The Program seeks to enhance the students' academic ability and interest in technology by providing opportunities to work on research projects with NJIT faculty and mentors by applying scientific concepts [1].

The learning experiences consist of a five-week residential instructional and mentoring component that is designed to simulate a post-secondary undergraduate experience. The academic component is comprised of 26 Saturday lecture and enrichment sessions. Additional contact with the students is maintained throughout the school week by utilizing technology tools such as the Internet, World Wide Web, E-mail, AIM and Chat rooms, in addition to telephone calls.

In this paper, we will describe examples of utilization of technology as hands-on tools to facilitate and appreciate the process of learning in the classroom and at the same time increase the curiosity of students to think beyond the box. The Vision of the program is to develop computer literate participants that have proficiency in the use of computers as a tool and the application of technology in the classroom. Through the use of a variety of technological tools and the program's Computer Education, Application and Programming classes, participants gain the necessary proficiency and knowledge-base to utilize the resources available on the World Wide Web and deploy them to resolve science and mathematics related problems.

Most of our participants (70%) lack the exposure, education and training in the use of computers and technology in their communities and high schools that will prepare them to have the required competency for college education and the work force. The participants (60%) in our program that do have computers lack the knowledge of the potential of their computer. Most of these participants use the computer as a glorified word processor or a tool for electronic games because of the lack of hands-on training in software packages on the computer.

## 3. Our Approach

The University Computer System permits access to all program information, calendar, assignments, quiz/survey, mail and discussions via the Internet. The use of this system within our program gives our participants the opportunity to be familiar with similar systems presently being used by other Universities and in the workforce. This system is in the implementation phase for classroom usage for a few select courses as a pilot project. The starting phase will begin this spring with a small group of participants. This experience will facilitate to broaden the scope of the instruction and to have an expanded implementation into our program. Once this system is in place, our participants will be ready for maximum utilization of the computational resources available as well as the use of the Internet in other Universities and the workforce.

The program's Computer Education, Application and Programming class educates, exposes and trains our participants in the use of computers and the vast resources available on the World Wide Web. Every participant is given a hands-on-training in the usage of each component of Microsoft Office. This course has been very successful because each participant is now able to use the various features that are available in the software programs. We are presently reviewing these classes in order to integrate expanded use of computers and technology in other science and mathematics courses.

4. Technology in the classroom beyond the Internet and the World Wide Web

The Internet is only a resource and the computer provides significant infrastructure to perform real-time experiments, data acquisition and data analyses. Much of this is possible by employing Input/Output devices such as the General-Purpose Interface Bus (GPIB) [2] or Multi Sensor Interfaces (MSI) [3]. In recent years, computers that traditionally included serial (RS-232) and parallel ports are now providing Ethernet, USB (universal serial bus), and the IEEE 1394 (FireWire) ports. These new buses provide ease of use (USB), connectivity (Ethernet), and high-speed (IEEE 1394). Examples of Multi Sensor Interfaces include the Universal Laboratory Interface (ULI), the Personal Science Laboratoroy (PSL), the MultiPurpose Lab Interface (MPLI), SensorNet Interface System (SNIS) and the Mac65 Computer Interface. While the prices of these products vary, they provide platforms for creating a software architecture that is not necessarily flexible. Key factors such as ease of implementation, software compatibility and integration and time taken for real-time data acquisition and analyses determine the choice of utilization of any of these interfaces.

5. Examples of Implementation

We have been utilizing the Universal Laboratory Interface made by Vernier [4] to perform experiments in Physics. The ULI consists of a serial interface to the microcomputer and has a number of analog and digital inputs that can be connected to a variety of electronic sensors. These are connected to an EPROM (Erasable Programmable Read Only Memory) that has several machine coded routines built in. These routines handle the preprocessing of signals from the sensors and the serial communication with the computer. These routines allow applications, such as *Logger Pro*, to control and read a wide range of sensors and probes. The ULI is integrated with Pasco Scientifics' [5,6] motion sensors and photo gates to assist in experiments such as the study conservation of energy and momentum during collisions, monitor the sinusoidal motion of a mass on a spring and measure the motion of large objects.

A physics experiment that utilizes the capabilities of a computer for real-time data acquisition and analysis is presented here:

## Experiment - Motion with Constant Acceleration

Objective:

To measure the constant acceleration of a glider by two different methods.

Theory:

When an object moves with constant acceleration, the six physical quantities $x$, $x_o$, $v$, $v_o$, $a$ and $t$ *(final displacement, initial displacement, final velocity, initial velocity, acceleration and time, respectively)* that are used to describe the body's motion are interrelated by the three constant acceleration equations:

$$v = v_o + a\,t \qquad (1)$$
$$x - x_o = v_o\,t + 1/2\,a\,t^2 \qquad (2)$$
$$v^2 = v_o^2 + 2\,a\,(x - x_o) \qquad (3)$$

with $x = x_o$ and $v = v_o$ at $t = 0$.

Equation (1) is a straight line whose slope is the acceleration $a$, and the intercept is the initial velocity $v_o$.

If we divide equation (2) by the time we obtain:

$$\frac{x - x_o}{t} = v_o + \frac{1}{2}at \qquad (4)$$

Equation (4) is also a straight line if we plot $(x\text{-}xo)/t$ against the time $t$. The slope of this straight line is $a/2$ and the intercept for $(x\text{-}x_o)$ is $v_o$.

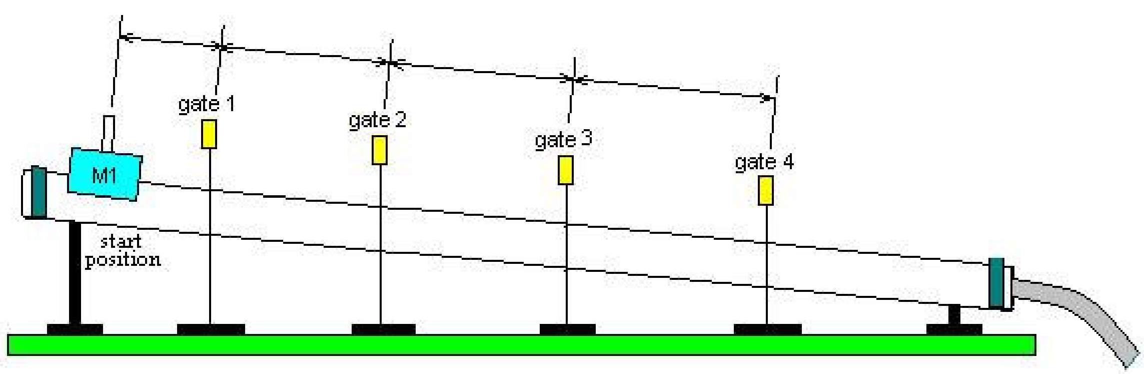


Figure 1

a. Procedure:

i. For the inclined air track, as shown in Figure 1, photo gates are to be placed about every 30 cm down the track, with the first gate about 30 cm from the start. Use the air track supports to position the gates.
ii. Measure and record the distances between the gates.
iii. With the following Counter - Timer setting:

· Mode Timer
· Counter Period ∞
· Timer Mode Pulse
· Input Hold Off
· Slope (down)

measure and record the time (**t**) it takes for the glider to move from gate 1 to gate 2, gate 1 to gate 3, and gate 1 to gate 4. Each of these measurements must be made on a separate trip down the air track. Start each trip with the glider at rest and in the same position at the top of the air track.

iv. With the following Counter - Timer settings:

· Mode Timer
· Counter Period ∞
· Timer Mode Gate
· Input Hold Off
· Slope (down)

measure and record the time (**Δt**) it takes for the flag to pass each gate (measure **Δt** for gate 2, 3, and 4 only). Each time interval **Δt** must be measured on a separate trip down the track. Next measure the width of the flag (**d**). Velocity of the glider at each gate can be evaluated by the ratio **d/Δt**.

b.Data Analysis:

I. For each time measured in part iii of the Procedure, evaluate **(x - xo)/t** and plot this versus time **t**. Find the slope of the graph and from this the acceleration.
II. For each time interval measured in part iv of the Procedure, evaluate **d/Δt** and plot this versus time **t**. If we assume that this approximates the plot of *v* vs. *t,* evaluate the slope of the graph and from this the acceleration.

c. Conclusion**:**

Determine the acceleration of the glider on the inclined air track.

d. Brain Storming**:**

Evaluate the time it takes for the glider to move from gate 2 to gate 4. Check your answer.

e. Discussion of Results:

Are the graphs from the Analysis of Data straight lines? How well does the straight line you drew fit the data? Can other straight lines fit you data?
From the graphs plotted in the Analysis of Data, find the initial velocity.

## 6. Conclusions

A brief overview of the activities relating to the incorporation of technology into the curriculum of New Jersey Institute of Technology's Upward Bound Mathematics & Science Program (UBMS) has been presented. An example of a physics experiment has been described to demonstrate the use of technology in the classroom. While the Internet will continue to serve as a resource, the computational capabilities will have an expanded role in curriculum development especially in relation to real-time data acquisition and analysis in science and mathematics related experiments in high schools.

## 7. Acknowledgements:

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## Biographical Information:

HENRY MC CLOUD, TRiO Director,
Mr. McCloud served as Associate Director of the Graduate Division for a little more than a year. In 1989 he became Director of the Upward Bound Program and Director of TRiO Programs in 1991. He serves in these capacities to the present time. His responsibilities include directing and supervising staff in Upward Bound, Talent Search and the Upward Bound Mathematics & Science Center. He writes and secures funding for all TRiO programs, hires and supervises all administrative and teaching staff.

DR. N. M. RAVINDRA, Professor of Physics & Academic Coordinator
Dr. Ravindra has been associated with the Upward Bound Mathematics and Science Program for the last nine years. He is the academic coordinator of the program. His interests in the program are focused on technology implementation in the classroom. He is an author of over 130 research papers in semiconductor physics and is a frequent guest editor of the Journal of Electronic Materials.

ANTHONY C. CULPEPPER, Assistant Director/Coordinator
In February 2002, Anthony C. Culpepper Jr. joined the TRiO staff at the New Jersey Institute of Technology within the Upward Bound Mathematics and Science Program. Prior to NJIT, he was employed at Stevens Institute of Technology and Stevens Technical Enrichment Program (STEP) as the full-time Director of the Upward Bound Project for four years.