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# Short-term Exploratory Summer Program for At-Risk First Year Students (work in progress)

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Dr. Melissa Danforth is an Associate Professor and the Chair of the Department of Computer and Electrical Engineering and Computer Science at California State University, Bakersfield (CSUB). Dr. Danforth is the PI for a NSF Federal Cyber Service grant (NSF-DUE1241636) to create models for information assurance education and outreach. Dr. Danforth is the Project Director for a U.S. Department of Education grant (P031S100081) to create engineering pathways for students in the CSUB service area. She is also the co-PI for an NSF IUSE grant (NSF-DUE1430398) to improve STEM retention and graduation, the Activities Director for a U.S. Department of Education MSEIP grant (P120A110050) to develop an engineering calculus sequence and engineering outreach programs, and the Summer Program Director for another MSEIP grant (P120A140051) to improve pre-calculus and provide research opportunities for first and second year students. Her research interests are focused on network and system security, particularly with respects to protecting mission-critical resources and services. She is also conducting research in applying biological concepts to cybersecurity, such as artificial immune systems.

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ACADEMIC RESPONSIBILITIES: (2009-Present) Associate Professor for the STEM Affinity Group, School of Natural Sciences and Mathematics, California State University, Bakersfield. Duties included teaching responsibilities in Undergraduate Biology, Graduate Level Science Curriculum, Philosophy, and Issues; Elementary and Secondary Science Methods; Student Teacher Supervision, and Educational Technology. Additional duties included grant writing, management, and evaluation; and university committees.

RESEARCH INTERESTS: Include teaching and learning cognition skills, informal learning environments and strategies, and curriculum design.

# Short-term Exploratory Summer Program for At-Risk Students (Work in Progress)


## Abstract

The work and findings in this paper are based on a short-term exploratory summer program for at-risk students conducted at California State University, Bakersfield, in the Summer of 2015. The summer program consists of a one-week exploratory program in one of three STEM fields – Chemistry, Engineering, and Mathematics. In this paper, the details of each of these programs are presented and the findings based on attitudinal surveys are discussed. Students indicate an increased interest in STEM research and an increased awareness of the skills and knowledge needed to succeed in a STEM field as a result of participating in this summer program.


## Introduction

California State University, Bakersfield (CSUB) is located in a region with a history of low education achievement. According to US Census Bureau data, only 72% of the population finish high school and about 15% of the population hold university degrees, well below national average. The region is also highly diverse, with 63% underrepresented minorities, and rapidly growing, with a 32% growth since the 2000 census. CSUB first year student population have a high number of first-generation college students. Enrollment in STEM majors at CSUB is growing, especially in Engineering, but many first year students display indicators for being at-risk. Most students begin university curriculum either in remedial mathematics or in pre-calculus. First and second year students also have a low GPA and high course repeat rate, particularly in mathematics courses, which puts them at-risk for academic disqualification. This program was aimed at these at-risk first and second year students.

In the Summer of 2015, 26 students were chosen to participate in a one-week science exploratory summer program in Chemistry, Engineering, and Mathematics. The program involves a three and a half day exploratory workshop in one of the three disciplines, led by an experienced faculty member, and concluded with a half-day career workshop conducted by the University Center for Career Education and Community Engagement. This workshop program was modeled after previous work that has been shown to increase interest and retention in science and engineering disciplines for underrepresented minorities [1] [2]. The major focus of the program was to use hands-on activities to engage students, to introduce these students to a STEM discipline of their interest, and to increase career awareness at an early stage.

A majority of the participants were deemed “at-risk” in STEM majors, as they were enrolled in either remedial mathematics or pre-calculus at the time of application to the program or they were not making adequate progress in their chosen STEM major (e.g. low GPA, high course repeat rate, etc.). Academic advisors also referred at-risk students to the program, and may have used additional criteria to identify at-risk students beyond academic success. Students participating in this program completed pre- and post-surveys to gauge their attitudes towards

STEM careers and research. Retention data was tracked for the immediate Fall quarter after participation.

**Program Activities**

Recruitment of students was conducted during the Winter and Spring 2015 quarters through mathematics class visitations and recommendations by academic advisors in the School of Natural Sciences, Mathematics, and Engineering (NSME). To encourage participation, students were given a stipend of $500 upon completion of the four-day program. The program also took place shortly after Spring finals concluded, so students could still seek other summer employment. The outline of the each of the discipline's programs is described as follows.

The Chemistry program aimed to give students hands on experience making chemical solutions and using a UV-Vis photospectrometer to acquire spectra of color mixtures uniquely created by each student group. Table 1 has a more detailed description of the activities.

Table 1: Chemistry program and schedule with description of activities

| | |
|---|---|
| Day 1 | • The principles of solution preparation.<br>• Used volumetric glassware to prepare a series of six solutions by mixing primary colors to make new colors. |
| Day 2 | • Learned about UV-Vis photospectroscopy.<br>• Learned to perform data acquisition.<br>• Student teams iteratively returned to the spectrometer and produced dilutions of a known sample to achieve proper absorbance spectra, keeping track of dilution factors. |
| Day 3 | • Finished data acquisition.<br>• Learned spreadsheet basics.<br>• Created a spreadsheet to analyze each of the uniquely created color mixtures. This spreadsheet used the principles of Beer's Law and was programmed to spectrally decompose the color mixtures using the solver function and the primary color absorbance spectra as basis sets.<br>• Errors between known and fit spectra were used to evaluate the precision of the solution preparation that took place several days prior to data acquisition. |
| Day 4 | • Summary and feedback. |

The Engineering program involves the study of the wettability of natural surfaces and plant leaves. It is described in Table 2.

Table 2: Engineering program and schedule with description of activities

| | |
|---|---|
| Day 1 | • Introduction of members, overview of the project, safety. Molecules and liquids, chemistry review. Surface tension. Surfactants experiments.<br>• Liquids surface tension. Surface tension of water. Paper clip experiment. Measure pendant drops of liquids in contact angle. Water and surfactants. Oil and water and surfactants. Detergents and how they |

| | |
|---|---|
| | clean. Water-ethanol mixtures surface tension. Surface tension oils and organics.<br>• Water interaction with surfaces. Contact angle of some synthetic surfaces with water.<br>• Bring natural samples, leaves, and other samples students would like to test. |
| Day 2 | • Surface modification of glass slides with POSS silanol. Modify surface of cotton with POSS silanol.<br>• Testing of contact angles of glass slides. Water.<br>• Testing of contact angles of ethanol mixtures, oils and water-ethanol. Glycerol, formamide, ethylene glycol contact angles. |
| Day 3 | • Teflon tape. Testing of contact angles of glass slides. Water.<br>• Testing of contact angles of ethanol mixtures, oils and water-ethanol. Glycerol, formamide, ethylene glycol contact angles.<br>• Creating highly oil repellent surfaces. Neverwet. Testing of contact angles of ethanol mixtures, oils and water-ethanol.<br>• Glycerol, formamide, ethylene glycol contact angles. |
| Day 4 | • Commercial product Never wet plus krytox. Testing fluorinated wax. |

The mathematics program, described in Table 3, is an investigation on nonlinear dynamical systems. The intent was to introduce at a very basic level some discrete, one-dimensional maps. The basic level reduced anxiety about bringing any prior skills to the workshop. The veracity of starting at this basic level was justified by the importance of these models in the real world. Students were inspired to study systems that may predict chaos in population models, financial calculations, or in weather prediction.

Table 3: Mathematics program and schedule with description of activities

| | |
|---|---|
| Day 1 | • Linear iteration and types of fixed points.<br>• Explore the use of Excel. |
| Day 2 | • Graphical iteration and population models.<br>• Computer investigations. |
| Day 3 | • Nonlinear iteration and Chaos.<br>• Computer investigations and discussion. |
| Day 4 | • Wrap-up.<br>• Group discussion on how to replicate this learning process in traditional classroom. |

**Results and Analysis**

There were 26 participants in the three programs, with the breakdown by program detailed in Table 4. Pre- and post- surveys were conducted to assess the effectiveness of the program. All 26 participants completed the pre-survey while 21 completed the post-survey. Among the 21 participants that completed the post-survey, only 16 completed the entire survey. Twenty

students completed both the pre- and post-surveys. At least 52% of all participants identified themselves as underrepresented minority. Fifteen out of 26 students did not declare a major, but were still taking courses specifically for majors in STEM for Spring and Fall 2015. Students at CSUB are not required to declare a major until the end of their sophomore year, so this high rate of undeclared students is not by itself an indicator of at-risk status. Looking at students' course histories, on average, the participants had not passed 16 units of courses up to the point that they participated in the summer program. Students at CSUB are limited to 24 units of course repetition with grade replacement, so participants are coming very close to that limit. After that limit, the poor grades are not forgiven in the GPA when the students retake the course and get a better grade.

Table 4: Number of participants in each program.

| | |
|---|---|
| Chemistry | 6 |
| Engineering | 12 |
| Mathematics | 8 |

Survey questions are rated on a five-point Likert scale (5=strongly agree to 1=strongly disagree). The survey questions were matched on the pre-survey and the post-survey. The survey questions are intended to gauge attitude towards STEM fields and research, as well as interest in STEM fields.

Respondents were required to indicate the level to which they agreed or disagreed to each statement. Table 5 is a summary of responses for key questions pertaining to raising interest and awareness in a career in STEM.

Table 5: Summary of survey findings

| | **Pre-survey (n=26)** | | | | **Post-survey (n=21)** | | | |
|---|---|---|---|---|---|---|---|---|
| | Strongly Agree or Agree | Neutral | Strongly Disagree or Disagree | No response | Strongly Agree or Agree | Neutral | Strongly Disagree or Disagree | No Response |
| I am interested in the field that I am studying. | 22 | 3 | 0 | 1 | 20 | 1 | 0 | 0 |
| I am interested in a career in STEM. | 20 | 5 | 0 | 1 | 19 | 2 | 0 | 0 |
| I am/was prepared for this program. | 13 | 12 | 0 | 1 | 14 | 6 | 1 | 0 |
| I am aware of the academic knowledge required for a career in STEM. | 15 | 8 | 2 | 1 | 17 | 3 | 0 | 1 |
| I understand what skills are required for a career in STEM. | 15 | 8 | 2 | 1 | 17 | 4 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I understand what "research" in STEM means. | 14 | 9 | 2 | 1 | 19 | 2 | 0 | 0 |
| I am interested in research in STEM | 17 | 6 | 2 | 1 | 19 | 2 | 0 | 0 |

In order to gauge changes in attitude, individual responses were compared. The change in attitude on the 5-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree) is summarized in the Image 1. Results indicate that students are evenly split on whether they are prepared for the summer program. The majority of participants indicate an increase in awareness in knowledge and skills required to be successful in STEM. Participants also show an increased understanding of research and interest in research.

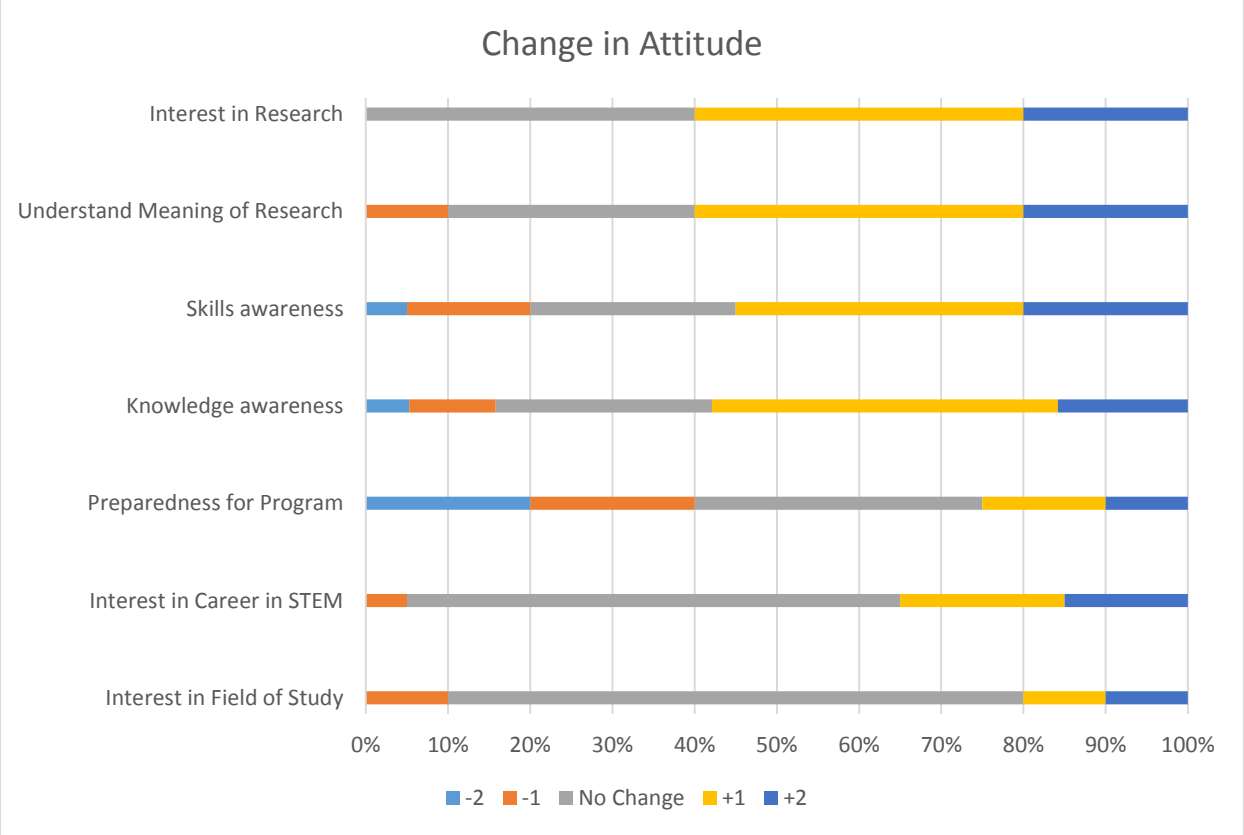


*Figure 1: Change in Attitude Among Participants*

In the post-survey, the majority of the participants (90.47%, 19 out of 21) agreed that "The career workshop helped me to understand what is needed to be successful in STEM fields," 87.5% (14 out of 16 respondents) indicated that the interest in their field of study has increased, 81.5% (13 out of 16) indicated that their interest in a career in STEM has increased, and 87.5% (14 out of 16) also indicated that their interest in research in STEM has increased. All the respondents (16 out of 16) would recommend this program to their friends.

Student retention in the Fall 2015 term was also tracked to gauge program effectiveness. Out of 26 participants, 24 students remained in a STEM program or pre-STEM pathway in Fall 2015. The remaining students are still CSUB students, but no longer active in a STEM program.

## Conclusion

While the sample size is small, the summer one-week workshop seems to have had a positive effect on participants. Although there were no significant changes in interest in the field of study or interest in a career in STEM, the majority of participants show an increased awareness of the knowledge and skills required in STEM fields and an increased interest in, and understanding of, STEM research. The majority of the students also continued in their STEM pathways in the following academic term.

## Future Work

Upon the completion of the summer program, both participating students and faculty indicated that they prefer a longer program. In response to this feedback, the Summer 2016 programs will be expanded to two weeks in duration. Students who participated in the Summer 2015 will be invited back to participate in the longer Summer 2016 activities.

Survey results for future summer sessions will show if the positive impact on student interest and knowledge is sustained across a larger group of participants. Student success and retention data will continue to be tracked and compared to the average for their chosen majors to see if the program has made a lasting positive impact in success and retention.

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