

Among those underrepresented minority students who begin their community college careers in developmental mathematics are the future engineers needed to provide the scientific and engineering skills to solve the problems of energy independence, environmental sustainability, infrastructure replacement, and many other pressing societal needs.

--Irving Pressley McPhail

NACME received a planning grant of \$91,000 from the Lumina Foundation for Education in 2009 to develop a comprehensive plan for increasing the number of underrepresented minority students who begin their community college careers in developmental mathematics and later successfully complete the bachelor's degree in engineering. The plan builds on the seminal efforts of the *Achieving the Dream: Community Colleges Count [AtD]* initiative [www.achievingthedream.org] in improving student learning outcomes in developmental mathematics.

In this ambitious initiative, NACME identified 19 *AtD* community colleges that have formal or informal transfer and articulation agreements with one or more of the 50 partner universities in the NACME national network. NACME convened a National Roundtable of 37 distinguished mathematics and engineering science faculty from *AtD* community colleges; engineering faculty and deans from NACME partner universities; and workshop facilitators from ConnectEd: The California Center for College and Career [www.ConnectEdCalifornia.org] to explore the possibilities of Problem-Based Learning [PBL] in intermediate algebra and pre-calculus courses that integrate engineering awareness, concepts and skills. The National Roundtable is intended as the first step in a multi-year effort to develop curriculum resources for all levels of developmental mathematics courses that engage students in learning and raise academic achievement through PBL approaches in mathematics and engineering; increase students' awareness of engineering careers and opportunities for transfer to four-year engineering colleges, beginning in developmental mathematics courses, the earliest stage of their college careers; and pilot test these new PBL curriculum materials and strategies to introduce students to engineering careers at a group of leading two-year institutions.

Springfield Technical Community College (STC) [www.stcc.edu] of Springfield, MA, participated in the National Roundtable and began implementation of PBL approaches in developmental mathematics and engineering in Fall 2009/Spring 2010 in Pre-Algebra, Algebra 1, and Elementary Algebra 2. This brief shows results associated with implementation of PBL in the two developmental courses: Pre-Algebra and Algebra 1. As developmental classes, both of these courses feature content that is usually covered in the 8th or 9th grades of middle or high school.

Traditional Approach: Linear Equations and Slope

"Here are the formulas and definitions you need to know."

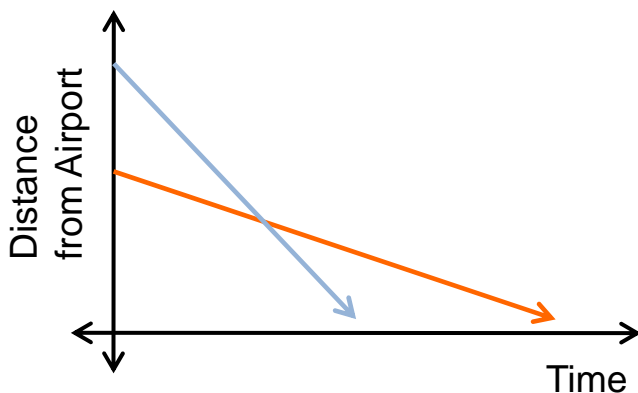
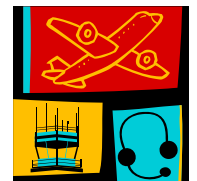
- Slopes of parallel lines are equal
- Slopes of perpendicular lines are opposite reciprocals
- Point-Slope form: $y_2 - y_1 = m(x - x_1)$
- Slope-Intercept form: $y = mx + b$
- Standard form of linear equation: $ax + by = c$

What is Problem Based Instruction?

- Instruction is relevant and student-centered
 - Content is context-specific
 - Students uncover the content
- The project challenges prior learning and assumptions
 - There are no single right answers
 - Solutions require collaboration

PBL Approach: Linear Equations and Slope

Begin with the context: Air Traffic Control



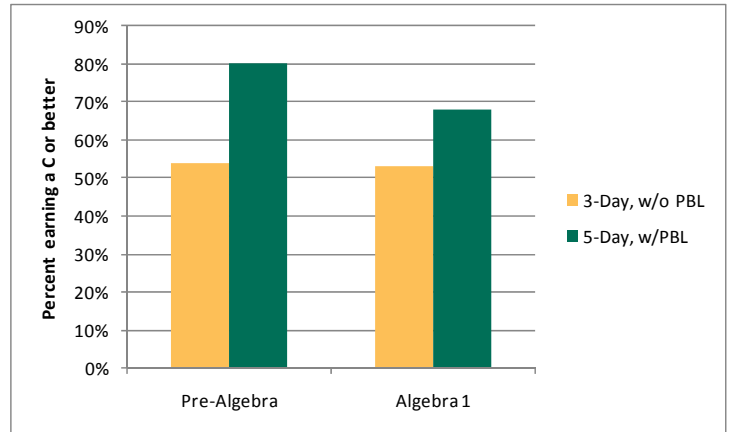
Planes approach an airport at different speeds and different initial positions. It is the job of air traffic controllers to direct the planes safely by telling pilots to adjust their speed or course.

- At what rate is each plane approaching the airport?
- When do they reach the airport?
- If the planes are on the same flight path, what does it mean when the lines intersect?

The AtD Developmental Math Initiative

At Springfield Technical Community College, instructors implemented the PBL approach in Pre-Algebra and Algebra 1. The PBL classes met for five full periods [M-F] each week for a total of six contact hours per week. Instructors incorporated PBL projects developed by ConnectEd in the course design. In contrast, the traditional classes were three days a week.

The graph compares students' end-of-semester grades in the two PBL courses to the average grades of students in all traditional sections offered in the same semester. The key metric of student performance was achieving a grade of C or better. The graph shows that in both Pre-algebra and Algebra 1, a larger percentage of students were successful in the PBL classes than in sections with traditional scheduling and instruction.



The table shows another way to look at these classes by using the instructors as their own controls. The table compares the *AtD* classes with traditional three-day sections taught by these same instructors in previous years. Students appeared to do better with the five-day per week PBL model in Instructor A's Pre-Algebra classes. But the results are not as clear for Instructor B's Algebra 1 class. These different results may be due to any of several factors: variations in how instructors implement the PBL approach; differences in instructional materials; or differences in the preparation and other characteristics of the individual classes.

	Instructor A Pre-Algebra	Instructor B Algebra 1
Success rate with 3 day format without using PBL	46%	74%
Success rate with 5 day format using PBL	80%	68%

The ultimate goal: move more URM students successfully through developmental mathematics on to higher level mathematics courses. Integrating mathematics concepts via PBL with principles of engineering design will hopefully result in more students discovering that they can become engineers.

Although it is impossible to disentangle whether the additional time, the PBL approach or both factors, together were associated with these findings, STCC faculty are convinced that the approach can be important for student success. At STCC students not only did better with extended hours and PBL, but also appeared more highly engaged. Many students who completed the extended hours/PBL Algebra 1 course in Fall 2009 continued on to the Algebra 2 class in Spring 2010.

About the National Action Council for Minorities in Engineering, Inc. (NACME)

Since its founding 37 years ago, NACME has stayed true to its mission: To insure American resilience in a flat world by leading the national effort to expand U.S. capability via better engagement of African American, American Indian and Latino women and men in science, technology, engineering and mathematics (STEM) education and careers. NACME Alumni hold leadership positions in industry, medicine, law, education and government. With funding from corporate and individual donors, NACME has supported over 22,000 students with more than \$124 million in scholarships and other support. Currently, NACME provides scholarship support to more than 1,300 college engineering students through a national network of 50 partner universities. NACME is engaged in a middle school through community college strategy to increase the proportion of underrepresented minority students in STEM disciplines. <http://www.nacme.org>.

NACME Partner & Affiliate Universities

Arizona State Univ., Tempe	Milwaukee School of Engineering	The City College of New York
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Kansas State Univ.	Rose-Hulman Institute of Technology	Univ. of Texas, El Paso
Kettering Univ.	Stevens Institute of Technology	Univ. of Texas, San Antonio
Louisiana State Univ.	Syracuse Univ.	Univ. of Washington
Marquette Univ.	Temple Univ.	Virginia Polytechnic Institute and State Univ.
Michigan Technological Univ.	Tennessee Technological Univ.	

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