AC 2012-2984: ANALYSIS OF MATH COURSE PLACEMENT IMPROVEMENT AND SUSTAINABILITY ACHIEVED THROUGH A SUMMER BRIDGE PROGRAM

Dr. John R. Reisel, University of Wisconsin, Milwaukee

John R. Reisel is an Associate Professor of Mechanical Engineering at the University of Wisconsin, Milwaukee (UWM.) He serves as Associate Director of the Center for Alternative Fuels, and Co-director of the Energy Conversion Efficiency Lab. In addition to research into engineering education, his research efforts focus on combustion and energy utilization. Reisel was a 2005 recipient of the UWM Distinguished Undergraduate Teaching Award, the 2000 UWM-College of Engineering and Applied Science Outstanding Teaching Award, and a 1998 recipient of the SAE Ralph R. Teetor Educational Award. Reisel is a member of ASEE, ASME, the Combustion Institute, and SAE. Reisel received his B.M.E. degree from Villanova University in 1989, his M.S. degree in mechanical engineering from Purdue University in 1991, and his Ph.D. in mechanical engineering from Purdue University in 1994.

Ms. Marissa Jablonski, University of Wisconsin, Milwaukee

Marissa R. Jablonski is a Ph.D. student of civil/environmental engineering at the University of Wisconsin, Milwaukee (UWM). She serves as program coordinator of the National Science Foundation (NSF) funded FORTE (Fostering Opportunities for Tomorrow's Engineers) program at UWM and works to recruit and retain undergraduate minorities and women to UWM's College of Engineering and Applied Sciences. Jablonski is focusing her dissertation on sustainable oxidation of textile wastewater and is working to create small-scale wastewater treatment units for cottage textile industries. She trained at the National Environmental Engineering Research Institute (NEERI) in Nagpur, India where she worked on biodegradation of azo dye intermediates. Jablonski served as Co-chair of UWM's student chapter of Engineers Without Borders for two years since its inception in 2007 and continues to help design and implement water distribution projects in Guatemala. Jablonski was a 2008 recipient of the NSF Graduate Fellowship Honorable Mention, the 2008 Wisconsin Water Association Scholarship, and the 2007, 2008, 2009, 2010, and 2011 UWM Chancellor's Graduate Student Awards. Jablonski is a member of ASEE and EWB. She received her B.S. degree in natural resources and Spanish from the University of Wisconsin, Stevens Point in 2003, her M.S. degree in civil/environmental engineering from UWM in 2009, and will receive her Ph.D. in civil/environmental engineering from UWM in 2013.

Leah Rineck,
Ethan V. Munson, University of Wisconsin, Milwaukee
Prof. Hossein Hosseini, University of Wisconsin, Milwaukee

Hoessein Hosseini has received his Ph.D. in electrical and computer engineering from the University of Iowa in 1982. He has been a faculty member with the Department of Electrical Engineering and Computer Science at the University of Wisconsin, Milwaukee (UWM) since 1983. Currently he is professor and Chairman of the Computer Science Program. Hosseini's expertise is in the areas of computer networks, computer architecture, fault-tolerance, and distributed and parallel computing. He is the Founder and Co-director of the Computer Networks Laboratory at UWM. Hosseini has published more than 120 research papers in refereed journals and conference proceedings. One of his co-authored papers has won the Best Paper Award, and he has published two book chapters. He is the recipient of a patent in the field of computer networks. He has supervised nine Ph.D. and more than 60 M.S. students and has received funding from NSF and industry. Hosseini is an internationally known figure; he has served on the editorial board of a journal and on the program committee of several international conferences. He regularly reviews research papers for various journals and conference proceedings and textbooks for book publishers. Hosseini has played a leading role in the development of electrical engineering and computer science programs, including the development of the new B.S. degree program in computer engineering, the initiation of the computer science program accreditation by ABET, and the growth and expansion of curricula in computer architecture and computer networks, where he has developed several undergraduate and graduate courses. Hosseini has extensive administrative experience, as well. In addition to serving as the computer science chair, he has served in important committees such as the College of Engineering and Applied Science Strategic Planning Committee, the Division of Natural Sciences Executive Committee, and the UWM Senate.

Analysis of Math Course Placement Improvement and Sustainability Achieved Through a Summer Bridge Program

Abstract

As part of an NSF-supported project, a summer bridge program for incoming engineering and computer science freshmen was conducted each summer between 2009 and 2011. The primary purpose of this program was to improve the mathematics course placement for incoming students who initially place into a course below Calculus I as determined through a math placement examination. The students retake the university's math placement examination at the end of the bridge program to determine if they may enroll into a more advanced mathematics course. Generally, if a student improves his or her math placement the program is considered successful for that student. However, it is also important in evaluating the success of the program to consider the performance of the students in their Fall semester math courses.

The mathematics portion of the bridge program centers on using the ALEKS (Assessment and Learning in Knowledge Spaces) software package for targeted, self-guided learning. The program took place exclusively in an on-campus format, and also featured a required residential component and additional engineering activities for the students. The program's duration was 4 weeks, and students were expected to improve their math placement by at least one semester. It is expected that improving their math placement will reduce the student's time-to-graduation which should in turn improve retention rates and eventually graduation rates. Data from the 2009 and 2010 cohorts have been collected and analyzed to judge the effectiveness of the program with respect to both improving the students' math placement and the students' performance in future math courses. A lower percentage of students (69%) improved their math course placement in the 2009 cohort, and the students had comparable success to other students in the Fall 2009 semester. For the 2010 cohort, students succeeded at improving their math placement at a higher rate (83%), but the overall performance of the cohort in their Fall 2010 semester math courses was not as good as the previous year's cohort's first-semester performance.

The changes made in the program between 2009 and 2010 are discussed, as are the results of the programs and subsequent math course performance. The evolution of the program to its 2011 format is also described, as are the results for math course improvement in the 2011 program.

Introduction

In recent years, there has been a push in the United States to increase the number of students pursuing and completing studies in the Science, Technology, Engineering, and Mathematics (STEM) disciplines.[1,2] There are two primary tasks that are needed for this goal to be accomplished. First, more students need to be attracted to pursue college-level studies in the STEM fields. Second, once those students are attracted to a STEM field, the colleges and universities must provide an attractive, nurturing environment designed to allow a wide range of students to succeed, while still providing a rigorous technical education.

The College of Engineering and Applied Science (CEAS) at the University of Wisconsin-Milwaukee (UWM) has generally been able to attract as many students into its engineering and computer science programs as for whom it can provide quality educations. But the graduation rates have been much lower than desired. For example, the 6-year graduation rate for Fall 2004 incoming freshmen for the college was 26.3%. Recognizing that this type of rate is undesirably low in that it indicates that students who have shown interest in engineering and computer science are not receiving degrees and achieving their goals in these STEM fields, CEAS has sought to improve this by creating a bridge program for incoming freshmen who may not be academically prepared for engineering and computer science studies in college.

The bridge program has two components. A secondary focus of the program is providing students with activities in engineering and computer science in order to excite them about their future studies so that they have increased motivation to continue with their studies through the often difficult first year of college studies. But the primary focus of the bridge program is the improvement of the students' math course placement. Such bridge programs are somewhat common.[3-7] At UWM, all incoming students must take a math placement examination to determine into which math course they will enroll. CEAS has determined that one of the best predictors of the eventual graduation of incoming freshmen from CEAS is the students' original math placement. Based on studies of students over several years, it was found that students who place below Intermediate Algebra very rarely graduate from the college, students who place into Intermediate Algebra (Math 105) graduate at a rate of about 13%, students who place into College Algebra/Trigonometry (Math 116/117) graduate at a rate of about 43%, and students who place into Calculus (Math 231) graduate at about a 44% rate. These numbers do vary from year-to-year, but are fairly typical. While none of these graduation rates are impressive, there is clear improvement which can be made by improving the math placement of students to at least the College Algebra/Trigonometry level. One thing that should be noted is that nearly all of the incoming freshmen students have completed high school math courses through at least Intermediate Algebra, and most through at least College Algebra; some have taken Calculus courses in high school. If math course placement was based solely on their high school studies, i.e., without a placement test, these students would likely be placed into either College Algebra or Calculus I. However, the placement test has noted deficiencies in their mastery of the lower-level material which then calls for the students to begin at a lower-level than is sometimes necessary. Therefore, the purpose of the math component of the bridge program is not to teach the students completely new material, but rather to reinforce familiar concepts through additional practice and tutorial instruction.

While some students who have low math placements eventually do not graduate because they simply did not have the mathematical aptitude to succeed in math-intensive disciplines, another important factor is that low math placement delays the student's ability to take engineering and computer science courses. The curricula in the college have been designed with most courses expecting a Calculus background, and that students should begin their freshman year by taking Calculus I. If the students have to wait a year or more to take Calculus I, it is more difficult to maintain the students' interest in engineering or computer science. They quickly run out of courses from their intended discipline that they can take. Furthermore, by starting at a lower math level, the expected time to graduation for incoming students increases by a semester or year. This will mean that the students are looking at needing to pay an additional year of tuition

to graduate. The lack of technical courses of interest to the students that are available for them to take in their early years coupled with this extended time required in college produces enough discouragement as to drive some students from STEM disciplines. By improving the students' math placement, we expect that the overall graduation rates will be improved by keeping the students engaged in engineering and computer science studies and by decreasing their time to graduation.

To facilitate the math instruction, CEAS has used the ALEKS[8] software program. As will be seen below, the efforts of CEAS in the bridge program as implemented have been good with regards to improving math course placement. However, the benefits of improving math course placement may be jeopardized if the students then struggle in their subsequent math course and fail to advance through Calculus in a timely fashion. Therefore, performance in the bridge program is only one component of evaluating the utility of the bridge program; subsequent math course success needs to be accounted for in any evaluation. In this paper, we analyze the 2009 and 2010 bridge program students' performance in their respective Fall semester courses. We do not formally analyze their performance in the Spring semester courses, as this performance may be more influenced by their Fall courses than the summer bridge program. Finally, some modifications to the bridge program have been made to improve student success, and the impacts of these changes are discussed.

Description of the Program

As mentioned above, the four-week summer bridge program instituted in 2009 at CEAS involves two parts. In the morning session, students use the ALEKS software package designed to provide them with individualized instruction on mathematical topics most needed by them to improve their mastery of the material necessary for them to succeed in college-level math courses (College Algebra or Calculus). The afternoon sessions concentrate on engineering activities to provide the students with practical examples to help them understand why they need the mathematics courses. The focus of this paper is the mathematics instruction and results.

The bridge program was a residential program, with all students living in an on-campus dormitory and participating in supervised and structured programs during the day while being given free-time in the evenings. The mornings of the program were devoted to 2.5 hours of structured work on mathematics, with students working in a computer lab on the ALEKS software. Instructors were available to provide more hands-on explanations and assistance as needed. Before beginning the program, students had taken the university's math placement exam, and their individualized programs were set up to best help the students master the material which they most needed in order to place into a higher course. The students' progress was continually monitored, and students were encouraged to work more on the material in the evenings if necessary. Occasionally, additional work was provided to the students to be worked on during the evenings and weekends. The students retook the math placement exam on the second-to-last day of the bridge program. If they improved their math placement as a result of the program, the students received a $1,000 scholarship. Beginning in 2010, additional scholarship money was available for the students who excelled in the afternoon engineering activities. The program was designed based on lessons learned from running non-residential programs in previous years.[9,10]

Description of ALEKS and Observations on ALEKS Usage

ALEKS is a web-based assessment and teaching system.[8] ALEKS uses adaptive questioning to learn the extent of a student's knowledge of a subject, and then designs its instruction to address the topics for which the student is ready. ALEKS does not rely on multiple choice questions, but rather has the students enter answers using math symbols for each problem.

Students progress through ALEKS at their own pace, and the program focuses on only the material that the individual student needs to learn. The students can spend as much time as they need to on a topic, and then move to the next topic without waiting for the rest of the class to master the material.

The students are placed into the different courses, ranging from Basic Math to Pre-Calculus, based on their raw Mathematics Placement scores. On the Mathematics Placement examination, they are tested on Basic Math, Algebra, and Trigonometry. The raw scores range from 0 to 850 in each category. The students need a minimum of 450 in Basic Math to place into any course other than Basic Math at UWM. If they score above a 450 in Basic Math then their scores in Algebra and Trigonometry determine the course into which they are placed. This information is what was used to place them into the corresponding ALEKS course for the bridge program. The one exception to this is if the student had a Basic Math score that was under 500. Any student that had under a 500 in Basic Math was placed into a Basic Math course so they could review those topics. After they had mastered the Basic Math topics, they were placed into the course indicated by their placement scores. Then, as the students master all the topics in the first course, they move into the next course. In this way a student has the opportunity to increase their placement scores beyond one course.

The students are given an initial assessment in ALEKS when they start any of the ALEKS courses. When they finish the initial assessment, ALEKS gives them an individualized pie that includes all the items that are in that particular course. Some of the items are included as mastered, some are ready to learn, and others are not available based on how the student answered the questions on the initial assessment. ALEKS uses an artificial intelligence-based learning tree to organize the items. This way a student is only given items to learn for which they are ready. For instance, if a student has not factored any quadratics they are not given topics about solving quadratics. After the students are done with the initial assessment they start working on the items in their pie that they are ready to learn. ALEKS provides explanations for each topic, and there is at least one instructor in each classroom; therefore the students have multiple instruction options for each topic. As they learn new topics other topics become available based on the learning tree for that given course. Periodically the students are given a progress assessment to make sure they are retaining the topics they have learned. If they get a question wrong that they had previously learned, the topic will be put back in their pie to relearn. ALEKS is a mastery learning system, so there is no partial credit.

Once the students finish all the topics in their pie they are given a comprehensive assessment to determine if they have retained all the items in their pie. The progress assessments mostly give questions that the students have currently worked on, and some that they are ready to learn. The

comprehensive assessments give questions on any topic in the pie from the most basic material to the last item that they learned. If the student earns a 92% or better on this assessment they are moved to the next course. The 92% is based on percent mastery of the entire course, not 92% of the questions correct on the assessment. If they do not get a 92% they relearn the topics they got wrong, and try the comprehensive assessment again. Figure 1 shows an assessment summary from ALEKS.

ALEKS also records how much time each student spent in a particular course, and how much time they spent in all the courses they have taken with ALEKS. The amount of hours that a student spent in ALEKS, and their final percent mastery of the course they were in at the end of the bridge program were found to be very indicative of how they performed on the retake of their placement test.[11]

Student Performance in Subsequent Courses

In the 2009 bridge program, 24 of 36 students who completed the program improved their math course placement, as determined by retaking the math placement exam at the end of the program. One additional student placed higher due to receiving AP credit. So, overall, 25 of the 37 (67.6%) students are considered to have improved their math placement. Note, the one student who received AP credit for Calculus I still chose to take the Calculus I course in the Fall 2009 semester. Of the students who improved their math placement, 8 improved their math

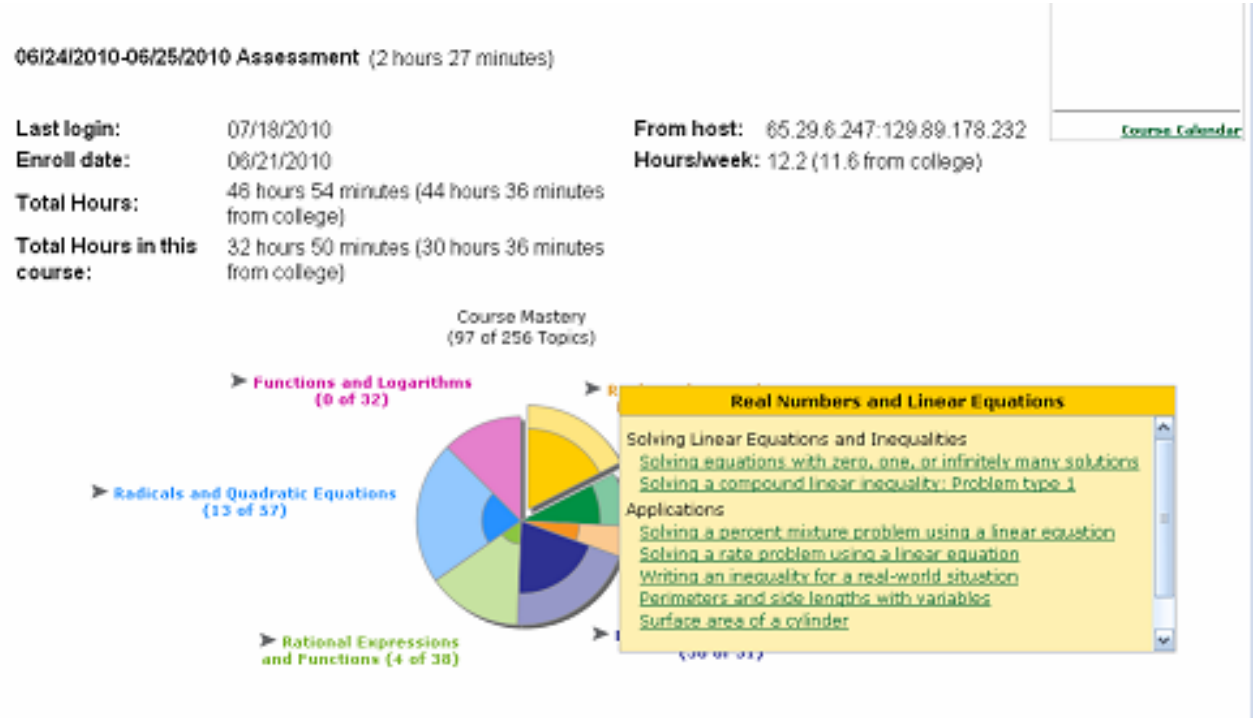

Figure 1: Typical assessment summary from ALEKS software.

placement by 2 courses. 7 of these improved from Intermediate Algebra (Math 105) to Calculus I (Math 231), while one improved from Basic Algebra (Math 095) to College Algebra/Trigonometry (Math 116/117). Two students did not take a math course in the Fall 2009 semester. This results in 35 students being considered in the analysis of course performance. Furthermore, one student withdrew in mid-semester. This student is counted in the statistics for math course performance. That student was taking Math 116, and is considered to have not passed the course.

Based on the results of the 2009 bridge program, some changes were made for the 2010 bridge program. As discussed elsewhere[9], these changes included using a more interactive, hands-on approach with all instructors for the 2010 program, the use of additional undergraduate and graduate student mentors into the classroom to provide additional supplemental instruction, making mentors available in the evenings to provide the students with additional tutoring if desired, and students were allowed to continue to work more on their own after the formal bridge program ended, but before the start of the Fall semester – however, only a few students took advantage of this opportunity.

The changes implemented in the 2010 program led to 39 of 47 students (83%) who participated in the program improving their math course placement. Eight students improved their placement by two levels. It should be noted that only 37 students completed a math course in the Fall 2010 semester. Some of this attrition was due to financial issues among the students. From the perspective of only the math course placement improvement rate, the changes appeared to be successful at improving the program. Therefore, the changes were retained for the 2011 program, and the results for students improving their math placement in the bridge program remained very good.

2009 Cohort

Figures 2-4 contain bar graphs of aggregate student performance for the Fall 2009 semester in Math 231 (Fig. 2), Math 116/117 (Fig. 3) and Math 105 (Fig. 4) for the 2009 bridge students. Note that student success in the course is being defined as receiving a C or higher in the course. This is done because admittance into the next sequential math course requires a grade of C or better in the previous course. Therefore, while a grade of "C-" is not be considered failing from the university's perspective, it is failing for the student as the student must retake that course to advance in the UWM math sequence. In addition, in Figure 3 the combined results from performance in Math 116 and 117 are shown. This does not mean that a student necessarily received below a C in both courses. Rather, if they were taking both courses (6 students took both courses, 6 students took only Math 116, and 1 student took only Math 117 – some students place out of one both not both courses), they were placed into the "C- or Worse" category if they received that grade in one of the courses. In this case, 3 of the 6 students taking both received a C or better in one of the two courses and only had to retake the other course. Of those 3 students, two persisted in the program in the Spring 2010 semester and received a grade of C or better in the class that they had not succeeded in during the Fall 2009 semester, and advanced to Calculus I in the Fall 2010 semester.

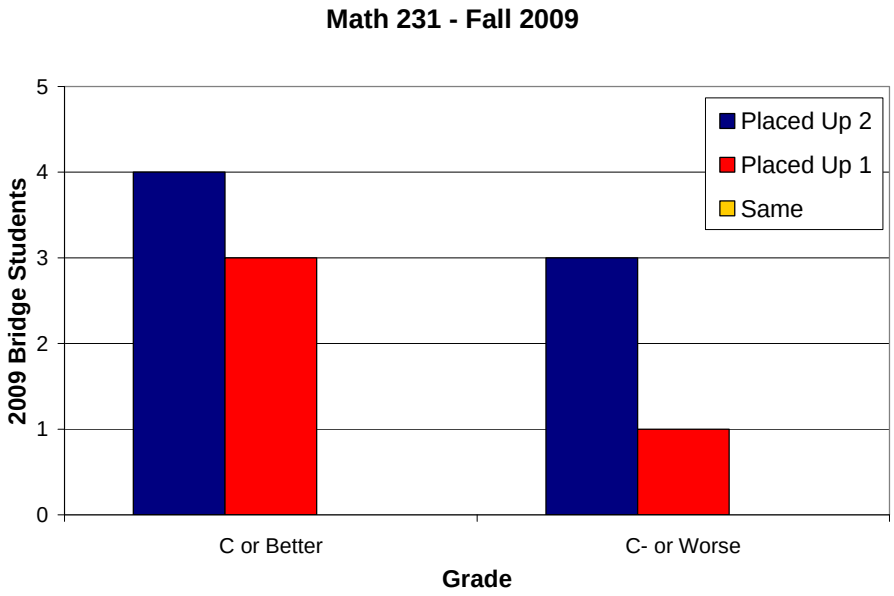

Figure 2: Performance of 2009 Summer Bridge Students who placed into Calculus I for the Fall 2009 semester.

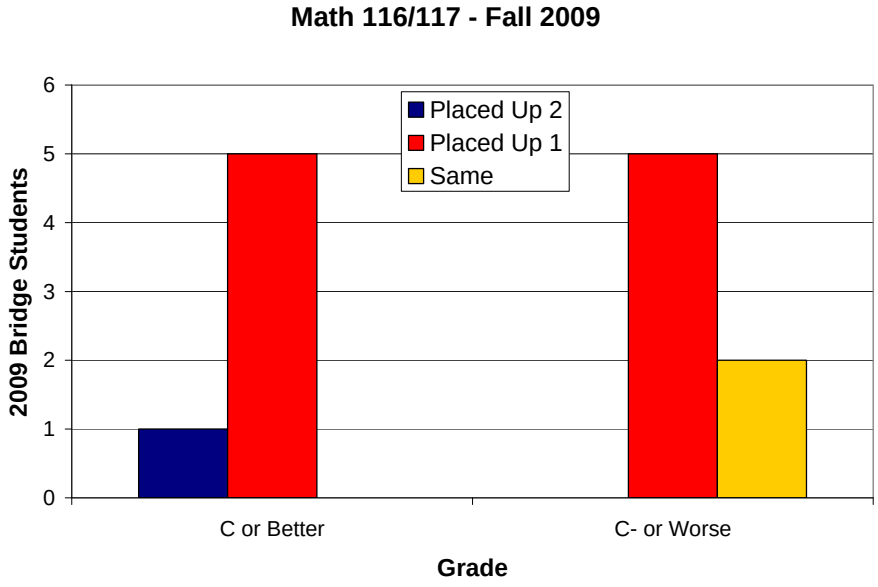

Figure 3: Performance of 2009 Summer Bridge Students who placed into College Algebra / Trigonometry for the Fall 2009 semester.

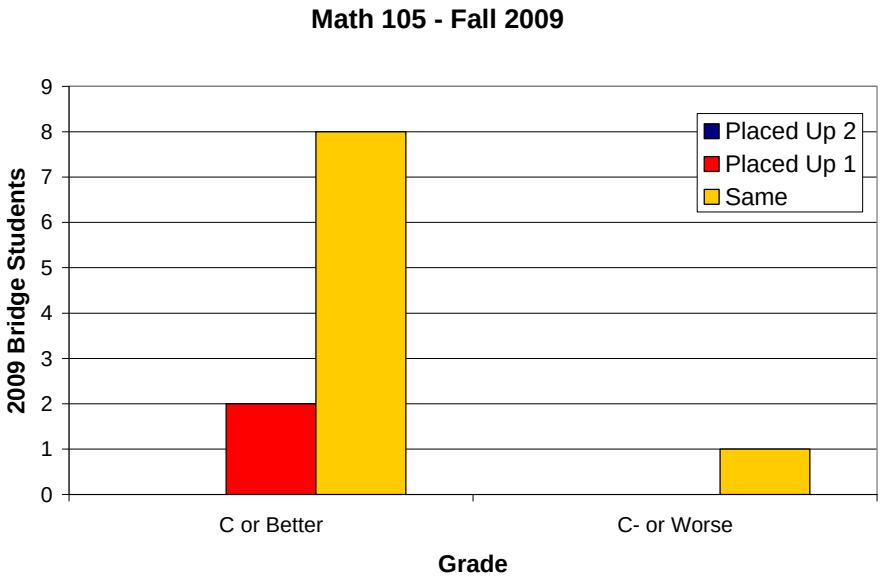

Figure 4: Performance of 2009 Summer Bridge Students who placed into Intermediate Algebra for the Fall 2009 semester.

When analyzing all of the results, it must be remembered that the sample sizes are small in each subcategory, and so most of the focus will be on the general observations in the results. First, considering the results from Calculus I as shown in Figure 2, there are two categories of students to be considered: one group placed up one course in the bridge program (from Math 116/117 to Math 231) and one group placed up two courses (from Math 105 to Math 231). Generally, the students who placed up two courses did an exceptional amount of work on their math in the bridge program. As shown in Figure 2, 3 of the 4 students (75%) who placed up one course into Calculus I received a C or better and were able to advance into Calculus II for the following semester. The success rate of 75% in this group is what would normally be expected as a passing rate for this small number of students. As these students succeeded at a rate similar to that experienced by students who did not improve their placement in a bridge program, and as these students were either more advanced in their math studies or at a similar level (the student who did not advance would have been no better off than in Calculus I in the Spring 2010 semester without advancing in the bridge program), the bridge program was successful for these students with regards to their math course advancement.

Judging the success for the students who placed up 2 levels is not as clear. The students who placed up two levels only succeeded in advancing into Calculus II at a rate of 57% (4 out of 7). On the one hand, the bridge program was very successful for the students who advanced two levels and continued on with a grade of C or better in Calculus I. Conversely, the students who did not receive a grade of C or better may have been more successful if they had only advanced one level. Considering that these students would still be more advanced than if they had not participated in the bridge program with regards to their Spring 2010 math course, the bridge program was moderately successful for these students. Note, of those 3 students, one passed

Math 231 in the Spring 2010 semester, one failed it again, and one did not take a math course in the Spring 2010 semester.

Figure 3 shows the data for the students who took Math 116 and/or Math 117 in the Fall 2009 semester. One student advanced two levels into this Math level, and passed both courses: this student clearly benefited from the bridge program. Two students began the Bridge program in Math 116/117 and remained at that placement level after the bridge program. Both of these students failed to advance to Math 231 through receiving a C or better in Math 116. For those two students, the bridge program clearly did not help their math advancement. There were 10 students who advanced one level into Math 116/117 through the bridge program. As shown in Fig. 3, 5 of these students (50%) received a C or better. At first, that may not appear very good, but it is consistent for students as a whole in Math 116. As will be discussed below, only 59.6% of the students who took Math 116 in the Fall 2009 semester received a grade of C or better. So, for 50% of these students, the bridge program was successful in helping them accelerate their math course sequence, and for the other 50% of these students, the bridge program did not hurt their math sequence, and probably aided it somewhat considering the large failure rate in the Math 116 course overall; i.e., even many of the students who advance to Math 116 after taking Math 105 do not advance out of Math 116 in their first attempt. As mentioned previously, 3 of the 5 students who placed into this level and took both courses failed one in the Fall 2009 semester, and two of these passed that course in the Spring 2010 semester.

The results from Math 105, shown in Fig. 4 are much more definitive. Only one of the eleven students (9%) did not receive a grade of C or better in Math 105. While only two students placed into Math 105 after the bridge program, it is likely that there were some residual effects on the other students' math skills after participating in the bridge program. While the bridge program may not have been necessary for all of the students who remained in Math 105 after the bridge program, the program did not hurt their progress. The program did aid the math progress of the two students who placed into Math 105 after completing the bridge program.

Because ultimately the purpose of the bridge program is to accelerate the students' completion of their required math course sequence, and subsequently improve retention and graduation rates of theses STEM students, it is also of interest to compare the bridge students' performance to others in the course. Figure 5 contains such a comparison for the four Math courses of interest. The three groups compared are the bridge program participants, all the CEAS freshmen in that course, and then all the students campus-wide taking the course. In this last group, there will be students who are more mature, and who have taken other math courses at UWM or other colleges and universities. Math 105 is considered a terminal math course for many programs at UWM, and so even if the students in those other programs have not taken other math courses in college, they may be well advanced beyond their first semester at UWM before they took the course.

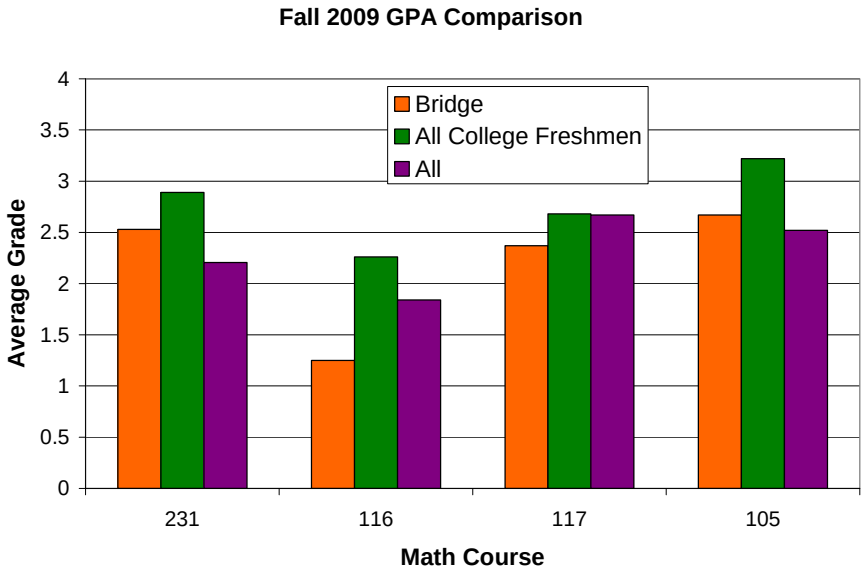

Figure 5: Comparison of the average course grade for 4 Math courses from the Fall 2009. The groups considered are the bridge program participants, all the UWM freshmen, and all students taking the course.

What can be seen in Fig. 5, again considering the sample size of the bridge program students, is that the bridge program students tended to do worse in these courses than their CEAS peers. The discrepancy is greatest in Math 116, but there the bridge program students' average grade was reduced by several grades of F which more significantly impact the average of the smaller sample size. It should also be noted that many students in the bridge program were identified as being weaker than their peers, which is why they were in the bridge program in the first place. Therefore, it is not surprising that these students would not do as well than their peers. When comparing to all students in the course, the bridge students did slightly better in Math 231 and Math 105, and slightly worse in Math 117: all of these results are subject to consideration of the much smaller sample size of bridge program students in comparison to all students in the courses. For a similar reason when comparing students from the 2009 bridge program to their UWM peers in Math 116, the Math 116 group did noticeably worse than the course as a whole. Overall, these results lend support to the idea that the bridge program helps many students, while providing harm to few if any students.

2010 Cohort

Figures 6-8 contain bar graphs of aggregate student performance for the Fall 2010 semester in Math 231 (Fig. 6), Math 116/117 (Fig. 7) and Math 105 (Fig. 8) for the 2010 bridge students. To an extent, the results are similar to those seen in the 2009 cohort, but overall the student success rate in their first-semester math courses is slightly lower than the 2009 cohort. These results are summarized in Table 1.

In 2010, 7 out of 10 students in Math 231 received a C or better in the course; this success rate of 70% is marginally better than the 64% in 2009. In 2010, 7 of 19 students received a grade of C

or better in either 116 or 117 (or both if they took both); this success rate of 37% is worse than the 46% in 2009. It can be noted that like 2009, two of the students who took both Math 116 and 117 received a grade of C or better in one of the two classes, but not both. Finally, in 2010, 7 out of 8 received a grade of C or better in Math 105; this rate of 88% is comparable to the 91% in 2009. When combined, 57% of the students in 2010 received the necessary grades to continue forward in their math sequence in the Fall of 2010 versus 66% in the Fall 2009. Part of this decrease can be attributed to fewer students remaining in Math 105, and more students being enrolled in the more-challenging Math 116 and Math 117 courses. However, coupled with a larger number of students not completing a math course in the Fall 2010 semester in comparison to the Fall 2009 semester, this drop indicates that further changes are needed to fully build upon the success of the bridge program with regards to advancing math skills and shortening time to graduation.

Table 1: Comparison of the 2009 and 2010 cohorts with regards to success in Fall math courses following their bridge programs. The percentage pass refers to the percentage of the students receiving a C or better. Note, the grades in both Math 116 and Math 117 needed to be above C to be grouped in that category if both courses were taken.

Cohort	Math 231			Math 116/117			Math 105			No Course
Grade	> C	< C-	Pect. Pass	> C	< C-	Pect. Pass	> C	< C-	Pect. Pass	
2009	7	4	64%	6	7	46%	10	1	91%	2
2010	7	3	70%	7	12	37%	7	1	88%	9

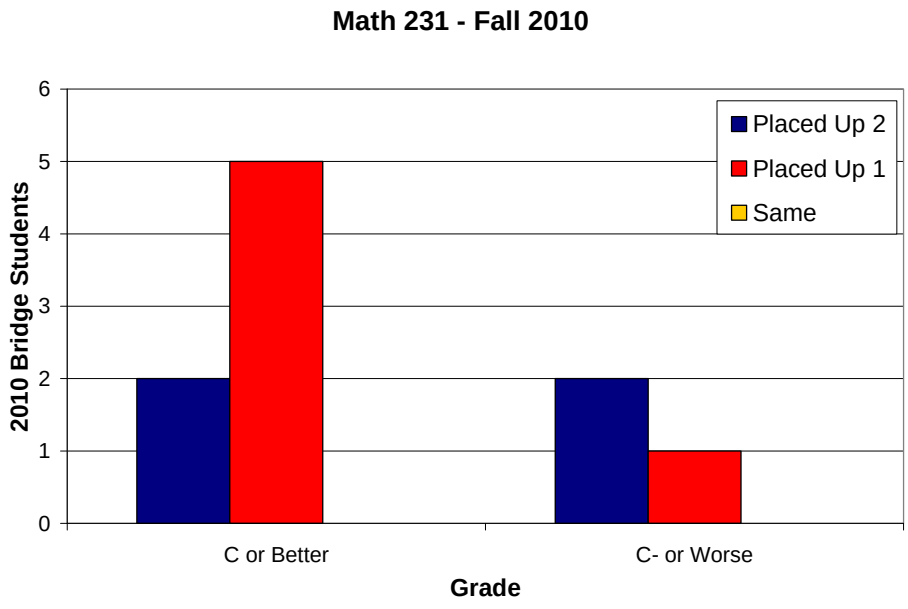

Figure 6: Performance of 2010 Summer Bridge Students who placed into Calculus I for the Fall 2010 semester.

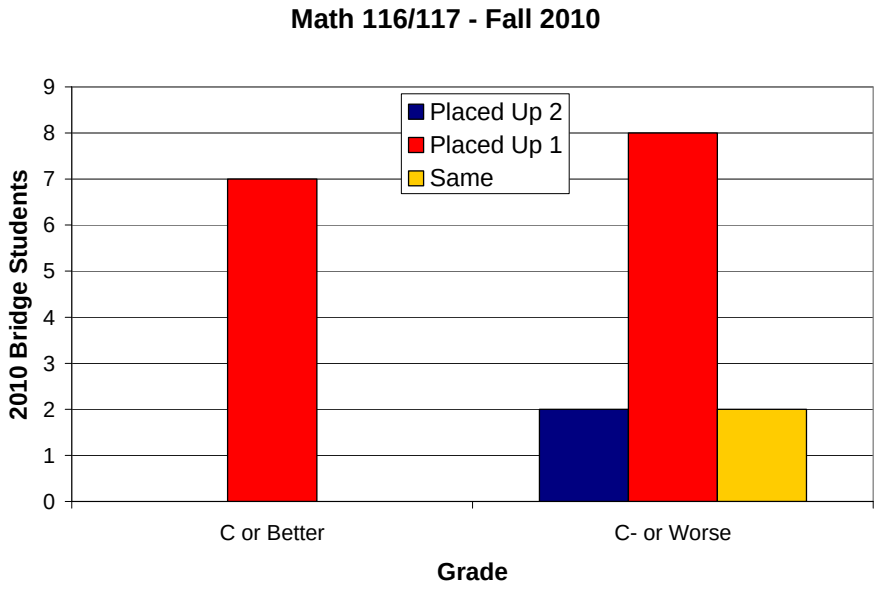

Figure 7: Performance of 2010 Summer Bridge Students who placed into College Algebra / Trigonometry for the Fall 2010 semester.

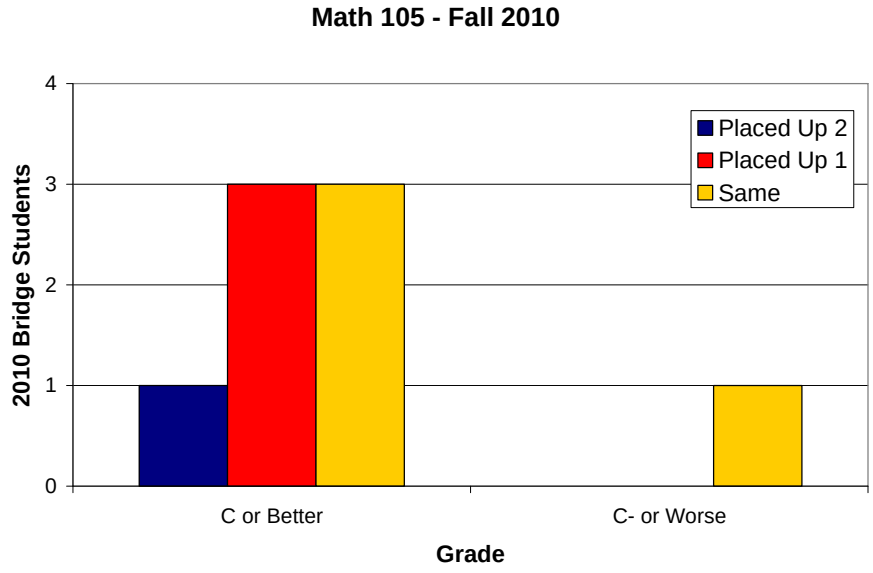

Figure 8: Performance of 2010 Summer Bridge Students who placed into Intermediate Algebra for the Fall 2010 semester.

It can also be useful to compare the student performances to the whole courses' rates of grades of C or better. In the Fall of 2009, the C or better rates for Math 231, Math 116, Math 117, and Math 105 for the entire number of students in the course were 65.4%, 59.6%, 85.1%, and 77.3%, respectively. Similarly, for the Fall of 2010 semester, the C or better rates for the courses were 61.9%, 67.8%, 71.8%, and 73.1%. Comparing these to the results in Table 1, the results for Math 231 are very consistent with the overall course rates, particularly considering the small size of the bridge program cohorts taking Math 231. It can also be noted that these would be the best students in the bridge program, typically. Also, the bridge program students outperform the course overall in Math 105, which is not surprising as Math 105 is a terminal math course for most students taking the course, indicating that these students are not in math-intensive fields and often have much weaker math skills than engineering students. While the results in Table 1 are combined for Math 116 and Math 117 success, most students have more trouble with Math 116. Considering this, it appears that the bridge program students are doing worse than the course as a whole in Math 116. This is an area targeted for emphasis for bridge program offerings in future years.

In response to these results, the 2011 cohort's bridge program was not changed significantly, as it appears to do a good job with improving math course placement. This was further demonstrated by the performance of the students in the 2011 bridge program: 56 of 64 improved their math course placement (88%), with 7 improving by two courses. However, to address the potential problems with Fall semester performance, a more intrusive advising program was implemented with a specific professional academic advisor charged with closely monitoring student progress so that interventions can be implemented quickly if necessary. The course grades for the 2011 semester are not yet available for analysis to determine the success of this intervention.

Summary and Conclusions

A residential summer bridge program in CEAS at UWM was held in the summers of 2009, 2010, and 2011. Students used the ALEKS software package along with supplemental instruction to attempt to improve their math course placement. In 2009, 67.6% of the participants improved their math course placement by at least one level, with 21.6% improving by two levels In 2010, 83% improved their math course placement by at least one level, and 17% improved by two levels. In 2011, 88% improved their math course placement, with 11% improving by two levels. While ideally this will accelerate the required math sequence for these students, the program will have little benefit if students are unable to succeed in their subsequent math courses.

While hindered somewhat by the small sample size of available students each year, it appears that the bridge program does help many students who advance one math course level through the program, and does not harm the remainder of those students. If students place one level higher, but then fail that course, they are at the same level as they likely would have been for the following semester, and in some cases may have still improved their ability to pass certain courses that give some students great difficulty (such as Math 116). In the future, with a larger number of students who have participated in the program, the impact of receiving a non-advancing grade on these students' persistence in the program can be studied.

For students who improve their placement by two levels, there again seems to be little immediate downside to the program, with many students benefiting substantially by potentially reducing the duration of their math sequence by one year. Again, as the number of these students increases, it will be of great interest to see the impact of advancing two levels on graduation rates.

Students in Math 105, even though many of them did not place up a level, still appear to have benefited from the bridge program. Only 1 of the 11 students in 2009 and 1 of the 8 students in 2010 failed to receive a C or better. While most of those students would have likely passed Math 105 without the bridge program, there is no indication that the bridge program harmed their math performance.

There was a decline in the success rate in the 2010 cohort with respect to their Fall semester math course performances. This can be partially attributed to fewer students remaining in Math 105 due to the improved success of the bridge program. To try to improve the overall performance in the Fall semester, CEAS is implementing more intrusive advising of the bridge program participants in order to improve the likelihood that course problems will be detected and resolved early.

Many of these conclusions need to be considered preliminary. As more students participate in future bridge programs, the size of the population studied will expand and the influence of one or two students on the overall average performance will be reduced. Furthermore, study of the overall program goal of increasing retention and graduation rates from CEAS will need to be postponed until sufficient time has passed for students to graduate.

Acknowledgments

Partial support for this work was provided by the National Science Foundation's Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) under Award No. 0757055. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. The authors would also like to thank Tina Tang, Cindy Walker, Todd Johnson, Tina Current, Sharon Kaempfer, and Jennie Klumpp (all at UWM) for their assistance with this project.

Bibliography

1. National Science Board. 2003. The Science and Engineering Workforce: Realizing America's Potential. Publication NSB 03-69. (www.nsf.gov/nsb/documents/2003/nsb0369/nsb0369.pdf)

2. Augustine, N. "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future", Committee on Science, Engineering, and Public Policy (COSEPUP), 2007.

3. Bochis, C., Hsia, S., Johnson, P., Boykin, K., Wood, S., Bowen, L, and Whitaker, K. "Integrated Engineering Math-Based Summer Bridge Program for Student Retention", Proceedings of the 2007 American Society for Engineering Education Annual Conference & Exposition.

4. Fletcher, S. L., Newell, D.C., Newton, L.D., and Anderson-Rowland, M. "The WISE Summer Bridge Program: Assessing Student Attrition, Retention, and Program Effectiveness", Proceedings of the American Society for Engineering Education Annual Conference & Exposition, 2001.

5. Varde, K. S. "Effects of Pre-Freshman Program for Minority Students in Engineering", Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition.

6. White, C., Curtis, M.W., and Martin, C.S. "Pre-Freshman Accelerated Curriculum in Engineering (PACE) Summer Bridge Program", Proceedings of the 2001 American Society for Engineering Education Annual Conference & Exposition.

7. Papadopoulos, C., and Reisel, J. "Do Students in Summer Bridge Programs Successfully Improve Math Placement and Persist? A Meta-Analysis.", Proceedings of the 2008 American Society for Engineering Education Annual Conference & Exposition.

8. www.aleks.com, 2010

9. Reisel, J.R., Rineck, L., Jablonski, M., Munson, E., and Hosseini H. "Evaluation of the Impacts of Math Course Placement Improvement Achieved Through a Summer Bridge Program." Proceedings of the 2011 American Society for Engineering Education Annual Conference & Exposition.

10. Reisel, J.R., Jablonski, M., Hosseini, H., and Munson, E. "Assessment of factors impacting success for incoming college engineering students in a summer bridge program." *Int. J. of Mathematical Education in Science & Technology* (in press), (2012).

11. Reisel, J.R., Jablonski, M., Hosseini, H., and Munson, E. "Evaluation of Factors Affecting the Success of Improving Math Course Placement for Incoming Freshmen in a Summer Bridge Program." 2010 American Society for Engineering Education Annual Conference & Exposition