

# Work In Progress - An Innovative Science and Engineering Outreach Program

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**Abstract** - Faculty and students in the Biomimetic MicroElectronic Systems Engineering Research Center (BMES ERC) at the University of Southern California in collaboration with teachers at Murchison Elementary School( MES) in Los Angeles are designing and implementing science and engineering modules that introduce inner city children in grades 3, 4, and 5 to the excitement and utility of engineering. Each module uses the research of the BMES ERC testbeds as focal and reference points to make the science relevant to the young children. Lesson plans are standards-aligned, rich in experience-dependent activities, and age-appropriate. The elementary children learn science by doing science. Student learning is measured by a series of written and practical formative and summative assessments that focus on both content knowledge and analytical reasoning skills. In addition, student attitudes toward science are measured. Essentially all MES students are Latino and come from families with limited formal education. This cohort of students is traditionally underrepresented in the science and engineering professions. Although this is a Work in Progress, preliminary results indicate that significant science achievement is attained by the majority of students but the degree of success is influenced by the English language proficiency of the students.

Index Terms - education outreach, language proficiency, science and engineering modules, underrepresented minorities

## INTRODUCTION

The U.S. Department of Labor projects that between the years 2004 and 2014 there will be on average a 24.5 percent increase in the demand for engineers [1]. A solid foundation in math and science is requisite for success in the engineering professions and the baccalaureate degree is the minimal educational requirement for most entry level positions. Although the educational demands of the engineering professions are high, the wages are correspondingly high and most engineers profess satisfaction with their jobs [2]. Of national concern, however, is the steady decline in the number of American students studying or planning to study engineering [3].

To reverse this trend and meet the demands of the nation's labor force, the recognition of the importance of early education intervention and the implementation of challenging curricula that capture and sustain students' interest in science

and engineering is critical. Research shows that children as young as 5 or 6 years old already show the ability to think scientifically [4]. It is imperative that the educational system design learning environments that prepare these students for success, otherwise they are in danger of losing their sense of wonder and will be lost from the science pipeline.

The BMES ERC, in partnership with Murchison Elementary School, has embarked on a comprehensive and innovative initiative designed to increase the science literacy of children by integrating science and engineering principles into the 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> grade curricula. MES is a typical urban school in the Los Angeles School District and is comprised of a student body that is essentially 100 percent Latino, socio-economically disadvantaged and comes from families that have limited formal education.

Science is a discovery process and the best way to excel at science is to practice science. With this in mind, the BMES ERC outreach program transforms the elementary classroom into a virtual scientific laboratory with students actively participating in experiential hands-on activities designed to demonstrate scientific principles and offer them the opportunity to use scientific methods of discovery to solve relevant problems. A series of modules, each of which utilizes research conducted in BMES ERC laboratories as focal and reference points, has been designed and implemented. The modules are composed of lesson plans that are age-appropriate, standards-aligned, and meet or exceed the California state science standards. In addition, the lesson plans utilize and build upon students' prior knowledge and nascent curiosity, introduce novel information in step-wise and incremental fashion, involve students in the collection, recording and analysis of data, and stress the scientific process over a "right or wrong" mindset.

Mentoring is central to the BMES ERC outreach program. In partnership with MES teachers, USC faculty and students guide small groups of MES students through a series of experiential hands-on activities. Mentors serve as role models of scientists and engineers and pass on their enthusiasm and knowledge to the younger generation of students.

A variety of assessment strategies is used by the BMES ERC outreach program and includes student science attitude surveys, debriefing of the mentors, and pre- and post- science competency tests. The measurement instruments serve as formative assessments and enable teachers and mentors to monitor student progress and modify lessons to meet the students' specific needs.

## RESULTS

Figure 1 shows the results of the student attitude survey to the questions “I like school” and “I like science”. The results indicate that on average, 84 and 88 percent of MES 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> graders report that they like school and science, respectively. This finding is consistent with the national average of 4<sup>th</sup> graders’ attitudes towards science [5]. At this point in their education, we have the students in the pipeline. Preliminary results from the pre- and post- science competency tests (Figure 2) indicate that students are meeting the objectives of the modules and are learning the science content and knowledge presented in the lessons.

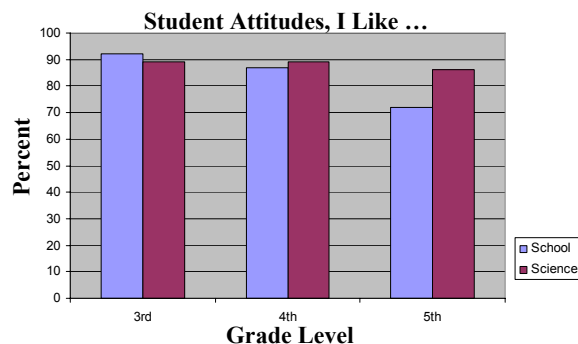


FIGURE 1

PERCENT OF MES 3<sup>RD</sup>, 4<sup>TH</sup>, AND 5<sup>TH</sup> GRADERS WHO REPORTED ON THE ATTITUDE SURVEY THAT THEY LIKE SCHOOL AND SCIENCE (N=109, 100 AND 101, RESPECTIVELY)

Typical of elementary schools in the Los Angeles School District, many MES students (~80%) are limited English proficient as measured by the California English Language Development Test. Consequently, we were interested to ascertain if the language proficiency of the students influenced their success in science. Figure 3 shows the results of the pre- and post- science competency tests when the students are disaggregated into high English proficient (HEP) and limited English proficient (LEP) subgroups. It can be seen that both LEP and HEP students demonstrated significant learning of science content following the outreach intervention. However, mastery of the material was greater for HEP students than it was for LEP students.

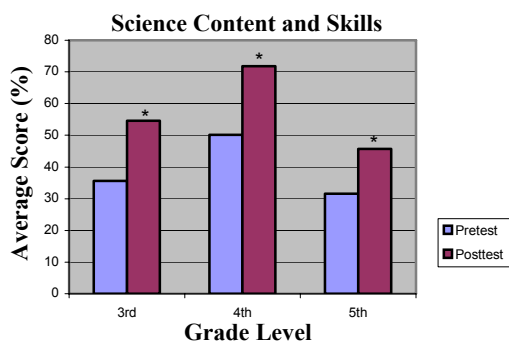


FIGURE 2

ASSESSMENT RESULTS IN SCIENCE COMPETENCY BEFORE AND AFTER OUTREACH INTERVENTION. THE % OF STUDENTS CORRECTLY ANSWERING QUESTIONS SIGNIFICANTLY INCREASED AFTER MODULE IMPLEMENTATION IN ALL 3 GRADE LEVELS

## Effects of English Language Proficiency on Science Competency Tests

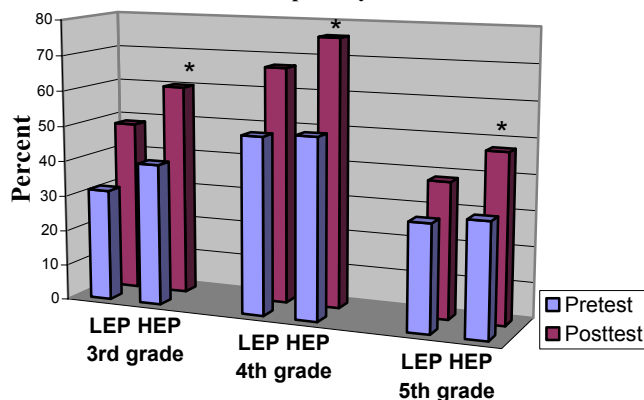


FIGURE 3

SCIENCE COMPETENCY RESULTS WERE DISAGGREGATED INTO LEP AND HEP SUBGROUPS. BOTH SUBGROUPS DEMONSTRATED SIGNIFICANT LEARNING OF SCIENCE MATERIAL FOLLOWING INTERVENTION BUT THE HEP STUDENTS SCORED SIGNIFICANTLY HIGHER ( $P < 0.01$ ) THAN LEP STUDENTS IN ALL 3 GRADE LEVELS TESTED.

## CONCLUSIONS

The BMES ERC outreach program, in partnership with Murchison Elementary School, is capitalizing on the elementary children’s enthusiasm towards science and is designing and implementing a series of science and engineering modules that are incorporated into all 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> grade classrooms. Preliminary results indicate significant student achievement in science literacy with achievement results directly correlated with English language proficiency. We are interested in modifying our curriculum so that all students, regardless of their English language proficiency, will equally benefit from our initiative. This type of early intervention will increase the number and diversity of U.S. citizens becoming scientists and engineers, thus ensuring the nation’s S&E competitive edge well into the future.

## ACKNOWLEDGMENT

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