

# An Initial Assessment of the Effectiveness of the Enhancing Access and Fostering Science, Technology, Engineering and Math (STEM) NSF Summer Workshop Program

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**Abstract** - The Enhancing Access and Fostering Science, Technology, Engineering and Math (STEM) Program for specific learning disabilities students is a National Science Foundation Research in Disabilities Education Focused Research Initiative (RDE-FRI) funded program at The University of Akron. The three major objectives of this pilot project are: 1) encourage Special Learning Disabilities (SLD) and typical students to explore STEM as a future career choice by building their confidence and efficacy in STEM, 2) develop empathy and better appreciation of diversity amongst students who would traditionally enter engineering programs and 3) develop understanding, better appreciation of diversity, and an elaborated sense of teaching and learning amongst the participants. Exciting hands-on activities based on the Society of Automotive Engineers' "A World in Motion", smart balloon, civil materials, and Information and Communication Technology (ICT) are designed to spark and capture the interests of participants in the STEM fields. The materials presented at the workshops will illustrate aspects of inclusive technology and engineering classroom education that will help the students succeed. The purpose of this paper is to describe, summarize the findings and assess the first year summer STEM workshop for SLD and typical middle school students. Data obtained from the participants and their parents via various surveys were used in the analysis.

*Keywords: Special learning disabilities, STEM, smart balloon, ICT, civil material.*

## Introduction

The Enhancing Access and Fostering Science, Technology, Engineering and Math (STEM) Program for specific learning disabilities students program is the first such program in Northeast Ohio and will provide educational opportunities designed to motivate and support specific learning disabilities (SLD) and typical middle school students in the STEM fields. According to the Ohio Department of Education census of 2004-2005, the percentage of Specific Learning Disability (SLD) middle school students enrolled in Summit and Stark county public and private schools is 6.3% and 6.9% respectively (of course, a much larger percentage is on some type of Individualized Education Program, IEP). Of current undergraduate students at The University of Akron, approximately four percent are classified as SLD students [1]. At the University of Akron, that is a rather large body of students, approximately 1000. However, a relatively small percentage of SLD students consider or enter the STEM fields.

In order to address the low enrollment and subsequent achievement of students with SLD, it is necessary to promote attitudes and strategies for inclusive education in science and engineering. In response, The University of Akron in

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partnership with the Summit and Stark counties public school systems developed a program that provided opportunities for SLD and typical middle school students to pursue careers in STEM fields.

The objective of this paper is to describe and summarize the findings of the hands-on engineering activities in the summer work camp to stimulate and encourage SLD and typical middle school students to be interested in the STEM curriculum and careers. Through hands-on projects SLD students can build technical self-confidence crucially needed to succeed in STEM high school and college programs, and also increase the SLD student applicant pool for the field. Other major long term goals are to develop a middle/high school-to-college transition program and an undergraduate retention program for SLD students seeking degrees in STEM. Of fundamental importance is the immediate need to develop programs that instill self-confidence in SLD middle school students.

Social cognitive theories [Lent, 2] recognize that early learning experiences are critical in the development of career interests, motivation, and choices. Learning experiences shape self-efficacy beliefs and outcome expectations, which in turn, affect the formation of vocational interests, which subsequently influence occupational goals, choices, and performance attainments. Based on social cognitive career theories, we would expect that positive educational and learning experiences would shape self confidence and career aspirations among students with specific learning disabilities. In addition, according to a comprehensive literature review of 66 reports involving science education for students with disabilities [Mastropieri, 3], knowledge and learning are facilitated by providing activities-oriented science curricula. Thus, the purpose of this project is to explore whether the use of hands-on educational activities will lead to better learning for students with specific learning disabilities. In addition to improved learning, such activities should lead to increased self confidence and career motivation.

The main hypothesis tested by this project is that providing intensive summer and Saturday experiences involving hands-on exercises will lead to increased self-confidence, self-efficacy, and career interest in the areas of science, technology, engineering, and mathematics (STEM) among Specific Learning Disability (SLD) and typical middle school students. A typical student is defined as one without any identifiable SLD and/or physical disabilities. This paper describes only the summer workshop program that was completed in August 2006 and the hypotheses tested include:

- Hypothesis 1: The hands-on program will increase self efficacy in STEM areas among SLD and typical students.
- Hypothesis 2: The hands-on program will increase self confidence in STEM areas among SLD and typical students.
- Hypothesis 3: The hands-on program will increase career interest in STEM areas among SLD and typical students.

### **Description of the Summer Work Camp**

One innovation of this project is development of STEM summer workshop programs using emerging technologies that will expose the SLD and typical middle school students to hands-on projects in engineering and science. A one-week, on-campus summer workshop program was developed at The University of Akron. The workshop was developed for sixth to eighth grade SLD and typical students. Using the Society of Automotive Engineers (SAE) 'A World in Motion,' smart balloon, sensors, information and communication technologies and civil structure materials, the summer program provides both lectures and hands-on experience in STEM curricula. The activities give participants the opportunity for direct observation and participation in on-going research. A percentage of SLD college students were, and in the future will be recruited to become role models for the SLD middle school students. The goal is not only to build self esteem, but also to increase the awareness of students, teachers and professors without disabilities so that they understand the capabilities of the SLD population in the STEM fields.

From the summer workshop experiences, participants will obtain a sense of the intellectual stimulation and challenge inherent in STEM as it is practiced in a highly productive and creative environment. The uniqueness of our approach will be to present the material in a simplified, but unified manner that links mathematics to the understanding of science and engineering disciplines. It also integrates several engineering disciplines which emphasizes the inevitable interaction among these subjects in our everyday life. For hands-on experiments, students will work in groups of 2 SLD and 2 typical students, 1 college student and a science/special education teacher. Work with a diverse group builds empathy and understanding amongst peers. Success will be closely related to their ability to connect and interact effectively with each other. This will guide students in reinforcing their commitment to success in STEM careers. In addition, the value of seeking the most up-to-date information will solidify understanding between science/special education teachers and professors to encourage diversity within their

classrooms. Some of the experimental setups will be distributed to participants' middle schools for their science curricula. Teachers are strongly encouraged to integrate these demonstrations into classroom experiences in their middle schools which will benefit even more students. Each hands-on activity will allow students to explore, probe, observe, collect data and investigate. By most accounts, this is the best approach for SLD and typical middle school students. The schedule and the summer work camp activities are summarized in Table 1.

A World in Motion [Lam, 4 and 5] was created by SAE in 1990 to captivate interests and motivate students to complete the rigorous Science and Engineering programs thru hands-on activities. During the first day of the summer camp, students participated in the can crusher experiment. They also learned about different types of simple machines using K'Nex sets. On the second day, the summer workshop focused on concrete use in civil engineering using three primary components, including a) lecture, b) introduction to laboratory equipment and safety and c) concrete mixing and testing. Primary goals included the familiarization of students and teachers to civil engineering materials and applications, introduction to concrete mix design and parameters that affect the basic performance of the material. During the third and fourth days, the students were exposed to the central concepts and hands-on experiences in state-of the art space surveillance, sensor technologies and Information and Communication Technology (ICT). The workshop is centered on designing and testing an intelligent balloon previously developed by the undergraduate engineering students of The University of Akron through a capstone senior design project. Some of these undergraduate students will also serve as mentors for the workshop. The last day of the workshop, each team tested and broke duplicate concrete cylinders after three days of curing. Additional concrete cylinders will be left to cure and will be tested during the academic year workshops. Data will be recorded and by testing over time, students will be able to observe the role of age or extent of hydration, influence of water to cement ratio, additive, aggregate type and grade on concrete strength.

Table 1: Summer Student/Teacher Workshop

<b>Day 1: A World in Motion</b>	
Part 1	Introduction to A World in Motion Can Crusher Competition: Lever
Part 2	Introduction to Simple Machines Using the K'Nex set to build simple and complex machines
<b>Day 2: Civil Structures Workshop</b>	
Part 1	Civil engineering materials and applications Introduction to concrete mix design
Part 2	Laboratory- concrete experiments: mix and curing of cylinders
<b>Day 3 and 4: Smart Balloon and Sensors Workshop</b>	
Part 1	Basic concepts of flight aerodynamics Introduction to temperature and pressure sensors and hands-on activities on sensors
Part 2	Introduction to wireless communication systems used in the smart balloon
<b>Day 5: Civil Structures Workshop</b>	
Part 1	Testing of concrete cylinders and data analysis

### Assessment

Assessment was accomplished using several different approaches. First, learning and knowledge was measured using short knowledge tests. Second, attitudes toward the program were assessed using short surveys completed prior to the workshops and following each workshop. In addition, the workshops were observed by the principal evaluator and comments were obtained from teachers and mentors.

In interpreting the results it should be realized that the sample sizes were small. There were 9 to 11 responses to the surveys distributed to the college student mentors and teachers. For the typical students there were 13 responses and for the SLD students there were 11 responses. Attitude responses were obtained on a 5 point scale. The questions asked of the teachers and mentors included:

1. I believe the students enjoyed this workshop.
2. I believe the students learned a lot in this workshop.

3. I believe this workshop has positively influenced the participating students' interest in taking more workshops or school classes like this one.
4. I believe this workshop has increased the participating students' confidence in their ability to do well in high school classes with similar subject matter.
5. I believe students participating in this workshop enjoyed working with a team on real world projects.
6. I believe it would be very beneficial to conduct this workshop in the class/school where I normally teach.

### **Discussion and Conclusions**

Based on our initial surveys and observations, the students both learned from and enjoyed the summer workshop. Qualitative data and observations suggested that an area that needs to be worked on in the future is encouraging interaction between the typical students and their SLD peers. Some of the SLD students had communication problems that interfered with interactions. In addition, the SLD students had a wide range of limitations, which limited the use of any one solution to the problem of encouraging interactions. Some of the SLD students were very high functioning, so it is important to not single them out as these students were trying hard to mainstream. One solution that will be considered in the future is rotating students through teams to encourage greater interaction.

Although all the workshops received high ratings, the highest rated workshop was consistently the civil engineering concrete activities, probably due to all the hands-on projects. The ratings were lower for smart balloon and simple machines. The responses from the teachers and mentors were very positive. On the 5 point scale, with a 5 being the most positive response, the means were consistently above 4.00 and many were above 4.50. Thus, responses from the teachers and mentors were very positive. The responses from the typical students were also very positive. Again, they were consistently above 4.00. Most of the SLD student responses were also positive, above 3.00, with most of the responses being above 4.00. Based on the surveys, most of the SLD students favor the program.

From the attitudes surveys, the responses from the typical and SLD students are somewhat similar. In addition, the SLD students also tend to be a little more negative than the typical students. This is to be expected because the SLD students were less engaged and they did not always totally understand the attitude survey questions. In order to keep the attention of all the students in focus, especially the SLD students, the authors plan to limit the lecture portion of the workshop to twenty to thirty minutes. Overall, the workshop was well received by teachers, mentors, parents and both the SLD and typical student groups.

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### **Biographical Information**

**Dr. Paul Lam**, is Professor and Associate Dean of Undergraduate Studies, Diversity Program, and Co-op Education Director at The University of Akron and a ASME Fellow. Research interests include structural dynamics, fatigue and fracture evaluation of material behaviors, pre- engineering and minority engineering retention issues. Dr. Lam is the recipient of numerous distinguish alumni and outstanding teacher awards.

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**Dr. Dennis Doverspike, Ph.D., ABPP**, is a Full Professor of Psychology at The University of Akron, a Senior Fellow of the Institute for Life-Span Development and Gerontology, and Director of the Center for Organizational Research. Dr. Doverspike holds a Diplomate in Industrial/Organizational Psychology from the American Board of Professional Psychology and is a licensed psychologist in the State of Ohio. He has over twenty years of experience working with consulting firms and with public and private organization. Dr. Doverspike is the author of 2 books and over 100 refereed journal publications. He also provides consulting services in the areas of Industrial Psychology and Human Resource Management.

**John Zhe** is an assistant professor of Mechanical Engineering at the University of Akron. His research interests include MEMS, sensors and actuators, microfluidics devices, smart materials and structures. He is currently working on intelligent sensors for bioparticle detection, and micro scale actuators for optical communications. He has authored or co-authored 25 technical papers and is the co-authors of one approved and one pending US patents.

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