

California State University, Northridge

Bridging the Gap: Improving Passing Rates in Math 103 Mathematical Methods for Business

Category: Demonstration Grant.

Project Team:

Katherine F. Stevenson, Department of Mathematics (Project leader)

Helena Noronha, Chair, Department of Mathematics

William Watkins, Department of Mathematics

Randal Cummings, Director of Online Instruction

The Need

About 3,250 students a year at California State University Northridge (CSUN) enroll in an introductory mathematics course that fulfills a major program requirement or a prerequisite to one. These courses include Math 102 College Algebra, Math 103 Mathematical Methods for Business, Math 105 Pre-calculus, Math 255A Calculus for the Life Sciences, and Math 150A Calculus I. In these courses, passing rates are typically only 55-65%, where passing is defined as a grade of C or better. These numbers are not unique to CSUN, but unfortunately are typical of many public and private universities throughout the country. The national concern for improving mathematical understanding and computational skills of college students is reflected by the fact that the greatest proportion of course redesigns funded by the National Center for Academic Transformation (NCAT) have been introductory math courses.

The large number of students who have to repeat these courses is highly detrimental to retention in many majors and graduation rates of those who complete the major. Further, in order to accommodate repeaters, more sections of these courses must be scheduled each semester, which is a drain on university resources. The entrance requirements to the CSU necessitate that students have been exposed to all or most of the prerequisite material in these courses. However, the Department of Mathematics at CSUN recognizes that the dominant reason for failure in these courses is the lack fluidity and/or depth of understanding of the mathematics taken in secondary school. Therefore, students cannot learn new concepts in the college level courses that rely on the prerequisite material. What is missing is a bridge between the prerequisites and the course material.

Objectives and Milestones:

The Department of Mathematics at CSUN proposes a “Bridge-the-Gap Model” to increase student success in these courses. The model has two key elements: 1) a prerequisite test that determines the existing level of understanding of prerequisite material and 2) a self-paced, modular enrichment laboratory that includes synthesis of advance software tools and face-to-face time with a laboratory instructor. To pilot this model for the 2007-2008 academic year, we have chosen Math 103 Mathematical Methods for Business. Only students in the College of Business and Economics (COBAE) enroll in this course. Hence, they have a common student learning

outcomes. COBAE is a willing partner in the effort to increase student success and mathematical understanding of their students. The course, formerly entitled Calculus for Business, had not been taught for some years. The lecture portion of the course was redesigned and offered in Fall 06 and Spring 07. Expected enrollment for 2007-2008 is ~1200 students.

The Mathematics Placement Test (MPT), Part I has been selected as the prerequisite test. All students are required to take the test in order to enroll in Math 103. Those who score below 24 are required to enroll in the enrichment laboratory in order to concurrently enroll in Math 103. This is a critical filter that avoids the “one-size-fits-all” approach to course design because those who are already proficient in prerequisite material are not required to enroll in the enrichment laboratory. The prerequisite of MPT Part I is a new requirement for students registering for Fall 07, so there are no existing figures on the number of students who score below the benchmark. We anticipate that it will be between 50 and 66%. Hence, our projection is that between 600 and 800 students will be part of our pilot model. Students who score below the benchmark on the MPT will be allowed to enroll in Math 103 if they concurrently enroll in the enrichment laboratory. The Educational Policy Committee of CSUN has approved this as an experimental course for Fall 07, and we plan to offer it in the future as a permanent course Math 103L.

There are two main components that the CR/NC enrichment laboratory uses to establish the optimum pedagogy for a course that is designed to “bridge a gap,” i.e., address material that the students have been exposed to, but either did not understand or retain sufficiently. The first is that the material is placed in distinct online modules, which the students can move through at their own pace. Because each student will be unique in their understanding and retention of prerequisite material, each student can focus on his or her areas of specific difficulty. Some students might finish all modules in 8 weeks, some in 16. The time-on-task is optimized by each student for his/her specific needs. The second element is that the enrichment laboratory will provide an instructor to assist students that have difficulties with the material and/or software. Face-to-face time in learning concepts that are difficult for students is essential. This hybrid format, therefore, allows students to move at their own pace, but have access to face-to-face time with an instructor when their encounter difficulties.

By developing Math 103L as a demonstration project, it will serve as a model also for Math 102 (College Algebra), Math 105 (Pre-calculus), Math 255A (Calculus for the Life Sciences) and Math 150A (Calculus) both on our campus and at other CSU’s. Evidence collected from assessment activities will guide our efforts to implement, revise, and expand this program. Ultimately, this project would affect approximately 2000 students a year at CSUN and if implemented on other CSU campuses the impact would be enormous.

Cost Savings

As mentioned in the introduction, reducing the number of sections of Math 103 that must be offered to accommodate repeaters represents a major cost savings. Assuming an average pass rate of 60% for 1200 students and further assuming that 10% of those that need to repeat would not, 450 students will enroll to repeat the course. Currently, full-time faculty teach either sections of 100 students or 30 students and part-time faculty teach sections of 30. For purposes of this proposal, part-time faculty (PTF) cost of the 3 unit course is \$4138.80 and full-time faculty (FTF) cost is \$9312.30. The minimum additional cost to accommodate repeaters (four sections of

100 taught by FTF and two sections of 30 by PTF) would be ~\$45,600. Therefore, a significant reduction in repeaters represents a significant cost savings.

Expertise of the Project Team

The project team leader, Katherine Stevenson, is the coordinator for Math 103 and the principle designer of the new format of Math 103. William Watkins has also assisted in the redesign of the lecture class. Both of these full-time faculty members also teach sections of the course. They will be responsible for the course content and training of the teaching assistants and student assistants who will be involved in instruction of the Math 103L laboratory sections. They will work closely with Randal Cummings, Coordinator of Online Instruction, in customizing the function of the software and design of the user interface. Dr. Stevenson participated in a workshop series offered by Online Instruction in Spring 07 that examined several of the major online-instruction software packages, such as Elluminate and RESPONDUS. Drs. Stevenson and Watkins have experience using webCT, Aleks, Webworks, MyMathLab, and Wiley Plus. During the pilot year of this redesign, they will be actively researching successful modules developed at other universities, particularly at NCAT partners such as Carnegie Mellon University, so that instead of re-inventing the wheel, they customize it for CSUN students. The Chair of the Mathematics Department, Dr. Helena Noronha, is strongly committed to the pilot model for Math 103L and the implementation of similar enrichment laboratories in other introductory math courses. She will ensure that department resources are available for hiring teaching and student assistants and that departmental computer laboratories are available for the course. The dean of the College of Science and Math, Jerry Stinner, had committed to also reserve computer labs for this course if necessary. Additionally, we will work with the CSU course redesign team as well as faculty from other comprehensive universities with experience in math re-design work. Some areas where they might help are:

- A. The problem sets and online support in the software.
- B. The cost/benefits model, i.e. which parts contribute the most value to the desired learning outcomes.
- C. The possibility of sharing after hours student support, either within the CSU or through an outside source.

Outline of Methods and Activities

I. The idea

Math 103L will review the prerequisite material required for Mathematical Methods for Business (Math 103) with examples and topics coming from *both* the content focus of math 103 (business) and the *type of computations* necessary for success in math 103.

II. Example:

Many students have seen, but do not understand how to use and compute with, functional notation. Thus, when confronted by a cost equation $C(x) = 30x + 500$, they are distracted by the functional notation and unable to attend to this as a model for the cost of producing x radios or car seats. Moreover, they are *lost* when we talk about approximating the cost of producing the 10th car-seat using the derivative of $C(x)$ (i.e. marginal cost). Here we see the need for both types of review. In the math 103L-course, we would focus on fluency in computing with and graphing linear functions. Moreover many exercises would involve an application, like the cost function above, where the computations and graphs are interpreted in the context of the business application. This

should help bridge the conceptual gap between the prerequisites and the content of the courses.

III. The Hybrid online class

- A. There will be a web-based set of homeworks and assessments.
- B. The problem sets will use scaffolding to move students quickly through the material that they know. One of the key emphasis of course redesign is the use of technology to help automate the process of fast-tracking students through individualized paths of concept mastery so that the easily-grasped concept to one student doesn't get swept aside when it is an obstacle to another and vice versa. This individualized concept scaffolding incorporates conversely, branched remediation which completely deconstructs building block concepts into their minute constituent elements in order to buttress weaknesses in the construction of complex mathematical operations. This implies constant assessment of student weaknesses/obstacles to concept mastery, which also allows for the possibility of self-paced approaches to matriculation through learning outcomes.
- C. The problem sets and assessments will be computer generated problems so that each student has the same type of problem but with different numbers (e.g. Webworks).
- D. Students will be required to have 2 contact hours per week. One hour will be at their discretion and the other a scheduled (Friday PM) class meeting with TA. Compliance will be accounted for by a card swipe in lab.
- E. Students will be required to do a minimum of two additional hours of work on the program outside of the lab until they complete the material.
- F. Intermediate and Final assessments will be done online in the scheduled (Friday PM) computer lab meeting.

II. Personnel.

- A. One faculty member, Prof. Katherine Stevenson, will be in charge of each Math 103L as general oversight and course developer. Prof. Bill Watkins will assist her in the development of math 103L.
- B. One graduate TA per approximately 40 students in Math 103L. This person will
 - a. Monitor student progress.
 - b. Check that the students are meeting minimum weekly hours both in lab and in homework
 - c. Contact student (and faculty supervisor) when a student is not progressing or is not working hard enough or often enough.
 - d. Keep track of grades.
 - e. Hold the scheduled class meeting along with a student assistant. Here study groups can be organized and assessments will be given.
 - f. Maintain a bulletin board for this section with FAQ.
 - g. Contribute to main bulletin board for 103L.
- B. Undergraduate Student Assistant (SA) working in the lab and online. The SA could come from a service-learning component coordinated with our math major in secondary math education. The SAs will:
 - a. Work one on one or in small groups with students in the lab for 10 hours per week.

- i. 15 to 1 ratio in the lab for the first three weeks to get students used to the system.
 - ii. 30 to 1 ratio in the lab for the rest of term.
 - b. Be on call for online help for 5 hours per week.
 - i. E.g. 9AM-midnight online help available for first 3 weeks. Done via Elluminate and webCT.
 - ii. Limited Online help available for rest of the term.
 - c. Contribute to bulletin board for math 103L.

III. Bulletin Boards.

- A. Main Bulletin Board: For each topic, the bulletin board will have some thing of the type: most common errors (Like FAQ) with an explanation of the error, why it is wrong, what the misunderstanding usually is when students make that type of mistake.
- B. Bulleting Boards for Sections: We will split the class in chat rooms where each room has at most 30 students. These chat-groups will discuss specific problems and will be monitored by a TA. Again, the TA will explain the misunderstandings and errors. The group will meet in their TA in the chat room and their TA in the scheduled class meeting

IV. Assessment of individual student learning.

- A. MPT Score as a baseline.
- B. Midway assessments: Every four weeks, there will be an assessment of pre-determined topics with the TA in the scheduled class meeting. Students who are ahead may take this assessment earlier, but still in the scheduled class meeting. Students who fail the assessment will be regrouped. The course coordinators, in consultation with the TA, will create a chat room and bulletin board for this group. The students who passed go on and the course can be planned so that a student that passes all tests is able to cover everything is 8 or 9 weeks. This would allow 7 weeks for the slow ones to still practice and practice.
- C. Final Assessment: Done in the scheduled class meeting
- D. Remark: For students who wish to start the class before term time. They can do all the work and take the midway and final assessments in the first of second scheduled class meeting.

V. Assessment of math 103L

- A. The require score to enroll in Math 103 is 24. We will compare common final scores of students with 24 though 30 on the MPT with those of students who finish math 103L.
Reaction to assessment activity:
 - a. If significantly more students who passed the MPT with a score of 24 though 30 pass the Math 103 common final, then we need to revise its Math 103L
 - b. If significantly more students who passed math 103L pass the Math 103 common final, then we need to revise the passing score of 24 or revise math 103.
- B. We will compare scores of students in math 103L and not math 103L on particular problems on the common final in Math 103. This will enable us to identify and fill *specific gaps* that have not yet been covered. *Reaction to assessment activity:*
 - a. If students who passed the MPT do better on problem P, then we will see that that topic (or a some prerequisite topic) needs to be added to math 103L.

- b. If students who take math 103L do better on problem Q, then we see that that topic needs to be covered in more depth in Math 103.
- C. Coordination with COBAE: We will work with COBAE and Institutional Research to track student success in selected business classes to look at the impact of 103 and 103L on student success.
- D. Student survey on satisfaction regarding lab hours, online help, TA's, SA's.
 - a. Does anyone use the bulletin boards? How often?
 - b. Is the weekly scheduled hour in the lab helpful, beyond for assessments?
 - c. Is the online help useful?
 - d. Is the mix 1 hour scheduled lab, 1 hour self scheduled lab and 2 hours of online homework time the right mix?

Reaction to assessment activity:

- a. Revise bulletin board use.
- b. Revise mix of scheduled and unscheduled time.
- c. Should we move to (1,0,3) where the 3 could be online or in the lab?
- d. Do we need the scheduled meeting or would it be better to have the lab time completely at the students' discretion? Maybe have a pilot group with one TA have all the lab time completely at the students' discretion and compare results.
- e. Do we need to require lab time or should we allow students to do all they can from home using online help? Maybe have a pilot group with one TA with no lab requirement unless they fail the first assessment.
- f. How can the online help be improved technically?

Timeline for Completion of Project

- Summer 2007: Prepare to implement math 103L for students who fail the MPT for math 103.
 - Stevenson and Watkins will set up the first iteration of the modules using software that is currently being tested by several current math 103 students. They will set up a WebCT page for the class that will direct students into "work groups" of 30-40 students headed by a TA.
- Fall 2007: Implement math 103L for students who fail the MPT for math 103.
 - Instructors: Two faculty members (Stevenson and Watkins) and a number of GA's and SA's will run the program. Prof. M. Helena Noronha will hire the GA's and TA's using funds generated by the FTES for the one unit class 103L. Faculty will oversee the program and its assessment as well as develop and refine the next iteration of the online modules for Spring 2008.
 - Resources: We will use existing lab classrooms on campus (JR254 with 30 computers, SH272 with 20 computers). Online help equipment for GA's and SA's (tablets or smart board). Smart Pens and headset with microphone.
 - Consultant: May 2007 Randal Cummings. August 2007 invite expert in from the CSU course redesign team or other comprehensive university.
- Spring 2008: Implement hybrid model for math 103L.
 - Instructors: Two faculty members (Stevenson and Watkins) and a number of GA's and SA's will run the program. Prof. M. Helena Noronha will hire the GA's and TA's using funds generated by the FTES for the one unit class 103L.

Faculty will oversee the program and its assessment as well as develop and refine the more finalized version of the online modules for Fall 2008.

- Resources: We will use existing lab classrooms on campus (JR254 with 30 computers, SH272 with 20 computers).
- Consultant: May 2008 invite expert in from the CSU course redesign team or other comprehensive university as external evaluator in to assess and advise.

Expected Results and Broader Impact

Student success in Math 103 is strongly affected by mathematical preparation and confidence of the student. The range of these factors within a class spans a large continuum. Provision of this optional C/NC enrichment laboratory to students enrolled in Math 103 gives the student an opportunity to deepen and strengthen mathematical competence and confidence, no matter what level he or she is starting from. The students can move through the modules at their own pace to enhance their understanding of lecture material and to gain a stronger overall foundational knowledge of major mathematical principles and skills important in business and economics. The proposed course includes two aspects of course redesign that we believe will optimize student learning, student time-on-task, and university resources:

1. The enrichment laboratory decouples the “traditional” linkages between credit hours, time in the classroom, and learning objectives by establishing a curriculum that is modularized in sequence with lecture topics, but is self-paced, allowing students to achieve learning objectives at different rates.
2. The technology is purposefully deployed as a tool for facilitating learning, but the opportunity for face-to-face instruction and assistance is also available to accommodate other learning modes.
3. The enrichment laboratory provides an option that can shorten time to graduation because it allows students to enroll in MATH 103 if they also enroll in MATH 103L in the same semester. Furthermore, we anticipate that additional of laboratory will significantly increase the number of students who pass Math 103 on their first attempt, significantly decreasing the number of repeaters.

Successful implementation and outcomes for Math 103L in improving pass rates on Math 103 will provide the model for similar CR/NC enrichment laboratories that will fill the gaps for Math 102, 105, 255A and 150A at CSUN. Furthermore, the model should be easily transportable to other CSU campuses and community colleges. We will make all course materials developed for Math 103L readily available to the CSU community via a webpage or wiki.

Institutional Support for Transforming Course Design

California State University Northridge is a strong advocate of academic transformation. Provost Harry Hellenbrand has supported efforts on this campus by funding five course redesigns and hiring Michael Dolence, a well known expert on course redesign strategy, to serve as a consultant. In addition to the faculty involved in the redesigns, the team includes the CSUN coordinator of online instruction, Randal Cummings; two staff members from the library, Helen Heinrich and Luiz Mendes, experts in cataloging and electronic resources; and the associate deans of the colleges of the redesign courses. Furthermore, CSUN is a member of Phase 3, Colleagues Committed to Redesign, of the National Center for Academic Transformation (NCAT). CSUN has also funded the attendance of four members of the redesign team at the annual conference of NCAT. On the assessment side, CSUN has a dedicated and experienced

team headed by Dr. Bettina Huber working in the office of Institutional Research. Through that office we are able to easily track groups of students through as the progress through their academic programs.

Budget

PERSONNEL

Stevenson Summer Stipend	2007 August	\$2,000
Katherine Stevenson, Project leader	Fall 2007	\$4,875
3 units RT @\$55,284/yr	Spring 2008	\$4,875
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	Total personnel	\$11,750

Consultant	Fall 2007	\$2,000
	Spring 2008	\$3,000

SUPPLIES

Online help equipment	Smart board or tablet laptop	\$5,000
	Headsets with microphone	\$500

Total Year 1: \$22,250

Budget Justification: Similar successful models for hybrid classes exist for College Algebra and Pre-Calculus exist. For example Carnegie Mellon University has many “math modules” that may be adapted to our situation. Also there are several online learning systems that have been implemented in both the math department and in developmental math (e.g. Aleks and webwork, My Math Lab, and Wiley Plus). We will employ these programs so that we do not re-invent the wheel. However, we will customize the wheel for CSUN and the CSU. It will take a great deal of time to sort through all the available resources to determine with fits our situation best.

- Summer stipend for Dr. Stevenson is for developing course materials for fall 2007.
- Course release-time for Dr. Stevenson in Fall 2007 and Spring 2008 are to implement refined modules for 103L.