Summer Mathematics Bridge Program at CEET

O. Ghrayeb, P. Vohra, N. Pohlman & F. St Clair

Northern Illinois University
DeKalb, Illinois, United States of America

ABSTRACT: The College of Engineering and Engineering Technology (CEET) at Northern Illinois University (NIU) is the location for the hosting of an annual *Summer Mathematics Bridge Program*. The programme is a one-week (the week before classes begin), full-time intensive mathematics review and study course. The ultimate goals of this programme are: to provide students with an in-depth review of algebra, trigonometry and pre-calculus; to help students identify their weaknesses in mathematics areas that are a part of an engineering and engineering technology curriculum; to provide students with an introduction to the rigours and demands of college-level work; and to create a sense of community with the college and with students having the same interests as theirs. Through the programme, the students are given many opportunities to learn and implement analytical and social skills, and develop the ability to work in a highly challenging and diverse environment. Students are taught on the programme to ask for, and accept help, and to prepare for activities. The contents and the nature of the programme are presented and discussed in this paper.

INTRODUCTION

The College of Engineering and Engineering Technology (CEET) at Northern Illinois University (NIU) is composed of three engineering departments and one technology department. The engineering departments are: Electrical Engineering with emphases on biomedical engineering and computer engineering; Mechanical Engineering with emphases on mechatronics and advanced computing and simulation; and Industrial and Systems Engineering with emphases on manufacturing systems, health systems and engineering management.

Incoming students at CEET are about 60% freshman and 40% transfer students. Many of the transfer students from community colleges join CEET having undertaken some mathematics courses. However, some transfer students might join CEET without any prior mathematics courses beyond high school. Some students have Advanced Placement (AP) credits for Calculus I. If a student has not undertaken a mathematics course that defines his/her mathematics level, he/she has to take the mathematics placement examination.

The majority of the students who join CEET are placed by the placement examination at the Calculus I level, which is the ideal starting course for the mathematics series (Calculus I, II, III, and DFQ). However, some students are placed at the Trigonometry (Math 155) or College Algebra (Math 110) level.

Students who are placed at a level less than Calculus I including Trigonometry (Math 155) and College Algebra (Math 110) level, have the option of enrolling in the annual *Summer Mathematics Bridge Program* (as explained in the brochure in Figure 1).

In general, the programme is designed to achieve the following objectives: improve mathematics placement status; prepare students for the rigours of college-level work; improve and enhance social and interpersonal skills in small-group settings; build a support network with students, faculty (academic staff), advisers and staff; help students learn to analyse, review and identify various limits and weaknesses in their own mathematical skills; provide early one-to-one academic advice from a faculty member; and, most importantly, get students to the requisite mathematics starting point for the engineering or engineering technology degree of their choice.

Study sessions are provided in the dormitories every night until the end of the programme. Teaching Assistants (TAs) are on hand every evening to supply tutoring, review the day's mathematics topics and challenge students to apply the concepts they have learned in class. A thorough review of all materials is offered on Friday, the last day of the programme, after which the students retake the mathematics placement examination.

This paper, the authors discuss how the programme is structured, as well as the topics covered. Also, the results of students' placement and their success as a result of their participation in the *Summer Mathematics Bridge Program* are presented and discussed in this paper.

PROGRAMME DESCRIPTION AND STRUCTURE

The *Summer Mathematics Bridge Program* is intended to bridge the gap between incoming freshmen students' scores on the NIU mathematics placement test (which is administered during the spring and summer orientation periods) and the first level of mathematics required for all three NIU engineering fields viz. Math 229 Calculus I. Students are required to either take the NIU mathematics placement test (encouraged prior to their orientation day), or they may use their AP placement result.

Students who have been placed at Math 110: Advanced Algebra or Math 155: Trigonometry are candidates for the *Summer Mathematics Bridge Program*. Additionally, students must have an American College Test (ACT) mathematics sub-score of at least 20.

The programme runs the week before classes start at NIU. All classes are held in the Engineering Building on the University's main campus. The programme is marketed on the CEET Web site and at all spring and summer orientation sessions, both to parents and students. Registration for the course is handled through the NIU Outreach Program. There is a modest registration fee, which includes a week in the student's assigned dormitory, two meals and two snacks per day, a course textbook and a programme T-shirt for solidarity during the subsequent placement test.

The instructor for the course is a CEET professor with teaching awards from the department and college. The course instructor is assisted by four tutors, who are graduate students from the engineering programme. The topics covered over the four days of classes are shown in Table 1.

Table 1: The topics covered.

Day 1	Fundamental algebra; order of operations; factoring and multiplication of polynomials; inequalities; properties of exponents; rationalising radical expressions.
Day 2	Absolute values; logarithmic functions; analytic geometry; algebraic functions.
Day 3	Trigonometric identities; triangles; law of sines and cosines; vectors and polar co-ordinates.
Day 4	Systems of equations; basic linear algebra; conic sections.

Each day consists of a combination of lectures to cover the topic and, then, group work on practice problems. The lectures act as a formal introduction to the content delivery that new students will experience in college. With the high percentage of first-time university students, there is the opportunity to learn note-taking and attentive participation. Students are chosen at random to answer questions to ensure full engagement. The material is not derived from first principles but instead presented as a reminder of the analytical tools in mathematics.

The group activities take place in another room, helping students to retain attention. The students are mixed, with high performing students (ACT score of 27 or better) distributed among the groups. The instructor and tutors circulate throughout the room to immediately assist in problem-solving techniques and to point out errors in methodology. The pedagogy of students-teaching-students serves two purposes:

- to reinforce the knowledge of the high performing student;
- for the student who is catching up, the terminology is easier to understand from someone at the same learning level.

Each day ends with more practice homework problems. The graduate student tutors are, then, made available for 2-3 hours during the evening for students to continue to receive help. The beginning of each subsequent day starts with a quiz of the cumulative material covered. Instead of multiple choice answers, which are available on the placement examination and can, therefore, inflate scores, the questions are open-ended forcing the student to demonstrate their understanding. After the quizzes are graded by the tutors, the instructor can adjust the lecture material and each day's practice problems.

Finally, on Day 5, an early morning review session takes places. Students can select the types of problem they wish to practice in last-minute preparation for the examination. The rapid fire questions and variation enliven the activity for the early morning. Students, then, take the placement examination and receive their scores approximately one hour later.

The collaboration with Testing Services for the short turn-around time is critical. With the new scores, students then complete a one-on-one meeting with the NIU Department of Mathematics co-chair, who, then, helps reconfigure their schedule if co-requisites are now satisfied. Students are also encouraged to visit the CEET Tutoring Center, located in the Engineering Building, beginning on the first day of the semester.

PROGRAMME SUCCESS AND DATA

The programme has a maximum of 50 slots; however, it has been determined that 40 is the optimal number for the students to maximise success. This allows more one-on-one support for students in the breakout and work sessions.

Over summer 2011 and summer 2012, 62 students participated in the *Summer Mathematics Bridge Program*. There were nine female and 53 male students. Students' placements coming into the programme were as shown in Table 2.

Table 2: Students' placements coming into the programme.

KCMA 098: Algebra	1 student	Average ACT Sub Score	19.0
MATH 110: Advanced Algebra	30 students	Average ACT Sub Score	22.6
MATH 155: Trigonometry	31 students	Average ACT Sub Score	25.2
Overall, there were 16 students who did not improve, 36 students who improved at least one level, eight students who improved two levels, and two students who went down one level			
The overall improvement rate for summer 2011 was 84% The overall improvement rate for summer 2012 was 63% The overall improvement rate for summer 2011 and summer 2012 was 73.5%			

CONCLUSIONS

The *Summer Mathematics Bridge Program* is a retention tool utilised by NIU's College of Engineering and Engineering Technology. It continues to be a popular programme.

Parents see it as a way to increase their child's odds of being successful in engineering, as well as a way for their child to make up some ground in mathematics and save on tuition costs. Students see it as a way to start on an even footing in the programme, as well as a way to meet people with similar ideas about their careers, and also to get a head-start on finding out what college is really like.

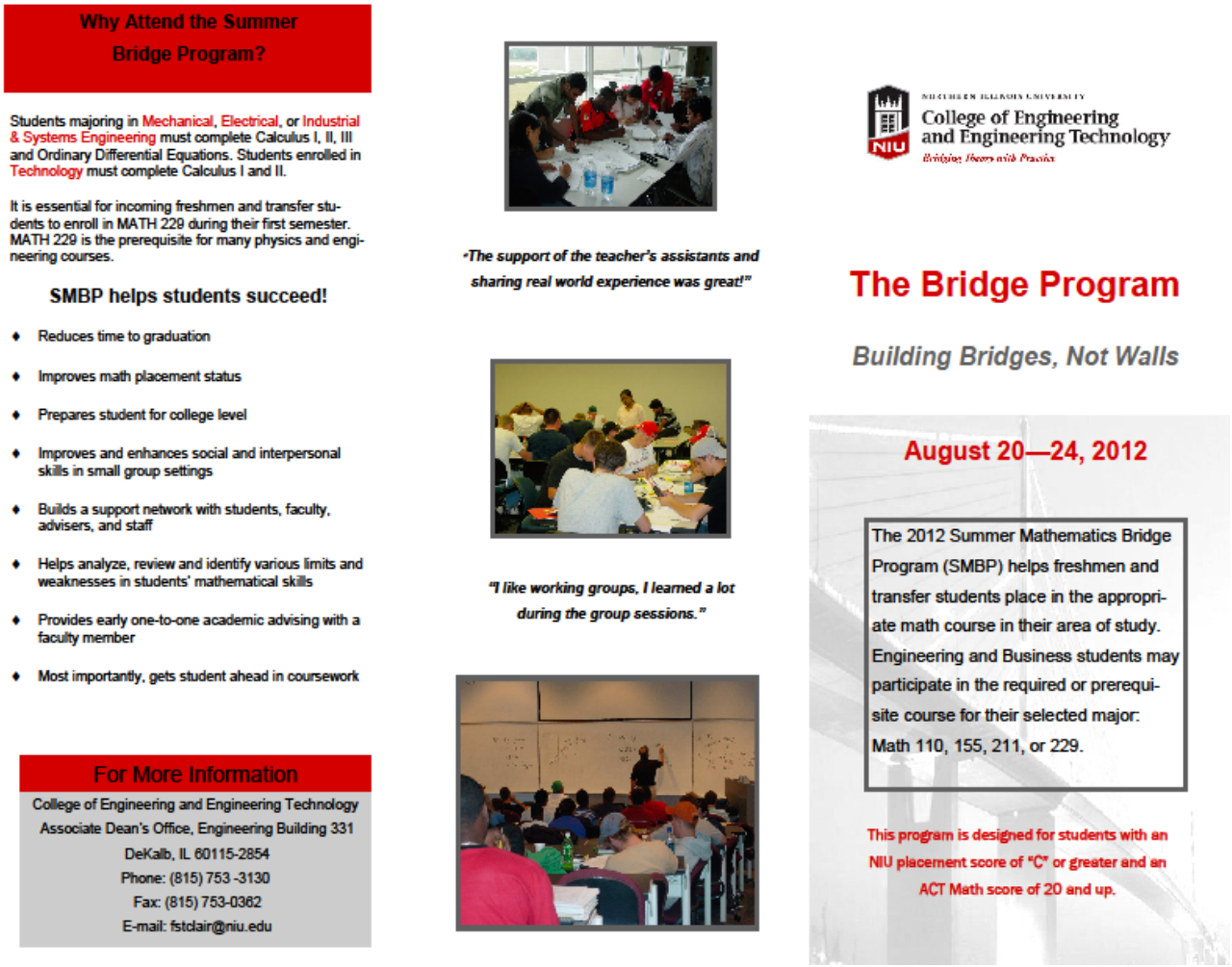

Figure 1: Part of the brochure for the bridge programme.

REFERENCES

1. Allen, L., An Evaluation of the University of Missouri-Rolla Minority Engineering Program 7-weeks Summer Bridge Program. Unpublished Doctoral Dissertation, Rolla, Missouri (2001).
2. Barrow, D.L. and Fulling, S.A., Using an integrated engineering curriculum to improve freshman calculus (1998), American Society of Engineering Education: Seattle, http://soa.asee.org/paper/conference/paper-view.cfm?id=14109
3. Fowler, D.A, Maxwell, D.A. and Froyd, J.E., Learning strategy growth not what expected after two years through engineering curriculum (2003), *ASEE Conf. Proc.*, Nashville, Tennessee, http://soa.asee.org/paper/conference /paper-view.cfm?id=19039
4. Klingbeil, N.W., Mercer, R.E., Rattan, K.S., Raymer, M.L. and Reynolds, D.B., Redefining engineering mathematics education at wright state university (2006), American Society for Engineering Education, http://soa.asee.org/paper/conference/paper-view.cfm?id=1833