Proven Course Redesign: Closing the Gap in Persistence and Graduation
for STEM Bottleneck Course Calculus I M150A
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May 2013

Calculus I M150A was a high demand, low success course and a pedagogical bottleneck to entry into virtually all STEM majors.

The redesigned M150A course shows marked increases in student success.

Key Takeaways
- Responded to the bottleneck crisis by redesigning Calculus I. Over a two year period, pass rates increased from 58% to 67%.
- Improved the students' average scores and the distribution of the grades.
- Reformed departmental placement test procedures that were barriers to student success.
- Developed a system that identifies at-risk students based on their pre-requisite performance.
- Required at-risk students to take a one-unit supplemental hybrid lab.
- Developed a parallel approach for the courses proceeding and succeeding Calculus I, Trigonometry M104 and Calculus II M150B.
- Augmented traditional physical tutoring lab with an online tutoring lab to providing additional support students in the evening
- All interventions are easily transferable to other CSU campuses. This project is scalable.

Overview
M150A Calculus I is a pre-requisite for a range of higher-level courses in math and other subjects. Because of this, M150A Calculus I is a gateway course for science, technology, engineering, and mathematics (STEM) fields. M150A directly affects approximately 25% of the total STEM student population of 5000. Secondarily, mathematics service courses impact at least 43 non-mathematical STEM courses required by 25 degrees in Engineering, Computer Science, Mathematics, Physics, Chemistry and Biology.

Historically, M150A has had a 50-60% pass rate. Success in this course is highly correlated to retention and timely graduation. Of the CSUN students admitted as first-time freshmen between 1996 and 2002 who entered STEM majors less than 30% completed a degree in 6 years. Of this, only 4% completed their degrees in 4 years. In examining the data closely to determine what factors led to success, we found that over 80% of entering freshmen who began as a STEM major and took Calculus in their first semester received a degree. Failure to pass Calculus I negatively impacts retention rates and delays degree completion. Thus, the most promising approach to increasing retention of freshmen entering STEM majors is to ensure their timely matriculation in Calculus and required Mathematics courses.
CSUN has developed a technology-enhanced hybrid course model that has significantly improved student success and proven cost efficient and scalable. The model, first fully implemented in 2011, incorporates interventions and practices, such as improved course coordination, supplemental hybrid instruction, and online tutoring. We believe that even further improvements can be made which will reduce the achievement gap. Math can be taught more inclusively. We know that we can adopt our teaching practices to improve all students’ performance, particularly underrepresented minority (URM) and disadvantaged economic groups.

We look forward to refining and disseminating our work.

**Main Accomplishments: Redesign of the STEM Pipeline**
Our calculus I M150A course redesign has proven success. We have increased the passing rates from 58% to over 67% over a two year period. This was accomplished by several steps:

1. Improved the Mathematics Placement Test (MPT) procedure for students, advisors, and
   - Adopted an online test format.
   - Use diagnostics from the MPT to get a better handle on student preparedness.
   - Phased in online payment with registration for the MPT prior to test date.
   - Reduced the wait time between MPT retakes by doubling the number of test dates.
   - Increased the amount of time allowed to complete the exam.
   - Updated a letter with Q&A about the MPT for advisors.
   - Provided students with better information about the MPT via a letter from the chair.
   - Created of an online MPT preparation site which is staffed by online tutors and supervised by faculty.

2. Developed a system that identifies students who have a high risk of failure, the so-called at-risk students.

3. Required at-risk students to take the supplemental hybrid lab. The one-unit hybrid lab meets weekly for one hour. The hybrid lab has a complete set of interactive notes tied to the text. As part of the lab, the MPT is retaken during the first week of class. A targeted remediation is required in areas of deficiency during the first three weeks of class.

4. Created an Online Tutorial Center open five days a-week during evening hours. Faculty supervised tutors by reading through the communications and working with tutors to improve their communication skills.

5. Used online free homework system called Webwork which gives the student instant feedback.

6. Adopted a common textbook.

7. Engaged in periodic common assessment of SLO’s of our common final.

8. Created a repository of course materials.
Our project addresses student success outcomes. We track accountability metrics, and engage in formative and summative assessments and evaluations as outlined by Chancellor White in the “Reducing Bottlenecks and Improving Student Success” RFP. **We will track data on B4 and B5 (Increasing the Number of Degrees Awarded), C1 and C6 (Improving CSU Graduation Rates), D1 and D4 (Reducing Time to Degree).**

### Funding and Acknowledgments

Many CSUN faculty members have collaborated on this project. A major push came when Dr. Vicki Pedone, Dr. Cristina Cadavid, and Dr. Werner Horn were awarded a National Science Foundation (NSF DUE 0969627, $1.268,004) grant called Students targeting physical sciences (STEPS). This grant helped to pay for the development of some of the materials. Dr. Carol Shubin, Dr. Alexander Alexander, Dr. Jacek Polewczak, and Universal Design Center Director Sue Cullen were funded by both CSUN Provost's Office and Chancellor's Office for improvements made to MPT Practice Website, ELM CSU Student Success Website, and Online Tutoring System. We gratefully acknowledge Dr. David Protas’ contributions to the course design and management. He contributed the assessment report. We thank many authors for the CSUN Calculus homework Webwork database. Dean Stinner and Math Department Chair Werner Horn contributed additional funds to the Online Tutoring scale-up.

This work was made possible by Provost Harry Hellenbrand’s enthusiastic support and guidance.
Summary of Student Success in Calculus I M150A

The chart below shows the enrollments for 150A over the period 1999-2012 (blue line). These are annual enrollments excluding summer. The value for a given year is the total enrollment for the academic year starting at this date, so 1999 represents the 1999/2000 academic year. The red line represents the total number of students passing Calculus with a C or better in a given year, starting 2011 it is with a C- or better, as this represents the new threshold for advancing to the next course.

Students enrolled and passing in 150A

The enrollment data are actual through Spring 2013. The passing data for the 2012/13 academic year are forecasts based on the Fall 2012 pass rates.
The second graph shows the annual cumulative (all sections) pass rate for Math 150A. There are notable dips and increases in this graph. The sharp decline from 2001 to 2002 probably reflects the changes in the ELM and Developmental Math made around that time. With the preparation courses adjusting to this new reality, the rate climbs up to somewhat below its historic average. But the year after, it reaches a higher plateau.

There are several possible explanations for improved pass rates:

- The Calculus book was standardized; all instructors use James Stewart's *Calculus* textbook.
- Calculus Labs were introduced for students with weak test scores or low grades. Higher pre-requisites were instituted for students who are not required to take the labs.
- Online tutoring was opened Sunday – Thursday evenings.
- Passing standard was changed to C-.

Influences of individual instructors should average out in these data. However, we note that some instructors have significantly lower passage rates than others. Over the years the pass rates of individuals can fluctuate quite a bit. In one instance, one instructor had a pass rate of below 50% in one semester and a rate of close to 90% the following semester. Especially in fall (when students can enroll long before the semester starts), “good” students with early enrollment dates will gravitate to particular sections (based on time and instructor), other sections will have a high percentage of repeaters and students who take Calculus in their junior year (those students are usually weaker). Popular instructors are those with historically high pass rates and evaluations on the different internet sites. This trend tends to amplify the differences between instructors with high pass rates and low pass rates.
Overall students who participated in the labs have the same pass rates similar to those of students who were not required to take the labs because of stronger performance in pre-requisite courses or exams. Note: students receive No Credit in the lab if they fail to participate in more than three sessions.

**Observed Grade Improvement**

![Grade Distributions of At-risk Students in Calculus I](image)

**Performance of At-Risk Students in 2011**

![Performance of at risk students compared to well prepared students and the historical average](image)
Summary on Results

Course redesign has paid off. CSUN multi-section M150A course is better coordinated and more effective. The course is more consistent and of higher quality.

Well–coordinated courses are easier for instructors to teach. All instructors have access to the course repository and can view “best practices” and access a wealth of common resources. Novice instructors may find this repository particularly useful.

The additional one-unit for the supplemental hybrid lab is money well-spent by the student and the State. There is no replacement for well directed time on task.

Teaching assistants and tutors are well-trained and monitored through-out the term. Each supplemental hybrid lab is directly tied to one instructor’s course. Instructors and teaching assistants are in contact on a weekly basis.

Online tutors are supervised by faculty. Communication is reviewed for effectiveness. Best practices are collected and disseminated to all tutors.

The program’s effectiveness is measured in numerous ways. There are formative assessments and summative evaluation are periodic.

Overall, this project has led to an increase in the number of STEM majors at CSUN.
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Mathematics Placement Test

Summary
Streamlining MPT procedures can have a measurable impact on B4 and B5 (Increasing the Number of Degrees Awarded in STEM disciplines), C1 and C6 (Improving CSU Graduation Rates), and D1 and D4 (Reducing Time to Degree).

CSUN students who want to place beyond College Algebra M102 (3-unit course) take the Mathematics Placement Test (MPT). The default of not taking the test or receiving a non-proficient score on the MPT is automatic course assignment to College Algebra. Students want to be STEM majors then attempt Trigonometry (3-unit course) or Pre-calculus (5-unit course).

Improving the test procedure is an obvious (and excellent) way to cost to the student and the State by decreasing the time to graduation

Test procedures have been improved. The number of placement tests was reduced from two to one and the test is now given online. Improved information is provided to Students and Advisors. Payment is online with test registration. The length of time to complete the test was lengthened. Students are now directed to a test preparation site.

The percentage of test takers who placed into calculus increased from 32.4% to 40.4%
The percentage of test takers who placed into pre-calculus or trigonometry increased from 10.6% to 12%.

The Math Placement Tests (MPT) are Department Exams
CSUN offered two math placement exams to determine eligibility to enroll in specific math courses at CSUN. The Math Placement Test (MPT) is required for students to enroll in all lower division math classes beyond College Algebra M102 (ie, for Business Calculus M103, Trigonometry Math M104, Pre-calculus M105, Calculus I M150A and Calculus for Life Sciences 255A). These tests had to be taken within two semesters preceding enrollment in courses. They could only be taken once in a six month period.

The MTP tests were designed to measure student readiness for a broad range of mathematics courses. More importantly, the tests were developed to provide students and the Math Department with diagnostic information about student preparedness. This information can help students identify specific areas where additional study or review is needed. It can help teachers identify topics and skills that need more attention in courses.

**MPT I Mathematical Analysis Readiness (MR)** level tests assess preparation for pre-calculus or other courses at that level; they can be given near the end of a second year algebra course or at the beginning of pre-calculus courses.

**MPTII Calculus Readiness (PC or CR)** level tests assess preparation for calculus; they can be given near the end of a mathematical analysis or pre-calculus course.
Implemented changes:

Change #1: The MPT is now an online test.
The new MPT is an online test. This enables the student and department to get immediate results and diagnostics. The diagnostics are important for appropriate placement. The tests help identify particular topics in which students need better understanding and skill; however, the tests are not comprehensive mastery tests. MTP tests are multiple-choice tests. Each option or distractor is chosen with care. A review of the wrong responses can often indicate to teachers where their students are making errors in their solutions. MTP takes into account the California state standards and framework, national standards, and current discussions in mathematics education.

Change #2: Increased the number of times the MPT is offered and the time allowed for the exam
The MPT is offered various times throughout the year. The test consists of two parts: Part I and Part II. The MPT Part I consists of 45 multiple-choice questions to be completed in 75 minutes. The MPT Part II consists of 40 multiple-choice questions was increased to 75 minutes from 60 minutes.

Change #3: Implemented new test registration and payment system
Currently, there is a $10 charge for the MPT, payable the day of the examination. Payment can be made by exact cash, check or money order, payable to CSUN. A picture ID is required on the day of the test. Students must know their CSUN student ID. Also a student who wanted to retake the MPT had to wait six months. THIS WAITING PERIOD WAS REDUCED TO ONE MONTH. Students now have the option to pay on-line. On May 11, 2013 we offered a free test to first time freshmen in Science and Engineering, with the test costs covered by the NSF STEPS grant. We plan to institutionalize this practice with the cost covered by the Colleges of Science and Mathematics and Engineering and Computer Science.

Change #4: Mathematics Placement Test website system integration
The original project will use the free Content Management System (CMS), Drupal and the free Learning Management System (LMS), Moodle. Other CMS and/or LMS that support LATEX ASCIIMath, and MathML will suffice. However, one advantage of using Moodle is that WeBWorK, an open-source online homework system for math and science courses, is well integrated within Moodle. WeBWorK is developed and supported by the Mathematical Association of America and the National Science Foundation and comes with the National Problem Library (NPL) of over 20,000 homework problems including high school mathematics, college algebra, discrete mathematics, probability and statistics, single and multivariable calculus, differential equations, linear algebra and complex analysis. The problem sets are of high quality and are used by 240 colleges and universities in the US. The online resource has similar features as ALEKS, but are free to use and easy to modify by the faculty at each campus on the CSU. Drupal will serve as a gateway and front webpage for Moodle, WeBWorK, and other online tools.
Proposed Changes

Change #1: Use only one test

Incoming students or students who passed 093, are asked to take our placement exam, or will be put into College Algebra M102 with Lab by default. The placement test consists of two exams the MPT I and the MPT II. The MPT I uses the test called MDTP MR 45, which tests for readiness for Trigonometry and consist of 45 problems from seven categories: linear equations, rational functions, geometry and applications, expressions and exponents, logarithms and exponentials, polynomial functions, and functions in general. The MPT II uses the test called MDTP CR 40, which tests Calculus readiness, which consists of...
40 problems in eight categories, the seven listed above and trigonometry. Only five problems are in trig. And 35 problems are in the same categories as the MTP I. We essentially test students twice on the same day on mostly the same kind of topics. They have currently 75 min for each test. We use combinations of cut scores to place students into the correct class. This is a complicated system that puts an enormous burden on students. Moreover, our cut score of 28 on the MPT II does not guarantee that the student knows trigonometry. This can only be achieved with a cut score of 36 or higher.

Both tests allow for scoring in the individual categories. If we use these individual scores a single test would allow placement. The MPT II has 35 non-trig questions, and 5 trig questions, the table below indicates how we could place students using only MPT II.

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
<th>150A</th>
<th>150A+L</th>
<th>M105</th>
<th>M105+L</th>
<th>M104</th>
<th>M104+L</th>
<th>102</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-trig</td>
<td>35</td>
<td>24</td>
<td>21</td>
<td>24</td>
<td>21</td>
<td>18</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Trig</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

These cut-scores roughly correspond to the ones we currently have. For the non-trig scores I used the current MPT I requirements and computed roughly equivalent scores. So 30/45 in the current MPT I becomes 24/35 in this model. Students who do not take the test will automatically be placed in 102 with the lab, as before.

**Change #2: Offer multiple paths**

Only about 50% of GE ready STEM majors take the MPT. However, many of the other students have other test scores available, such as ELM, EAP, SAT Math, and ACT Math. The ELM has 40 questions from arithmetic, beginning and intermediate algebra, and geometry. 25 correct solutions (a score of 50) is the passing score for the elm. However, some students have well over that. And data show that students with 35 or more correct answers do extremely well math 102, however they might place into math 105, 104 or even Calculus, if they had taken the MPT. This fall we will run an experiment by allowing students with 34 or more correct answers directly into 105+L, and students with 37 or more directly into 105 with out lab. There are only a few dozen students in this category. Math SAT scores and Math ACT scores can be easily mapped into ELM scores, which would allow more students in this category.

Of course, students can prepare for the MDTP by using their online tests. However, the results from these practice tests are not available to CSUN instructors. Our site allows students to remediate in areas of weakness.

We continue to aim to increase the number of test takers and students who pass the test. We have met with the Director of Student Services Centers/EOP or college advisors to discuss ways to increase the number of students passing the placement test early. This “intervention’ must occur in March to be effective. June is too late.

We believe that the test should be free rather than $10. The cost is little and yet it is just one more barrier to students taking the test in as a timely a manner as possible.

**Conclusion**

Improving the MPT procedure has increased STEM participation and reduced time to degree at a very low cost to the student and the State.
Common Text and Common Finals

Calculus 7th ed by James Stewart was adopted as the common textbook for Calculus M150A. In recent years, the CSUN Math Department has voted three times on the issue of textbooks for its main calculus sequence, and has in all cases voted to have a single textbook policy. Unfortunately, some faculty members continue to use other texts which do not follow the syllabus. This is a serious impediment to successful adoption of an improved program.

The main reason that a single text book choice for calculus is so important is that the calculus is a sequence of courses rather than just one course. We believe that the differences among the faculty concerning how the calculus should be taught are not so great that they could not be dealt with by a common syllabus along with a common final exam if it were a matter of a single course. However, as we all know, the calculus at CSUN is a three semester sequence of courses with most calculus students required to take all three courses by their major and the overwhelming majority required to take at least Math 150A and Math 150B.

As a student goes through the calculus sequence, he or she should expect seamless transitions from one course to the next. Both now and in the past, we have not provided this. Recently, the problem has been mainly with transcendentals as students go from one book to another. Back when the official policy of the Department was to use one of two books, we also had trouble keeping the coverage uniform. It got to the point that although we were able to offer a common 150A final with only the usual amount of arguing, we regularly had separate versions of the 150B common final for the two books.

Even if there is an agreement on a common syllabus for each individual course and that agreement is actually followed, there is the very real issue of cost. We are all aware that students are being burdened with outrageously high textbook expenses. Because of the scheduling demands of work and other courses, we can expect significantly many students to not be able to go through the calculus sequence with instructors using the same textbook if we do not have a single textbook policy. Already, transfer students face the cost of changing books; let's not add to the problem. Any multiplicity of books, even with ones labeled as "inexpensive," is an unnecessary expense for our students.

Common Syllabus

1. Catalog Description
   a. Course level: Math 150A
   b. Title: Calculus I
   c. Credit: 5 units
   d. Term to be offered: F, S
   e. Course Description: Limits, continuity, and derivatives for functions of one variable, applications of the derivative, the definite integral, applications of the integral.
   f. Prerequisites: Passing score on or exemption from the Entry Level Mathematics Examination or credit in Math 093, and either a passing scores on the Mathematics Placement Test or completion of Math 105, or both Math 102 and 104, with a C or better. Students who transfer the equivalent of Math 105, or both Math 102 and 104, with a C or better are required to achieve a passing scores on the Math Placement Test.

2. CSUN Math Student Learning Objectives
   The Student Learning Outcomes for the undergraduate mathematics program state: At the end of their program of study, students should be able to:
1. demonstrate a command of the content usually associated with an undergraduate degree in mathematics;

2. communicate mathematical ideas clearly and cogently, both orally and in written form;

3. present clear and rigorous proofs;

4. build mathematical models and demonstrate problem solving skills, including proper use of mathematical software;

5. understand principles underlying various branches of mathematics and recognize their interrelationship;

6. experience mathematical discovery and independently read and understand mathematical articles or texts written at an undergraduate level

In completing this course, students will be able to:

i. read, interpret and solve word problems.

ii. write solutions using correct technical notation and grammar.

iii. apply the theory of limits and derivatives.

iv. apply scientific concepts related to derivatives, functions, and relations.

v. apply scientific concepts related to integration.

b. Upon successful completion of this course, students will:

i. be prepared for more advanced courses requiring calculus.

ii. appreciate the importance of mathematics and its applications to the sciences.

iii. to use the concepts of calculus to solve basic applications, including word problems.

3. Course Outline

Weeks 1-3
Limits and Rates of Change
Limits of functions: introduction to limits and a rigorous definition of limit.
Rules for operations on limits.
Limits at infinity and infinite limits.
Limits involving trigonometric functions.
Continuity.

Weeks 4-6
Derivatives and Related Rates
Definition of derivative; use of the definition to find the derivative of simple functions.
Product and quotient rules.
Chain rule and Leibniz notation, differentials, linear approximation.
Derivatives of trigonometric functions.
Higher order derivatives.
Implicit differentiation.
Applications of the derivative. Rates of change. Related rates.

Weeks 7-9
The Mean Value Theorem, Interpreting Graphs
Rolle's Theorem and Mean Value Theorem.
First derivative test and Second derivative test.
Graphing.
Optimization problems.
Newton’s method.

Weeks 10-12
Methods of Integration
Definition of sigma notation.
Riemann sum, areas.
Indefinite integral and Antiderivative.
Definite integral.
Fundamental Theorem of Calculus.
Substitution Rule.

Weeks 13-15
Applications of Integration
Areas.
Area between curves.
Volumes of solids.
Work.
Average value of a function.

4. Evaluation of Student Learning
Evaluation may includes homework, weekly quizzes, a minimum of 3 in-class examinations, and a final exam.

This course satisfies the criteria for a writing active course through the emphasis on correct mathematical writing required when the student supplies complete reasoning as part of the solutions to problems.

5. Implementation
The text to be used is Calculus, 7th edition, by James Stewart; Brooks/Cole,

*The Final Exam is created and approved by all M150A instructors. However, it is not commonly graded, nor is the grading blind.* We suggest common, blind grading system be adopted to improve grading consistency and overall course quality.
Assessment Reports from Spring 2007 and Spring 2013

Assessment Report from Spring 2007: Results for two problems (Problem 1 and Problem 4) on the common final exam have been examined. These two problems, in part, assess Student Learning Outcome 1: Represent, understand and explain mathematical information symbolically, graphically, numerically and verbally. Problem 1 addresses the course objective, “Compute derivatives.” Problem 4 addresses the course objective, “Use differentiation in drawing graphs.”

The two Spring 2007 exam questions assessed:

1. (30 points) Find \( f'(x) \) for each of the following:
   
   \begin{align*}
   (a) & \quad f(x) = \tan(3x) - \frac{2}{x} \\
   (b) & \quad f(x) = \sqrt{1 + x^2} \\
   (c) & \quad f(x) = x^{\frac{3}{2}} e^{1-x^2} \\
   (d) & \quad f(x) = \frac{7x + 2}{x^3 - 1} \\
   (e) & \quad f(x) = \arctan(e^{5x}) 
   \end{align*}

4. (25 points) Let \( f \) be a function such that \( f'(x) = \frac{x}{(x-3)^2} \) and \( f''(x) = \frac{-x-3}{(x-3)^3} \) for \( x \neq 3 \).
   
   (a) Find the intervals on which \( f \) is increasing and the intervals on which \( f \) is decreasing.
   (b) Find any values of \( x \) at which \( f \) has a local maximum and any values of \( x \) at which \( f \) has a local minimum.
   (c) Find the intervals on which \( f \) is concave up and the intervals on which \( f \) is concave down.
   (d) Find the values of \( x \) at which \( f \) has an inflection point.
   (e) If \( \lim_{x \to \infty} f(x) = 1 \) and \( f(0) = 0 \), sketch the graph of \( f \), showing your results from the previous parts of this question.

The results from five sections that ran in Spring 2007 are summarized in the following. The bar chart shows the number of students with percentage scores in the given ranges.
Problem 1 was worth 30 points. The results from five sections are summarized in the following. The bar chart shows the number of students with percentage scores in the given ranges.

Median: 24 (80%)
Mean: 21.79 (72.64%)
Standard deviation: 6.94 (23.13%)

Problem 4 was worth 25 points. The results from five sections are summarized in the following. The bar chart shows the number of students with percentage scores in the given ranges.

Median: 18 (72%)
Mean: 16.18 (64.73%)
Standard deviation: 6.82 (27.28%)

We conclude that, considering the difficulty of the problems, students generally performed as expected. The results are in line with the results of past common final exams. For the most part, students had greater success with Problem 1, which focused on dealing with information symbolically, than they did with Problem 4, which involved dealing with information both symbolically and graphically. The mean of 73% for Problem 1 easily meets its course objective at level B, while the mean of 65% for Problem 4 barely meets its course objective at level I.
Assessment Report from Spring 2013

Results for two problems (Problem 1 and Problem 6) on the common final exam have been examined. These two problems, in part, assess Student Learning Outcome 1: Represent, understand and explain mathematical information symbolically, graphically, numerically and verbally. Problem 1 addresses the course objective, “Compute derivatives.” Problem 6 addresses the course objective, “Use differentiation in drawing graphs.”

Two Spring 2013 exam questions assessed:

1. (25 pts) Find $f'(x)$ for each of the following functions:
   
   (a) $f(x) = (x^3 + 1)^7$
   (b) $f(x) = \cos^4 x - 2x^2$
   (c) $f(x) = \frac{x + 2}{3x + 5}$
   (d) $f(x) = x^3(2 - x)^{1/5}$

2. (25 pts) Let $f$ be a function such that $f'(x) = \frac{64x}{(x^2 + 16)^2}$ and $f''(x) = \frac{64(-3x^2 + 16)}{(x^2 + 16)^3}$ for all $x$, and $\lim_{x \to \infty} f(x) = \lim_{x \to \infty} f(x) = 2$.
   
   (a) Find the intervals of increase and the intervals of decrease for $f$.
   (b) Find the domain values (if there are any) of the points where $f$ has a local maximum. Do the same for any local minimum.
   (c) Find the intervals of upward concavity and the intervals of downward concavity for $f$.
   (d) Find the domain values (if there are any) of the points of inflection for $f$.
   (e) List all horizontal asymptotes, if any.
   (f) List all vertical asymptotes, if any.
   (g) If $f(0) = 0$, use the information found above to sketch a possible graph of $f$. 
The results from six of seven sections that ran in Spring 2013 are summarized in the following. The bar chart shows the number of students with percentage scores in the given ranges.

Problem 1 was worth 25 points. The results from six sections are summarized in the following. The bar chart shows the number of students with percentage scores in the given ranges.

- Median: 22 (88%)
- Mean: 20.88 (83.51%)
- Standard deviation: 4.80 (19.18%)

Problem 6 was worth 25 points. The results from six sections are summarized in the following. The bar chart shows the number of students with percentage scores in the given ranges.

- Median: 16 (64%)
- Mean: 15.71 (62.84%)
- Standard deviation: 7.75 (30.98%)

We conclude that, considering the difficulty of the problems, students generally performed as expected. The results are in line with the results of past common final exams. For the most part, students had greater success with Problem 1, which focused on dealing with information symbolically, than they did with Problem 6, which involved dealing with information both symbolically and graphically. The mean of 83% for Problem 1 easily meets its course objective at level B, while the mean of 64% for Problem 6 barely meets its course objective at level I.

The problems from Sp 2007 and Sp 2013 are similar but not exactly of the same and the scoring of the total possible points are different. There is improvement in the pass rate for #1. The pass rate for the second problem is about the same.
Repository of Calculus Materials for Faculty

The Calculus Repository houses a wealth of information for course instructors. It includes sample syllabi, Student Learning Outcomes, sample WeBWorK problems, instructions for using WeBWorK, instructions for using the online tutoring center, instructions for using Moodle, information about the Math Placement Test, sample lecture notes, links to free calculus resources textbooks and such as Merlot, links of calculus archives, numerical stimulations, videos, pre-calculus review sites, and articles on how to improve math exposition. There are sample midterms and finals and solutions. Faculty members have a place to blog or post forums.

Webwork, a Free Online Homework System

M150A Calculus makes use of resources at CSUN including a server and course materials housed in the Math Department Moodle LMS which is integrated with WeBWorK, an open-source online homework system for math and science courses. WeBWorK is supported by the Mathematical Association of America and the National Science Foundation and comes with a National Problem Library (NPL) of over 20,000 homework problems. [http://webwork.maa.org](http://webwork.maa.org)

WeBWorK is used successfully at over 240 colleges and universities from large research institutions to small teaching colleges. WeBWorK has been developed and maintained by mathematicians since 1994 always with the goal of providing the mathematical community with the most robust, flexible, and mathematically capable online homework system possible.

WeBWorK is open-source and freely available for download. There is no cost to departments or institutions who wish to host their own WeBWorK server, and the WeBWorK community has always provided prompt technical and pedagogical support through active and friendly discussion forums and mailing lists. Additionally, the MAA will host WeBWorK courses on a limited basis for departments or institutions who are not in a position to host their own WeBWorK installation.

**Why use WeBWorK?**

It makes homework more effective and efficient and promotes active learning by students.

- It increases the effectiveness of traditional homework
- Providing students with immediate feedback on the validity of their answers and giving students the opportunity to correct mistakes while they are still thinking about the problem.

WeBWorK provides students with individualized versions of problems which means that instructors can encourage students to work together; yet each student must develop an answer to his or her own version of the problem. It increases the efficiency of traditional homework by

- Providing automatic grading of assignments.
- Providing information on the performance of individual students and the course (or section or recitation) as a whole.

**Key features of WeBWorK for CSUN M150A students:**

1. Using WeBWorK has the same homework problems as in Calculus textbook by James Stewart.

2. **WeBWorK Benefits to CSUN Student:**
   - Student knows what the homework is and when it is due.
   - Answers to questions are provided after the due date.
3. WeBWorK Benefits to Faculty
   - Cuts down on grading; standardizes grading.
   - Provides gradebook.
   - Reduces paper; no lost assignments; easy to reuse assignments.
   - Faculty can view student persistence with WeBWorK diagnostics.
   - Students can email faulty and faculty can enter their assignment and give personalized assistance.


Ambitious instructors may create their own questions or they may choose questions from the problem library. There is already a large collection of problems for calculus, pre-calculus, linear algebra, differential equations and some probability and statistics available in the National Problem Library.

CSUN WeBWorK problem sets were locally created to align well with the course. Dr. David Protas is the M150A course coordinator. He and others have created homework sets and assigns them to students. WeBWorK problems can be updated or changed without much effort.

4. CSUN WeBWorK administration is locally controlled. Dr. Jacek Polewczak is the System Administrator of the CSUN Math Department Webwork server. He manages the server, installs Apache, mysql, WeBWorK, etc. He also creates, deletes, archives and renames courses.

5. The central WeBWorK website is hosted by the Mathematics Association of America (MAA). This site is in wiki format and any WeBWorK user is welcome to signup to help update the information. In the left margin of the wiki is a link to active forums where one can ask questions.

Formulas are written in LaTeX. The recently added MathObjects features make it easier to write and maintain WeBWorK questions. In general it is fairly easy to make small changes in existing problems or to create similar problems from a model. With more programming knowledge PG becomes a valuable, extensible platform for presenting mathematics and interpreting mathematical answers.

These problem sets are available for CSU use.
Supplemental Hybrid Laboratory for At-risk Students

The supplemental hybrid laboratory is an effective model for turning around high-failure-rate math classes. It increases student success in a cost-effective, scalable way. The model does require well-coordinated course materials, access to technology, and a teaching staff willing to coordinate their work in order to improve student performance and ultimately lessen the faculty's burden.

Although the course is multi-section, each lab section is connected to only one instructor. That instructor and TA have the responsibility to stay connected to address the problems of that specific group of students (typically 35 students).

Lead faculty meet with faculty, teaching assistants, and tutors in joint meeting the week prior to class to discuss course coordination.

Student Success
To study the impact of the calculus labs, we consider the students who were required to enroll in these labs and received credit in the last three semesters and study their pass rates. Of the 457 students who enrolled in MATH 150AL in the period from Fall 2011 through Fall 2012, 281 passed the lecture, making the success rate for these at risk students 61.5%. However, if we just consider the students who received credit for MATH 150AL (i.e. the students who stayed in the lab until the end), their success rate is at 71.9%, almost identical to the rate for student who did not need to take the labs (71.5%). The message is clear, if you need to take the lab, and you take it seriously, your chance of success is the same as a student who does not have the lab requirement. Moreover, it is safe to assume that the “good” students (without the lab requirement) passed the course at around 70% in the previous years. The increased overall rate of success is likely entirely due to the “less prepared students”, who get the needed boost from the labs.

What is covered in the lab?
During the first week of the lab, students retake the MPT. Based on test results, students are directed to review using online free, open-source homework system called Webwork which contains a national database of math problems. Although Webwork does not adjust its content to student performance, it does serve as a mechanism to get homework and MPT remediation back to the students and to give them unlimited practice and instant feedback on their work. Remediation topics include fractions, function, geometry, and trigonometry. For the supplemental contact hour, we use pen-and-paper workbooks aligned with the textbook; here, the focus is on the act of writing mathematics as a connection between lecture, homework, and exams. These elements are coordinated with the work of the faculty and TAs, as well as with other course materials: lecture notes, supplemental contact hour workbooks, homework problems, and exam problems.

In addition, TAs received a set of interactive lecture notes coordinated to the Stewart Calculus book (written by Alex Alekseenko, Carol Shubin, and Emily Hoffman). These notes provide the basis for the in-class assignments.

M150AL Calculus I Laboratory Moodle currently resides on a Math Department Moodle site. http://mathweb1.sandbox.csun.edu/moodle1/ template is posted on http://moodle.csun.edu/course/view.php?id=45864
We included captioned calculus videos on the most difficult topics.

1. Limits [http://vod.csun.edu/~ama5348/Math_150a_2_5redo500_nBjeHDqd-15471.html](http://vod.csun.edu/~ama5348/Math_150a_2_5redo500_nBjeHDqd-15471.html)
2. Trig Limits [http://vod.csun.edu/~ama5348/Math_150a_2_7_500_nZxYM3wc-15471.html](http://vod.csun.edu/~ama5348/Math_150a_2_7_500_nZxYM3wc-15471.html)
3. Limits at Infinity [http://vod.csun.edu/~ama5348/Math_150a_2_8_500_JRAaTWSy-15471.html](http://vod.csun.edu/~ama5348/Math_150a_2_8_500_JRAaTWSy-15471.html)
4. Curve Sketching [http://vod.csun.edu/~ama5348/Math_150a_4_2_500_apTGeqsV-15471.html](http://vod.csun.edu/~ama5348/Math_150a_4_2_500_apTGeqsV-15471.html)

These videos were made by Alex Alekseenko, with the support of the Petri Grant.

Teaching Assistants are provided with a *Common Errors Manual in Calculus* by Mark Schilling. Students are quizzed on “How to Write Mathematics.”

Midterm and sample finals are provided on the Supplemental Instruction Moodle website.

M150AL students complete a Survey at the end of lab for assessment of the usefulness of the labs.

**Cost of Supplemental Labs**

The hybrid labs do not require any special facilities. We use standard classrooms for the contact hours and standard computer labs to support the lab's online component. At CSUN, no additional facilities have been constructed for this purpose.

The cost of a part-time lecturer or TA for the lab is roughly $3000 per course of 35 students.

The cost is the one-unit to the state and student, but we believe that when failure rates are high, this up-front cost may be far less expensive than repeating the course.

**Virtual Location of the Supplemental Instructional Materials**

M150AL Calculus I Laboratory Moodle currently resides on a Math Department Moodle site. [http://mathweb1.sandbox.csun.edu/moodle1/](http://mathweb1.sandbox.csun.edu/moodle1/)

A template is posted on [http://moodle.csun.edu/course/view.php?id=45864](http://moodle.csun.edu/course/view.php?id=45864)
Online Math Tutoring Center

Introduction: In response to high failure rates in mathematics, the Math Department initiated an Online Math Tutoring Center in Fall 2010. The purpose of the center is to provide students with homework practice assignments and activities, self-assessment tools, discussion forums and online access to Math Tutors and Faculty. The Online Tutoring Center services are closely aligned with the M150A curriculum. These efforts included specialized training for Math Tutors and careful supervision by Faculty.

The Online Tutoring Center provides a virtual space where students can get advice and strategies for problem solving, receive step-by-step assistance with problems, and collaborate with other students on solving homework problems.

To accommodate students' non-traditional schedules, the Online Tutoring Center is open in the evening and on weekends. In addition, the Tutoring Center seeks to accommodate all learning styles to make mathematics accessible to our diverse student body.

Background: The Fall 2010 pilot project showed that online tutoring improves not only mathematics skills but writing skills as well. This is believed to be the case because the primary mode of communication is conducted through written forums and chats. The improvement was demonstrated in the evolution of student-tutor, question-response in six sections of M150A Calculus I with total enrollment of 230 students. Five tutors were supervised by three faculty members in the Math Department.

An improvement was verified in the fluency with which students used mathematical vocabulary, articulated their questions, and demonstrated an understanding of mathematical concepts. In Spring 2011, the Math Tutoring Center is open to more than three thousand CSUN students enrolled in Calculus, Business Calculus, College Algebra, some statistics courses, and Developmental Mathematics. The Tutoring Center is part of the campus effort to decrease time to graduation by increasing passage rates in CSUN’s highest D-U-F mathematics courses.

Main ideas:

- Tutoring is a type of supplemental instruction; it does not replace regular instruction.
- Students seek tutors’ help, and can form strong lasting teaching influence on a student.
- A reliable tutoring service can raise passage, retention, and graduation rate

How online tutoring works:

- **Mode of communication:** forums, chats, but video and audio is possible.
- **Software:** Moodle enabled with LaTeX scripting, ASCIIMATH, and HTML editing
- **Hardware:** located on a CSUN MoodleRooms server.
- **Who can participate:** CSUN can ask questions, open for view to everyone.
- **Who is handling the communication:** Student tutors supervised by faculty.
- Tutors were available five nights a week for 3 hours per night.
- More than 40% of the class used the tutoring site, however, most of the visitors are passive.
- Tutor and student growth in Q&A develops over time.
Diagram of How the Online Tutoring System Works

How are tutors selected?

- Students receiving a B or better are eligible to become tutors
- Usually, a professor’s note of recommendation is sufficient
- Tutors are placed in the labs or in classrooms on campus and their times advertised

Online Tutoring Center Pedagogy builds independent problem solving through questioning. Problems fall into three types: one-step problems, multi-step problems, and process problems. It also provides students and tutors with an opportunity to improve their written communication skills.

The Online Tutoring Center helps to improve conceptual understanding, procedural fluency, and problem solving skills. Faculty work with student tutors and read through their posts. Tutors are trained with materials developed by Dr. Elena Marchisotto.

The online tutoring center is mindful of Universal Design principles. The goal is to create pathways for individuals to learn, communicate, and share via information technology, regardless of their individual learning and processing styles, or physical characteristics. Based on designing-in interoperability, usability, and accessibility, the site has been ATI tested the tutoring website for compliance with the World Wide Web Consortium’s (W3C) Web Accessibility Initiative (WAI) and the Section 508 Standards for Electronic and Information Technology (http://www.accessboard.gov/sec508/guide/1194.22.htm). General discussions about universal design and accessibility have been initiated with Susan Cullen and Sandra Caesar

Assessment of the Online Tutoring Center
A key component of the action plan is the formative and summative evaluation effort. Project implementation requires faculty to continuously monitor and track program utilization, student success with the module elements, faculty satisfaction with the support, and student progress.
Students are asked to complete a brief survey about the online Tutoring Center’s helpfulness at the end of the term with space at the end provided for additional comments.

Q#1: How many times did you use the Online Tutoring Webpage?
Q#2: If you never accessed the online tutoring, were you aware that the website existed?
Q#3: If you used online tutoring service during hours of operation (Sunday - Thursday 8 pm - 12 pm), was your question answered in.
Q#4: On the scale from 1 to 5 rate overall helpfulness the Online Tutoring Webpage.
Q#5: On the scale from 1 to 5 rate your ability to navigate and use the online tutoring site.

Both the Online Tutoring Center site and the tutors are periodically assessed for quality of tutoring services and administer the measures in the beginning of each semester and in the middle of it. Each tutor is evaluated on pedagogical maturity, ability to communicate, use of learning resources, ability to accommodate different learning styles, and effectiveness in answering student question.

We developed measures to assess the usage and of the web-space such as counting how many students visited the web-space, asked questions on the web-space, and acknowledged that using the web-space helped them answer their question or formed discussions.

The Online Math Tutoring Center fits in well with the CSU’s Affordable Learning Solutions (ALS) initiative improves the choice, affordability and accessibility of educational content for students through innovative delivery of open educational resources.

We believe that we have established a high impact practice. Students and student tutors engage in interactive experiential online learning community. The Online Tutoring Center’s evening hours and convenience appeals to a wide group of students.

Online Tutoring Center Evaluation Methods includes
- Site usage; frequency, quality of question response interaction
- Evaluation of tutor's communication skill gains
- Survey students, tutors, and supervisors
- Service to self-identified disabled students and repeaters
- Study individuals, classes, multi-section performance
- Accessibility reports
- Universal design reports, evaluation of tools

An Example of the Online Tutoring Center’s effectiveness
We count the number of return visits per student as a measure of usefulness of the site, then we correlate the visit count with student’s grade.
We believe that without the online tutoring center some students who received B’s or C’s would likely have received C’s or D’s, respectively. We will collect and compile more data on this.

**Costs of Online Tutoring** is $12 per hour for 10 hours per week, or $120 per week (less than $2000 per semester).

The math tutoring center is easily **scalable** and serves as a model for the CSU. It can be used an outreach tool to improve student performance in middle and high school mathematics.

**Advantages of CSUN online tutoring**

- Asynchronous forum mode: inexpensive and efficient.
- Re-use and recycle: materials can be pre-selected and re-used.
- Opportunity for training: tutors receive feedback from the supervising professor, both positive and negative.
Summary of Online Tutoring

1. CSUN Math Department provides a high quality, inexpensive online tutoring service which is open during evening hours.

2. Student tutors receive training while participating in online tutoring. This prepares them to be better teachers.

3. Innovative use of technology can change the landscape of student outside of the class interaction by making learning more social learning.

Given tough financial times, it is great to know that there are faculty created solutions to problems in higher education that are effective, low cost, easy to implement and engage students in a learning-centered environment.

Online tutoring provides a win-win situation!

Students – learn more, no cost, flexible hours.
Student Tutors – make money, gain experience, improve communication skills, work flexible hours.
Faculty – reduce workload, maintain local control or go with system.
Provosts – Increase SLO and graduation rates.
Universal Design Principles – How to Create Accessible Math Content

Sue Cullen and Sandra created a terrific resource for creating mathematical content for the web. [http://www.csun.edu/accessibility/guides.html](http://www.csun.edu/accessibility/guides.html) This website provides an overview on how to create, view and listen to math content on the web.

Mathematics is a core branch of education and is required in most other educational fields. In general, mathematical education involves the use of symbols, operators, etc. that are very unique to Mathematical Studies. With the advent of the World Wide Web, more and more math teachers want to use the internet as a means of pedagogy between them and their students. However, using these symbols, operators, etc. used, is generally quite complex and, therefore, most of the time cannot be rendered on the World Wide Web using Standard HTML format. The [W3C](http://www.w3.org) recommends the use of [MathML](http://www.w3.org/Math/) to display math content on the web. MathML not only makes it easier to display math content on the web, but also makes it accessible to students with a multitude of learning styles.

- Software for Creating Math Content
- Creating Math Content Using MathML
- Creating Math Content Using LaTeX and displaying it with MathJax Plugin.
- Creating Math Content in Moodle
- How to view and listen to Math Content.

After completing the above steps, one should be able to display Math Content on the Web.
The Future for Online Math Tutoring Support Center and Early Assessment Program (EAP)

The Online Math Tutoring Support Center has great potential to improve course completion, and college completion through a broad-scale technology-enabled center. The math tutoring center is easily scalable and serves as a model for the CSU. It can be used an outreach tool to improve student performance in middle and high school mathematics.

Future Plans include having an Online Math Tutoring Support Center reach out to high school students who are planning on taking the Early Assessment Program (EAP) students and/or Entry Level Mathematics Exam (ELM). We hope that this service can be just one of many ways to reduce remediation.

Expanding the Online Math Tutoring Support Center to serve the CSU will help freshmen who are weak in arithmetic and algebraic math skills. A CSU Online Math Tutoring Support Center will offer a repository for learning objects that faculty believe provide the best in online materials, self assessment tools and tutorials. Leveraging the shared strength of the CSU in a coordinated effort would allow individual faculty to spend time teaching students rather than continually gathering curriculum materials that can more easily be shared via the Online Math Tutor Support Center. The CSU will benefit from economies of scale if this project was expanded system-wide. Instruction will contain a mix of online and personal interaction. The proposed effort will lead to the creation of an online homework, assessment, and tutorial environment for mathematics useable anywhere within the CSU that can be easily tailored to individual campus needs. All resources will be available on the browser level. No extra software is required; resources are platform independent. Firefox, Safari, and others are all acceptable. When the program expands to other educational levels, this will be important. Perhaps, the resource will tie into the existing CSU Math Success site.

Potential benefits of expanding the Online Math Tutoring Support Center:

1. Scaling of a blended learning model, in order to improve learning outcomes and keep cost down.

2. Creation of a repository of learning objects and activities to improve student success.

3. Providing deeper learning and engagement through the use of richly interactive technologies to improve student learning outcomes.

4. Supporting the development and adoption of high-quality, modular, openly licensed core courseware.
CSU Wide Implementation Project Goals

• Support Mathematics education through shared online instructional materials and tutoring.

• Identify activities, resources, and tutor training models, which have been evaluated by trained mathematicians. There are hundreds of web sites that offer lecture materials or other resources, but most have serious deficiencies. Often sites provide misleading and incorrect solutions.

• Use evidence-based practices for teaching mathematics.

• Collect stories from students, tutors, and faculty about usage of the site.

• Increase the passing rates in mathematics courses for participating students.

• Improve student skills in scientific reading and writing of English.

• Define best practices for a broad-scale technology-enabled center system-wide.

• Provide students with a pool of faculty approved math problems organized to support their learning objectives.

• Provide a platform to share pedagogically innovative and student engaging instructional resources, which can be beneficial to education and teacher training programs.

• Define Universal Design best practices for teaching mathematics to all learners, with and without disabilities. This will be achieved by collaborating across and within campuses with STEM related faculty as well as the Universal Design Center, Center on Disabilities, Nation Center on Deafness, Communication Disorders, Human Factors, and various faculty and staff across the CSU.

• Identify barriers to access presented by the software applications used and define reasonable alternative methods of access as appropriate.

• Communicate compliance barriers to the Open Source community and/or application vendors regarding accessibility, interoperability, and usability of the products in use in this project.

• Provide a continuous improvement model for deployment of services and support to students with disabilities.

• Improve skills of tutors, and increase the number of teachers and tutors prepared to utilize the online resources in teaching mathematics.
Collection of Assessment Data

Our project addresses student success outcomes. We track accountability metrics, and engage in formative and summative assessments and evaluations as outlined by Chancellor White in the “Reducing Bottlenecks and Improving Student Success” RFP. We will track data on B4 and B5. Increasing the Number of Degrees Awarded, C1. Improving CSU Graduation Rates, D1 and D4 Reducing Time to Degree.

Summary
Before course redesign, Calculus M150A was a pedagogical bottleneck course. It had high volume and a large number of students were not receiving passing grades (As, Bs, and Cs) and as a result were likely to repeat the course or simply be deterred from entering a STEM major.

As a funded campus, we will submit common targeted course and course section attributes to permit the system to identify courses/course sections. Clearly, formative evaluations, addressing nuances about the redesign that contribute to the initiative’s success and its continuing improvement, are important parts of an assessment and evaluation, in addition to direct summative evidence.

We can track GPA, degree progress, and milestones over time.

The NSF STEM grant will be tracking STEM students. We must compare the persistence and eventual graduation of cohort students to students who received no intervention. We will track GPAs before and after various intervention practices. We have a system to track GPA, degree progress, and milestones over time. We can show a reduction in the percent of repeatable grades. Our program can be replicated by interested CSU campuses.

From the Moodle Statistics, we can evaluate use of online tutoring center by looking at activity logs and track the types of questions asked and how they are answered. From the Math Department or Institutional Research, we will collect final exam results and compare with past results. We will keep track of students outcomes in mathematics M150B (or M150A, if they failed) the semester after completing M150A and try to assess the value-added from the tutoring center. If a student failed, we will review their exams and tutoring center records.

We will research student preparedness background including high school of origin, SAT or ACT results, ELM, MPT results and other available pre-college indicators such as GPA. We will also collect data on past courses attempted at the college level. We will collect data generated from our course coordinator including comparison of instructor grading and class averages by instructor. We will attempt to review final exams over time for consistency in difficulty. We will survey and have focus groups with students, tutors, ATI staff and faculty participants to find out what worked and how could the tutoring center be improved. We will also look for any unusual patterns or behavior that may emerge over time.

This could be tied into the LAUSD data base which was obtained by Provost Harry Hellenbrand.

We will share data with all the CSU campuses.
**Closing the Achievement GAP in STEM: Increasing Retention for Students of URMs**

**Objectives**

CSUN’s STEM disciplines have been slow to find ways to teach inclusively resulting in high failure rates in required gateway mathematics courses. There is a high degree of correlation between failure of calculus, time to graduation, degree choices, and ultimately, career choices.

We seek to broaden the participation and achievements of all students in all fields of Science, Technology, Engineering and Mathematics (STEM) education and associated professional careers. We will achieve this goal by pursuing the following objective:

**We will increase the passing rates in STEM gate mathematics courses for students with URMs 3% per year for 3 years.**

As a consequence, we will increase retention of students specializing in STEM disciplines. This objective will be achieved through the development of an online student support center where students will (a) receive individual tutoring from trained staff and (b) participate in facilitated academic groups and peer-to-peer study groups.

The objectives of this proposal are milestones in the University's long term commitment to the development of new academic services, broad dissemination of practices of universal design in curriculum development, design of revolutionary cyber-learning curricula and elimination of the gap in opportunities in pursuing STEM degrees. These objectives are part of the University's vision to increase the numbers and the quality of CSUN graduates in STEM disciplines.

**Closing the Achievement Gap**

We will focus more attention on the performance of underrepresented minority (URM) and low-income students, most of whom are the first in their families to attend college. Failure to pass Calculus I negatively impacts STEM retention rates and delays degree completion.

**Closing the Achievement Gap Calculus I M150A Project**’s goal is to increase URM student participation in STEM disciplines. The project’s objectives include:

1. creating links between CSUN academic support

2. increasing math faculty awareness of students' needs,

3. providing in-person and online training materials to help faculty incorporate universal design into their pedagogy.
Better Addressing Disabled Student’s Needs
Students have difficulty passing gateway Mathematics courses. On average, it takes students with disabilities nearly twice as long to matriculate a Mathematics course then their non-disabled peers. The enrollment data, however, shows that students with disabilities are very interested in pursuing STEM degrees: 31.7% more students with disabilities are enrolled in STEM programs as compared to all students. However, 40% less STEM degrees are awarded to students with disabilities.

Indeed, the difficulty of achieving success at CSUN in STEM fields is a reflection a national phenomenon: millions of Americans (19%) have some degree of disability, yet few are pursuing careers in STEM. Indeed, the NSF reports "persons with disabilities earned approximately 2% of the 16,712 Science and Engineering doctorates to U.S. citizens and permanent residents in 2006.”

Work Plan for Online Support Center for Students with Disabilities in Mathematics Classes
The data from the COD indicate that of the 50 STEM majors enrolled in their programs in Fall 2008 (not including deaf and hard of hearing students) 38 (76%) have had the GPA lower than 3.0 and 8 students (16%) were on academic probation. The corresponding numbers of deaf and hard of hearing students and students with visual disabilities are even lower. The common experience in the Department is that students registered with the COD are actively seeking (and using) the tutoring and support services in NCOD. However, the same students are often concerned about the quality and overall helpfulness of the services available in the Department of Mathematics. We will find ways to make the existing services better using online communication and web accessibility. The PIs, the Mathematics Department, NCOD and COD will develop a new type of service for students with disabilities: an online student support and collaboration center for students with disabilities.

The National Center of Deafness has a tutoring center. Most of tutors are deaf or hard of hearing, and all know sign language. Tutors focusing on helping students sharpen their study skills, identify problem areas, gain greater mastery of subject materials, and develop greater confidence. The center has several outstanding tutors who specialized in Mathematics, but they work limited hours. The proposed online support center will supplement their work.

The Math Department Tutoring Center is staffed with undergraduate mathematics majors and graduate students in mathematics. There is an adjoining computer lab which is designed to help with computer based homework assignments such as WebWork. Our tutors receive training on how to teach mathematics. Also the Colleges of Engineering and Computer Science and Science and Mathematics have tutoring labs. An important result of this grant will increase coordination between already existing services. Well coordinated tutoring services will reduce duplicate services. The tutors can teach each other and give the Mathematics faculty feedback and advice on effective lecturing techniques.

In Phase II, we plan to particularly study whether the tutoring service particularly supports the needs of students with disabilities. This group of students takes twice as long to matriculate a Mathematics course. Enrollment data shows that students with disabilities are very interested in pursuing STEM degrees: 32% more students with disabilities are enrolled in STEM program as compared to all students. However, 40% less STEM degrees are awarded to students with disabilities. Our goal is to broaden the participation and achievements of students in all fields of STEM education and associated professional careers.
Develop measures of implementing practices of universal design and training tutors and faculty members to follow these practices.

1. In coordination with Sue Cullen (CSUN Universal Design Director), we will develop a table of different learning styles and check whether materials are available to address these styles.
2. How many training sessions were available to tutors and faculty in using universal design each semester?
3. How many tutors and faculty members attended the sessions?

We believe that it is possible to teach mathematics in a more inclusive manner which increases student success.

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