I propose to implement a program of robotics education for both students and educators. It is my hope that successful results of this project will address the need for interest and confidence in math, science, and technology among America's developing students.Two current robotics educations programs will be addressed in this project, as well as one current teacher education program. Robotics education in the classroom uses sound pedagogy to stimulate students' thinking.

Constructivist theory is the basis for discovery learning. Under constructivism, educators subscribe to the idea that "knowledge cannot be transferred from one person to another (Domin 1999, p. 1)." Instead, a student needs to experience an event in order to make it truly meaningful. This is consistent with developmental educational theory. According to Vygotsky, students in the zone of proximal development benefit from scaffolding tools when facing new material. Completing academic activities within the social context of cooperative learning groups is also beneficial to the cognitive development of these students (Lai, 1993; Robinson, 2005; Wagner, 1999).

> Experimentation with discovery learning in the classroom has produced several positive results. While not indicative of learning per say, the study conducted by Sungur and Tekkaya (2006) demonstrated the favorable outcomes of discovery learning.

A study conducted by Hake (1998) focused particularly on introductory physics and found results in favor of constructivism. It has been established that conceptual understanding is vital to obtaining a working knowledge of Newtonian physics. Hake found that discovery learning also "enhanced problem solving skills (1998, p. 70)."

The discovery-learning classroom favors exploratory labs, or those with a result that is unknown to the students and possibly to the teacher as well. Students then use

inductive thinking to construct, or "derive a general principle (Domin, 1999, p.1)." based on their experience (Domin, 1999).

> According to the American Association for the Advancement of Science (AAAS), the most effective method for teaching the nature of science is to have students physically engage in the practice of science (1993).

> Robotics provides experiences that directly correlate with the above philosophy. Robotics-based science teaches students to "problem solve in a realistic way (Wagner, 1999, p. 2)". When working with robotics, students must define a problem, brainstorm possible solutions and then program and test their model. There is not a predetermined correct answer. Such science is an example of "pure inquiry (Robinson, 2005, p. 79)," as the lab has no present procedure or outcome (Wagner, 1999).

CURRICULUM FUNDING PROJECT

Funding Agency:
NSF (National Science Foundation) via STS (Science and Technology Studies)

Funding Request: $119,500 for 2 years

Principal Investigator:
Kelly Stellmach Castillo

Co-Investigators:
Dr. Michael Rivas, California State University, Northridge
Mr. Robert Leri, Arcadia Unified School District

Project Name:
Robotics Education for Educators; Science, Math and Technology Education in the Lab School setting

Investigator Credentials:

Castillo	Arcadia Unified School District Middle School Robotics Coordinator MA candidate, Secondary Education, Cal State Northridge CA Clear Credential, Single Subject Science 8th grade science classroom teacher, AUSD SAEP robotics instructor
Rivas*	Professor of secondary education, Cal State Northridge SAEP Co-ordinator
Leri*	Director of Technology Information Services, AUSD Ph.D. Candidate, Education, University of LaVerne

*Many more that are not mentioned here

See link for more information on this particular grant:

http://www.nsf.gov/pubs/2001/nsf01159/nsf01159.html#PREP

PROBLEM STATEMENT

Science, math, and technology education in this country are in great danger. With a lack of relative success or improvement, educational and economical institutions are suffering. The United States has lagged compared to many other nations in the area of successful science, math and technology education. In 1998, the Third International Mathematics and Science Study (TIMSS) showed that American high school seniors ranked third lowest out of the 21 nations evaluated. (Pattanyak, 2003)

Currently, fewer than 20% of American High School students actually take a physics course. Half of the high school students in the country take two or fewer years of science. The vast majority of American high school students never even have the opportunity to study physics. In the U.S. approximately one third of bachelor's degrees are awarded in the fields of science in engineering; over half of international students have comparable degrees. (National Science Board, 2008)

The legislative response to this achievement gap has been to increase high stakes testing as a measure of accountability in public schools. While California has been using state wide standardized testing since the late 1990s, the introduction of No Child Left Behind (NCLB) legislation has added a new dimension to this reality. Upon the enactment of NCLB, California changed the format of its standardized tests to include only questions based on predetermined content standards, or universal, fact based curriculum components. In the Spring of 2006, the state department of education began to expand the scope of these tests; the science content of the California Standards Test (CST) was extended to include a pilot section assessing eighth grade physical science.

History suggests that no single assessment is going to solve a national problem of such scale. Instead, a local approach needs to attack the problem from multiple angles. In order to address this inequality, the opportunity to study science, math, and technology must be provided to all students in the US. Further, this opportunity needs to be one that is creatively stimulating as well as educationally valuable. One such program that has proven to be successful in this area is the incorporation of robotics education into the classroom.

ACTIVITIES

Outcomes:

Standards based assessment (CA based) according to appropriate grade level in science, technology, and math as applicable.
Follow students into the next school year and track academic performance in school, attitudes toward TIMMS subjects, and achievement test scores where available

Teachers fill out surveys regarding (prw and post) use of technology and or robotics in the classroom

DISTRIBUTION AND CONTINUATION

Results of this study will be shared in multiple stages, ranging from a local, school-based level to a national perspective. Results will be communicated and implemented locally by making any necessary modifications to both the AUSD and the SAEP programs. Additionally, successes of the program will be used to add to the current CSUN curriculum at the Masters' level. Successful continuation of each of these programs will severe as an example of continuation as well as a model for other schools interested in the project. Sustained success will be a motivating factor in having both organizations, CSUN and SAEP, begin to absorb the costs of the project as a part of their new program.

In order to spread the findings of the study to a wider audience, results of this project, as well as updates from the continuing programs in the form of a case study, will be shared at various conferences (ex: NSTA, NARST, etc). Further, information on establishing such programs will be provided to organizations and/or schools who express an interest. In addition to information, interested parties will also be provided with support in grant writing as well as a list of possible funders.

It is also a strong possibility that a successful implementation of this project will attract the attention of corporate and academic sponsors. Two of the main forces behind robotics education, Carnegie Melon University and Tufts University, are a possible source of future support. Also, LEGO Education will have a vested financial interest in the continuation and expansion of the program.

TIMELINE

Year 1:

Fall 1:

- Develop curricula to teach Sci MA students robotics education @ CSUN
- Develop curricula that will be taught in the classroom, educators in training will study and implement this curriculum during SAEP

Spring 1:

- Test and refine proposed SAEP curriculum via AUSD classrooms
  collect preliminary data on value of curriculum
- Teach Sci MA students how to use robotics in the classroom during a curriculum development course

Summer 1:

- Implement Lab School via SAEP
- Have volunteer MA students work with robotics education in the SAEP classroom

Year 2:

Fall 2:

- Conduct follow up research on SAEP students and survey CSUN MA students

Spring 2:

- Use teacher feedback to teach curriculum to next cohort of students. Science cohort will be "off track" during this semester. Implement similar curriculum in a course with the Technology cohort MA students.

Summer 2:

- Recruit Tech cohort students to teach robotics curriculum along with experienced teacher during SAEP
- Recruit Sci cohort graduates to serve in an intermediate role between incoming CSUN students and experienced teachers during SAEP
- Expand SAEP Lab school to include more CSUN students if possible

BUDGET

Curriculum developer (For SAEP and CSUN courses): 1 semester
$5,000

Cooperation and use of facilities from AUSD to test run proposed curriculum in AUSD 8th grade science classes:
$10,000

Stipend for AUSD teachers who implement and evaluate coursework:
$2,500 each teacher, $7,500 total (assumes 3 volunteer teachers)

Data analysis from AUSD trial:
$5,000

One time costs of preparation: $27,500

CSUN Instructor to teach robotics education as a section of the Science MA program:
$5,000

Instructor for SAEP course (2 periods):
$7,500

Use of SAEP facilities:
$2,500

Provide MA students with a stipend:
$1,000 each, $6,000 total (assumes 6 students elect to participate, 3 per SAEP class period)

CSUN to provide course credit for above students:
$10,000 total

SAEP teacher to supervise the MA students in the classroom and act as a mentor (stipend in additional to regular teaching salary):
$2,000

Statistician to collect and analyze data from SAEP summer courses:
$10,000

Cost to operate 1st year of SAEP with MA student lab school: $43,000

SAEP Summer #2: $43,000 (Assumes program does not expand)

Supplies: $1,000 **Overhead: $5,000** ***TOTAL: $119,500***

BUDGET JUSTIFICATION:

A majority of the funds listed above will be used primarily to supplement existing programs in exchange for their cooperation in the study. For example, both AUSD and SAEP will be providing the context for which the study will take place. Additionally, the CSUN Maters' in Education program will support the implementation of the program through modification of their existing coursework. The existence of such programs is evidence of academic acceptance of the study, as well as an available support system for implementation.

Both organizations will also provide equipment for students to use. In order to run a successful robotics program, each group of two students needs a LEGO Mindstorms kit, costing about $350 each as well as access to a computer for programming. The start up costs for such a program at one school site in Arcadia Unified School District can run up to $30,000. The generosity of these programs, both in terms of philosophical and material support will make this study possible at a minimal cost to the grant provider.

RESUME:

Kelly Stellmach Castillo

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Monrovia CA 91016
(401) 447-2066
KSC@Alumni.Brown.edu

Education:

California State University Northridge, California Fall 2005-Spring 2008

- M.A. in Secondary Education with an emphasis in Science Ed. (Projected May 2008)
- Comprehensive Project: "Constructivist LEGO Robotics Curriculum in the Middle School Science Classroom"

Brown University Providence, Rhode Island Fall 2000-Spring 2004

- B.A. in Biology
- Honors Thesis Project: "Gait and Footfall Patterns During Running in Simulated Arboreal Conditions in Gliding Squirrels *(Glaucomys volans)*"
- Completion of "Undergraduate Teacher Education Program" (UTEP)
- **CA Single Subject Teaching Clear Credential- Secondary Biology Grades 7-12**

Experience:

Arcadia Unified School District (AUSD) Arcadia, California August 2004-Present

Eighth grade physical science teacher- Foothills Middle School

- Provide robotics technological and curriculum support for all 8th grade science teachers in AUSD
- Awarded AUSD Model technology Grant "Classroom of the Future"
- Presented AUSD Robotics Curriculum at the National Science Teacher Association (NSTA) in St. Louis, Spring 2007
- Facilitate Love and Logic Parenting classes for AUSD-Attended National Training in Denver, CO, Winter 2005
- Participate in School Site Council- 05-06 Vice Chair, 06-07 Chair
- Member of Report Card Revision Committee
- Member of Textbook Adoption Committee
- Grade Level Representative for District Professional Development
- Served as FH Drill Team Director Summer 05-Winter 07

Brown University Providence, Rhode Island Spring 2003 and Spring 2004

Undergraduate teaching assistant for university level introductory biology course

- Conduct two weekly labs for approximately 20 undergraduate students
- Hold regular office hours and review sessions
- Assess student work

Providence Public Schools Providence, Rhode Island Fall 2003

High school biology teacher-Mount Pleasant High School, Grades 10 and 11

- Completed student teaching

Rhode Island Cancer Council Pawtucket, Rhode Island Fall 2002-Spring 2004
Intern

- Evaluate educational materials
- Research, write, and publish informational health-related brochures for public audience
- Attend health fairs and cancer screenings

Harvard University Project Health Boston, Massachusetts Summer 2002
Swim instructor and community liaison

- Taught swimming lessons and asthma education to urban children aged 8-12
- Worked with health clinics and families to provide health care education and access

Boston Public Health Commission Boston, Massachusetts Summer 2002
Assistant coordinator for asthma education camp

- Wrote and implemented curricula for students grades 5-8
- Managed day to day operation of a two week day camp consisting of five counselors and 50+ campers

Sea World Adventure Park Orlando, Florida Summer 2001
Education Department Internship

- Worked in teams of two and three educators to direct weeklong day camp classes grades K-8th

Brown University Annual Fund Providence, Rhode Island Fall 2000-December 2001
Student manager and student caller

- Supervised and motivated undergraduate students during phone sessions
- Oversaw nightly shifts of 30 undergraduate students.