PEMDAS: PUTTING EMPHASIS ON MATHEMATICAL DEVELOPMENT AND SUCCESS

1. PROBLEM STATEMENT & OPPORTUNITY FOR GROWTH:

1.1. INTRODUCTION. At the University of Southern Mississippi, every student is required to take a mathematics course as part of the GEC. The first mathematics course taken generally depends on ACT math sub-score and major. Students with a math ACT sub-score of 19 or below are required to take Intermediate Algebra (MAT 99) as a prerequisite to any further math course. The majority of students with a math ACT score of 20 or above would take College Algebra (MAT 101) or Quantitative Reasoning (MAT 100). In addition, however, students with a math ACT score of 24 or above may elect to take Trigonometry (MAT 103), Brief Applied Calculus (MAT 102), or Calculus for the Arts and Sciences (MAT 114), while those with a score of 26 or above may take Calculus I with Analytic Geometry (MAT 167).

The focus of this proposal is an approach to improving student success in mathematics courses and in the use of mathematics in other courses, with a strong emphasis on Intermediate and College Algebra. In this section, the issues and opportunities in remedial mathematics, entry-level mathematics, and lower level mathematics courses will be addressed.

1.2. INTERMEDIATE ALGEBRA (MAT 99) & COLLEGE ALGEBRA (MAT 101). In particular, the Intermediate Algebra and College Algebra courses have rather large enrollments. For the Fall 2012-Spring 2013 academic year (at the Hattiesburg Campus), there were 2200 grades of A/B/C/D/F/NA recorded. Roughly 1300-1400 students take these two courses in the Fall, and 600-700 in the Spring. The course delivery at the Gulf Park and GCRL campuses is by traditional 3 hour/week lecture, using online homework as a supplement. At the Hattiesburg campus, courses are delivered using an emporium-style delivery, where classes meet once a week for lecture, and the other two meetings are replaced with a flexible lab-hour requirement (Students swipe in at the front desk in the Math Zone, and must record a specified number of hours to get an attendance credit).

The A/B/C rates for both Intermediate and College Algebra, for the last 6 semesters is given below. Since the most recent change in prerequisites for College Algebra, these rates have been relatively steady, with a slight upward trend in College Algebra, and an alternating trend from Spring to Fall.

<table>
<thead>
<tr>
<th>A/B/C rates</th>
<th>MAT 99 Intermediate Algebra</th>
<th>MAT 101 College Algebra</th>
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<tbody>
<tr>
<td><strong>Semester</strong></td>
<td>Hattiesburg</td>
<td>GCRL &amp; Gulf Park</td>
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<tr>
<td><strong>Spring 2011</strong></td>
<td>45.6% (n = 263)</td>
<td>36.2% (n = 47)</td>
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<tr>
<td><strong>Fall 2011</strong></td>
<td>54.3% (n = 635)</td>
<td>56.7% (n = 67)</td>
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<tr>
<td><strong>Spring 2012</strong></td>
<td>46.0% (n = 189)</td>
<td>48.3% (n = 29)</td>
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<tr>
<td><strong>Fall 2012</strong></td>
<td>52.9% (n = 738)</td>
<td>40.0% (n = 100)</td>
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<tr>
<td><strong>Spring 2013</strong></td>
<td>49.8% (n = 269)</td>
<td>52.0% (n = 50)</td>
</tr>
<tr>
<td><strong>Fall 2013</strong></td>
<td>52.4% (n = 689)</td>
<td>55.8% (n = 77)</td>
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</table>

Table 1: A/B/C rates were calculated by comparing the number of students receiving a grade of A, B, or C, to those receiving the following transcript scores: A, B, C, D, F, NA, WP, WF (this total is represented by the variable n in the entries above). ¹

The content of Intermediate Algebra is designed to address deficiencies in mathematical background and preparedness, to prepare students entering MAT 101 or MAT 100. However, despite the remedial nature of the content, the success of students in MAT 99 is not commensurate with success of students in MAT 101 or MAT 100. In College Algebra, A/B/C rates are significantly better. In fact, for first-time full-time students, the rates (combined

¹ Data obtained from http://www.usmir.org/campus/course grade distribution course.html
across locations) are 83.5% (Fall 2013) and 81.5% (Fall 2012). While these are not extremely high, they appear to be comparable with A/B/C rates nationally (while no national studies exist, most studies report DFW rates between 40% and 60%).

In both College Algebra and Intermediate Algebra, this represents an opportunity to make a real difference in student success for a large number of students. Also, although the A/B/C rates are not extremely high in MAT 101, there is room to consider tying College Algebra more closely to the courses and majors that depend upon it and improving rigor, as long as this is balanced by efforts to address student stumbling blocks.

1.3. LOWER-LEVEL MATHEMATICS COURSES. Several lower-level mathematics courses, including MAT 099, 101, 102, 103 and 114, serve as prerequisites for higher-level courses, both in mathematics and other departments. Students’ ability to apply the problem-solving techniques learned in these lower-level courses to application problems in higher level courses is contingent on, among other factors:

- their ability to recognize the lower-level problem to be solved within the context of a higher-level application, and/or
- their ability to remember how to solve the lower-level problem, even though a semester or more may have passed since taking the lower-level course.

In particular, a common complaint is that students using algebra or other concepts from a lower level course in higher level courses (regardless of subject area) do not possess the ability to abstract or retain what they have learned in lower-level courses.

2. EXPECTED OUTCOMES & IMPACT ON STUDENT LEARNING:

The strategies and actions suggested in the following section are intended to produce the following outcomes:

(1) Increase the number of students enrolling in MAT 101 by way of a placement test.
(2) Decrease the attrition rate in Intermediate Algebra (students dropping between the last day to add, and the end of the semester).
(3) Increase student success (A/B/C rates) in Intermediate Algebra.
(4) Maintain (or improve) student success rates for College Algebra, while introducing additional applications and rigor.
(5) Increase student satisfaction with course delivery in Intermediate and College Algebra.
(6) Improve student performance in College Algebra for students beginning in Intermediate Algebra.
(7) Improve student performance on specific application problems in courses using lower-level mathematics courses as prerequisites (these should be both mathematics and non-mathematics courses).

3. STRATEGIES/ACTIONS TO BE IMPLEMENTED:

There are three distinct actions to be implemented to attain the goals listed above.

(1) STRATEGIES FOR STUDENT PLACEMENT & COLLEGE-READINESS. The first initiative is to place more students into College Algebra through placement testing and non-course based remediation. The current prerequisite for College Algebra and Quantitative Reasoning is an ACT math sub-score of 20 or higher. Students with a score below this that would like to enroll in either of these courses must demonstrate proficiency by a suitable score on the COMPASS placement test. This avenue for students to avoid remediation is currently under-utilized and under-supported. The actions to be taken to correct this would be the following:

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2 Data obtained from http://www.usmir.org/campus/course completion.html
(A) GIVE PLACEMENT TESTING A MORE DEFINED FRAMEWORK. In particular, placement testing can be run through a university testing center (i.e., at the LEC), offered on published and advertised dates/times.

(B) OFFER NON-COURSE BASED REMEDIATION ACTIVITIES. The University can host a web-based course, available for free, to prepare students to successfully complete the placement test. Multiple options for this exist, including WebWork (an open-source homework system from the MAA) or MyMathTest (available from Pearson). In addition, offer “boot camp”-type workshops on weekends in the summer, or coordinated with campus previews.

(C) INCENTIVIZE REVIEW FOR THE PLACEMENT TEST. As an example, refund the cost of the test for students that successfully complete a non-course based remediation activity, regardless of their score on the placement test.

(2) STRATEGIES FOR COLLEGE & INTERMEDIATE ALGEBRA. The second initiative is to redesign courses for College Algebra and Intermediate Algebra. One of the best practices for remedial programming suggested by the IHL is to identify reasonable faculty to student ratios, as “meeting the cognitive and affective needs of remedial students requires a large one-on-one time investment”. The Math Zone does provide a high level of individualized support for a significant number of students, more than would occur in a traditional classroom setting. However, some aspects of the traditional setting are missing, and could be addressed by a better compromise.

(A) FIX LAB HOURS AND REDUCE CLASS SIZES FOR MAT 99 (AND MAT 101). Fixed scheduling for Zone classes (along with reduced class sizes) can be implemented to increase the one-on-one time between instructor and student. Students would still have required hours in the Zone, but these two hours would be at a fixed time, not flexible.

For example, section H001 would be scheduled for MWF 9:00-9:50; students would meet in the classroom on Monday, and then in the lab, with their instructor, on Wednesday and Friday. During the days in the lab, the instructor of the course would meet with the students in the lab, and additional staff would be on hand to answer questions and tutor. To make efficient use of resources, three classes could be scheduled for this time slot, alternating the use of one classroom. In addition to addressing accountability, this provides an easier adjustment to the course design and a more convenient venue to deliver course announcements. This is highly recommended for MAT 99, and also recommended for MAT 101.

1. Offer a recitation alternative for one lab hour. In conjunction with implementing fixed scheduling, it is recommended to add an alternate attendance credit for each course. On the class day before lecture, a recitation session with an assigned graduate student can be held as an attendance alternative for those students who have completed homework from the previous lecture. Recitation sessions should focus on problem-solving in a group environment, with attendance credit only awarded for active participation, as defined by a clear rubric. Recitation sessions should address different learning styles, focus on application of concepts, provide active learning and inquiry, and provide students with a meaningful academic experience.

(B) REVIEW AND REVISE COURSE CONTENT. To best address student issues, and to increase the effectiveness of college algebra, a review of content for the two courses should take place. This is further addressed in strategies for lower-level mathematics courses, but two goals unique to college and intermediate algebra should also be addressed. For both Intermediate and College Algebra, some consideration should be given to the manner of delivery, to be sure that the organization of content fits correctly with one lecture per week, and that there is a clear scaffolding structure. For College Algebra, a stronger emphasis on modeling, (while maintaining sufficient preparation in fundamental mathematical operations) would help to clarify the role of College Algebra in the General Education Curriculum. In addition, the mathematics department currently proposing a course in Statistics


Tuesday/Thursday courses would require more creativity, but straightforward, if not elegant, solutions exist.

Lack of completed homework assignments was a significant problem in the traditional setting, so it may be best to avoid introducing old problems.
to be added to the GEC. A stronger emphasis in modeling would make these courses excellent complements (decision-making via data, or mathematical models)

(C) RELAX TEST SCHEDULING & OFFER MULTIPLE TEST ATTEMPTS. Currently, testing for the two courses in the Math Zone must be highly synchronized due to constraints on facilities and staff. In particular, offering students multiple attempts on unit tests (a common practice in emporium-style courses) is not possible with the current resources. However, transferring testing to a testing center, with additional hours, would allow for a more student-friendly schedule for testing. In particular, it would be possible to offer students a second attempt on unit tests, with the requirement of a successfully completed practice test.

(3) STRATEGIES FOR ALL LOWER-LEVEL MATHEMATICS COURSES. These strategies would apply to all of the following courses: MAT 101, 102, 103 and 114.

(A) INFORM ACADEMIC ADVISING. Advising, particularly the development of four-year plans, should take dependencies on mathematics courses into account in such a way as to, as much as possible, achieve “locality” in the sense that higher-level courses featuring application problems are taken not long after the lower-level mathematics courses on which they depend. To aid both students and advisers, it would be helpful for bulletins to include “dependency charts” for each degree plan that show prerequisites for major courses (certainly this is useful well beyond mathematics prerequisites).

(B) REVIEW AND COORDINATE COURSE CONTENT. There needs to be coordination between the instructors of courses that have lower-level math courses as prerequisites (especially those in other departments) and instructors of the lower-level math courses on which they depend. In particular, a content review of College Algebra (a terminal course for many majors) should include input from all departments which require College Algebra, as to what mathematics they would like their students to know. Lower-level math instructors should be exposed to examples of specific problems that their students will eventually see, and, to the extent to which it is practical, incorporate such problems or portions of problems into their own courses. This coordination will also expose both kinds of instructors to differences in notation; recognition of these differences can aid instructors in helping students to bridge the gap between their mathematics courses and their major courses in which this mathematics is applied.

(C) EMPHASIZE APPLICATIONS. In the lower-level mathematics courses, it is essential that course materials include sufficient coverage of applications, and that applications are included among topics. This may be difficult to achieve if courses are already considered “full” of material that can practically be covered in a semester, but knowledge of what mathematics is actually used in other courses may help restructure courses as needed, and may help to develop more meaningful learning activities.

(4) INCREASED OPTIONS FOR SUPPORT FOR STUDENTS AND FACULTY. In addition to strategies for redesigning courses and course work, the following strategies are also suggested.

(A) PROVIDE FACE-TO-FACE TUTORING SPACE IN THE MATH ZONE. Due to facility constraints, most tutoring in the Math Zone is done at lab tables with computers. The room above the lab is designated as a tutoring center, but is very small and narrow, and is not conveniently located. Space for tutoring tables and whiteboards can be used to address different learning styles.

(B) OFFER ONGOING PROFESSIONAL DEVELOPMENT TARGETED TO FACULTY TEACHING REMEDIAL COURSES. This is also one of the best practices for remedial programming suggested by the IHL\(^7\). While not specific to mathematics, this would impact all instructors of Intermediate Algebra.

4. STUDENT COHORT:

The affected student cohort would be all students taking College Algebra and Intermediate Algebra. The number of such students in the last few semesters is given in Table 1, and is roughly 2000 students per semester. In total, this would affect the majority of students attending USM.

5. MEASUREMENT/ASSESSMENT:

To assess the objectives of this QEP,

1. Measure the number of students taking advantage of placement testing.
2. Track performance of students enrolling in MAT 101 by way of placement testing.
3. Track performance of students enrolling in MAT 101 by way of a C or higher in MAT 99
4. Measure A/B/C rates for College Algebra and Intermediate Algebra
   a. In addition, use a common pre-test & post-test on core topics, both prior and after redesign, to ensure that results do not reflect grade inflation.
5. Survey students prior and after redesign regarding satisfaction with changes in course design.
6. Track student performance on specific application problems in courses using lower-level mathematics courses as a prerequisite.

6. RESOURCES:

6.1. FACILITIES. The following resources would be necessary to fully implement the strategies above:

1. Additional space / location for the Math Zone.
   a. For fixed scheduling, an increase in capacities for the Math Zone would be necessary. Classes could be overlapped, but there are about 30 sections (50 students each) that run in the Fall, and there are not enough slots available to overlap 3 sections of MWF courses (and 2 Tu-Th courses) without scheduling late courses, which have lower averages for attendance and final grades, or late lecture courses on Friday (which suffer the same fate). If additional classroom space were available, with slightly smaller class sizes, the current capacity of the lab itself would be sufficient, but it would be preferable to still offer open spaces in the lab for tutoring, though this could be accomplished at another location.
   Note: An alternative to addressing these issues of space constraints would be to address the large disparity (2:1) between fall and spring enrollments in College and Intermediate Algebra.
   b. For recitations, an increase in capacities for the Math Zone would be necessary. Again, additional, connected classroom space would be necessary to run recitations for an attendance alternative.
   c. For increased tutoring options, additional space (or re-purposed space) would need to be available for tutoring tables and whiteboards.
2. An expanded testing center. To accommodate testing from MAT 99 and MAT 101, included multiple attempts, the capacity of the university testing center would need to be increased, with increased hours of operation.

6.2. PERSONNEL. Personnel resources would include release time for the development of material for recitations for College Algebra and Intermediate Algebra. In addition, faculty time in many other departments to develop application problems and determine input for a review of lower-level mathematics courses, in particular, college algebra. Additional out-of-state waivers and graduate assistantships would be needed to cover recitation sections. In addition, faculty or staff to run professional development for remedial courses. Finally, a strong suggestion would be that the University consider hiring a full-time position for the Math Zone director, focusing on applicants at universities that have successfully undergone course redesign.

6.3. EQUIPMENT. To accommodate both drop-in tutoring and the number of sections meeting in the lab for fixed scheduling, the number of lab machines would need to be increased.