Instructor/Student Engagement in Math 103 (Basic Algebra)
Proposal for EWU Strategic Planning Pool Grant

Submitted by
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May 31, 2006

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The Necessity for Course Redesign in Math 103

Current Design
Multiple sections of Math 103 (Basic Algebra) are offered every quarter at EWU. Each section offered during the academic year is taught by a first-year graduate instructor (GI) earning a Master’s Degree in Mathematics. GIs are responsible for daily organization and delivery of lessons, grading at least 10 homework assignments, grading exams, and holding office hours. They are provided some grading support from undergraduate math majors working in the Math Tutoring Lab.

Math 103 is coordinated by a faculty member in the department (Jane Lane). The coordinator writes lesson objectives and group activities for each content topic addressed. She also writes exams (with GI input), and meets with GIs to examine student learning and to discuss grading criteria. In addition, she co-teaches a methods course (Math 521, 522 and 523) for the GIs with focus on assignment of tasks, effective questioning, and research supporting current theories of learning. The coordinator usually teaches a section of Math 103 summer quarter.

Math 103 students are supported by the Math Tutoring Lab, and a federal TRIO grant serves qualified students. In addition, Academic Support Center hosts PLUS groups facilitated by trained peer leaders.

Problems with the Current Design
Students enrolled in Math 103 struggle to successfully complete the course. During the academic year Fall 2004 through Spring 2005, only 39% of the 590 students who enrolled finished with a 2.0 or better. Students appear to be unengaged in the course, as evidenced by very poor attendance rates. (Daily attendance averaged 60% of enrolled students during Fall Quarter 2005.) Though outside support is offered, only 10% of Math 103 students used the Math Tutoring Lab more than once during the 2004-2005 academic year. Most Math 103 students are first-year college students (94% in Math 103-01 this quarter) who are inexperienced in the appropriate level of engagement and performance.

Math 103 students’ lack of engagement affects their entire undergraduate experience. Performing poorly in Basic Algebra means a lack of preparation for future coursework; not only in mathematics, but in the sciences as well. An unsuccessful experience in Math 103 means more time to completion of a degree. Some students may not complete a degree at all.

Math 103 instructors also appear to struggle with engagement in the course. Most GIs have had no teaching experience, and are unaware of students’ preconceptions or difficulties with Basic Algebra content. Research shows new teaching assistants to enter their first classroom with confidence in their abilities to teach, regardless of what their students know or learn.¹ Their beliefs about their abilities (and the way mathematics is learned) limit their preferred lesson delivery formats to daily lectures. Many of them are surprised at the difficulties students have in following their directions.

The Importance of Considering These Problems as a University Effort
Since success in Math 103 is so crucial for success in succeeding courses and student retention, this project could have far-reaching benefits for the EWU community. The focus of this proposed project will be on a ‘rigorous and engaged student learning experience’, an important goal of the Academic Strategic Plan. In order to accomplish this goal in Math 103, however, the support of the University is needed, as is the expertise of faculty members across campus.

The Goals and Expected Outcomes Guiding Course Redesign
Since lack of engagement on the part of both students and GIs appears to limit the opportunities for learning in Math 103, this proposal addresses engagement on several levels, motivated by the following goals:

**Goal 1: Increase student learning in Math 103.** This goal is central to the Strategic Plan’s goals and priorities of learning environment and student retention.
- Increase students’ procedural fluency in mathematical skills
- Increase students’ ability to solve problems, communicate mathematically, justify work, and participate in a community of math learners

**Goal 2: Increase GIs’ understanding of the nature and process of learning mathematics.**
This goal addresses the learning environment in a course many first-year students must take. It also speaks to the priority the university places on instructor and faculty support.
- GIs will appreciate the complexity and interrelatedness of teaching and learning.
- GIs will base instructional decisions on student understanding as well as on course objectives.
- In their instructional planning, GIs will plan questions, tasks and activities that target the big ideas of algebra.
- GIs will use technology as a tool in the service of student learning.

A Narrative Description of the Project Design
To address the problems of Math 103 as it is currently taught, and to address the goals of the project, project partners will need time to spend on course design as well as new equipment. Redesigning a large introductory course requires time before implementation to plan appropriate use of technology, re-think methods of assessment, and make curricular decisions. This redesign will not be undertaken in isolation; it will need the assistance of other faculty members.

The following components detail how this project proposes to address the above goals.

**A Master Class section of Math 103 will be offered at 8 a.m. Fall Quarter 2006.**
Since GIs enter the classroom with no experience in teaching, a different model of course delivery must be developed. Instead of teaching two sections of Math 103 their first quarter, they will observe and participate in a large section taught by an experienced faculty member early in the day, then deliver the same lesson in one section of Math 103 later in the day. The large ‘Master Class’ will enroll approximately 150 students (5 sections worth). GIs will attend the Master Class in order to critically examine lesson structure, mathematics content, student preconceptions, and students’ ways of understanding Basic Algebra concepts. GIs will engage with students as they work on challenging tasks. In turn, GIs will base their own class sessions on what they see, hear, and experience in the Master Class.
Technology will engage students as they complete their homework.

The Mathematics Department has adopted a new textbook for Math 103 that is supported by MyMathLab (MML), a well-respected online homework/quiz delivery system in which students are guided through the routine aspects of mathematics. As students work through assigned exercises, they are given immediate and individualized feedback on their performance, and their work habits are monitored and accessible to instructors. Results of other schools using MML have been positive, showing an increase in student success rates, and few student difficulties in appropriating the technology are reported. The primary benefits of this technology relate to students’ skill development. Research also shows, however, that students need to engage in a community of learners in which mathematical ideas are exchanged and extended. A different type of technology will encourage this sort of engagement.

Technology will engage students as they participate in Math 103.

Though group activities (designed around common student preconceptions) have been a major component of the Math 103 curriculum in recent years, GIs have tended to use them as lecture notes instead of using them as intended. GIs have also used the group activities as individual worksheets in their classes, but neglected to use them in class discussion to tie central ideas together. In order to address this issue, this project will adopt “clicker” technology as a way to engage students in the classroom experience. This technology will be used in all sections of Math 103 as a way of presenting interesting patterns and problems and making students’ thinking more explicit as they consider them. Planning time will be spent Summer Quarter in writing questions designed to further concept development and encourage engaged discussion. Good questions, delivered through this system, have the potential to help students make distinctions and connections among multiple mathematical ideas. To support GIs’ implementation of this technology, the Teaching & Learning Center will facilitate Scholars Learning Communities in which the GIs will be active participants.

Technology will engage GIs as they participate in the Master Class.

Using clicker technology on a consistent basis in the Master Class will not only help Math 103 students, it will also help GIs see what students do know and understand. GIs will also observe instructional decisions made in response to students’ ideas, highlighting the interactive nature of a mathematics classroom experience. The technology will also generate a pool of data from which to make instructional decisions during the course, and subsequent program decisions.

The Methods Course (Math 521, 522 and 523) will directly relate GIs’ experiences in the Master Class, their experiences in their own classes, and student learning.

The Methods Course is currently preceded by an intensive, four-day orientation experience (a ‘boot camp’). This fall, orientation will have an added focus of incorporating the new technology. In addition, the Methods course meets once a week through the quarter. Emphases will be on analysis of student work, multiple strategies for solving problems, implementing tasks, and listening to student responses. Data generated through MML and the clicker technology will be used formatively in discussing instructional decisions and reflecting on student learning.

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The above components of the project (a master class so GIs can observe student thinking first-hand, and use of technology as a tool to further student learning) need to be developed during the summer, before fall implementation. Since Ms. Lane will be teaching one section of Math 103 with a half-time appointment in the summer, she can maintain a second half-time appointment to set up the physical structures needed for MML and the clicker technology. More importantly, with university support she can spend the summer writing the types of tasks and questions that promote deeper understanding on the part of both students and GIs.

This project is, by nature, an experiment. Research indicates that students need strong skills and a deep conceptual underpinning through which they make sense of mathematics. Research also indicates similar needs of teachers as they make sense of what it means to learn mathematics. Institutions similar to EWU have found MML or clicker technology to support these research findings. This project extends most other institutions’ experiences in mathematics classes by combining both technologies, and by placing strong emphasis on a reflective experience for teachers as part of the project.

The following table reflects the project description:

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<thead>
<tr>
<th>Goals</th>
<th>Project Activities</th>
<th>Assessment Plans</th>
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| **Goal 1: Increase student learning in Math 103** | **Activity 1:** Develop and conduct a Master Class section of Math 103 which will be taught by an experienced full-time faculty member.  
**Activity 2:** Offer small-class versions of the Master Class which will be taught by GIs.  
**Activity 3:** Students will use clicker technology in the Master Class and the small classes as a way to engage them, and to monitor participation and understanding (for the purpose of increasing student learning during class).  
**Activity 4:** Student will complete math skill sets electronically in MyMathLab, an online tool that provides tutoring and immediate feedback to students (for the purpose of increasing student learning outside of class). | **Observation 1:** Compare student pre- and post-course survey responses. Survey questions will ask students about their study patterns, their attitudes toward technology and their beliefs about learning mathematics.  
**Observation 2:** Analyze student in-class clicker responses to confirm or discover common misconceptions. Questions will be designed around tasks or problems in which students will be asked to justify their work, and communicate their reasoning to classmates. Analysis of clicker responses will serve as a reflective tool for GIs in the Methods course.  
**Observation 3:** Analyze student performance on MyMathLab assignments. This analysis will give a picture of student work habits (such as length of time to completion, when assignments are completed, the nature of multiple attempts in submitting homework, number of correct responses).  
**Observation 4:** Compare rate of successful completion of the course with historical rates. |
**Goal 2:** Increase GIs’ understanding of the nature and process of student learning in mathematics.

**Activity 1:** Graduate instructors participate in the Master Class section of Math 103 for the purpose of observing student thinking and teacher responses.

**Activity 2:** Graduate instructors teach their own small-class version of the Master Class, experimenting with the ideas generated there.

**Activity 3:** Teach GIs to use technology as a tool to observe student thinking and develop an instructional response (through the ‘boot camp’ experience).

**Activity 3:** Graduate instructors use clicker technology in their own small classes.

**Activity 4:** Graduate instructors, with guidance from the Math faculty member, will monitor and analyze data generated by student use of MyMathLab.

**Activity 5:** One-credit methods course (Math 521, 522 and 523) serves as an intentional reflective experience for GIs. This course will focus on lesson design and implementation, interpretation of student response to planned activities, and subsequent instructional decisions.

**Observation 1:** Compare pre and post graduate instructor surveys about their beliefs concerning student learning in mathematics. This should highlight changes in their thinking about the role of mathematical rules and conventions, and the social development of mathematical concepts.

**Observation 2:** Compare graduate instructors’ written reflections on student behavior and performance in Math 103. These reflections will be part of the ongoing work in the Methods course. They should connect ideas generated through readings in research, class discussion, and data generated through use of technology.

**Observation 3:** Faculty visits of sections taught by graduate instructors. The observation form currently used emphasizes student engagement, and teacher decisions that support it.

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**Timeline for Planning Changes and Implementing Them**

The following table illustrates the proposed time frame in which these changes will take place:

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<tr>
<th>Time Period</th>
<th>Activity</th>
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<tr>
<td>Spring 2006 (prior to the start of the grant)</td>
<td>Attend a MML workshop, partially funded by Teaching &amp; Learning Center</td>
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<td>Structure Math 103 summer course as a pilot for fall implementation.</td>
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<td></td>
<td>• Work with MML publisher to set up online course</td>
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<td></td>
<td>• Structure Math 103 assignments, gradebook and study supports</td>
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<td></td>
<td>• Install necessary computer plug-ins to make MML accessible across campus</td>
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<td>Summer 2006</td>
<td>Teach a section of Math 103 (half-time) from new, MML-supported textbook</td>
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<td></td>
<td>Continue programming MML</td>
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<td></td>
<td>Test and pilot MML</td>
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<td></td>
<td>• Understand and test MML functions</td>
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<td></td>
<td>• Respond to student difficulties in using online format, and make appropriate adjustments</td>
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<td></td>
<td>• Consider level of tech support needed across campus for implementation</td>
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<td></td>
<td>Order and pilot test “clicker” technology</td>
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<td>• Write questions designed to make student thinking explicit</td>
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<td>• Write questions targeting student preconceptions and misconceptions</td>
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<td></td>
<td>• Write questions generating discussion about math concepts</td>
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<td></td>
<td>Communicate with university personnel about proposed changes to Math 103</td>
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<td></td>
<td>Work with Teaching &amp; Learning Center (R2R preceptor) as they provide student support for new technology</td>
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<td></td>
<td>Develop a Scholars Learning Community in which instructors of Math 103 participate</td>
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<td>Develop four-day GI orientation (the ‘boot camp’ experience)</td>
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<td>Plan changes to Math 521, the methods course</td>
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<td></td>
<td>• Devise potential course activities for GIs</td>
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<td></td>
<td>• Meet with Teaching &amp; Learning Center to consider their input in the methods course</td>
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<td>Fall 2006</td>
<td>Implement proposed project</td>
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<td></td>
<td>• Teach Master Class of Math 103</td>
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<td></td>
<td>• Teach GI Methods Course</td>
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<td></td>
<td>• Study data on student activity generated by technology</td>
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<td>Winter 2006</td>
<td>Continue to study data</td>
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<td></td>
<td>Identify lingering problems and propose changes for next quarter</td>
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<td>Consider extending project</td>
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<td></td>
<td>• How could at-risk students be identified early?</td>
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<td></td>
<td>• What kind of interventions could be developed to target these at-risk students?</td>
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<td></td>
<td>• Since the same students enrolled in Math 103 attend other introductory courses, how could faculty of these courses collaborate in improving student learning in all of the courses?</td>
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<tr>
<td>Spring 2006</td>
<td>Report results of assessment to the university</td>
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Assessment Plan

Assessment data gathered over Fall Quarter will support the goals of the project. In particular, the following questions will be considered:

1. What kind of study habits do Math 103 students exhibit?
   This question has remained unanswered until now, because teachers at this level do not see what students do at home. How much time do students spend? When do they spend this time? In what kind of preparation do they engage before submitting homework and quizzes? These questions relate directly to student success and will be answered by analyzing generated through MML.

2. What do students believe about the nature of mathematics and their role in learning it?
   Research in mathematics education has focused on K-12 students, and little research has been done on questions such as this at the college level. Do students believe that mathematics is restricted to a list of rules to memorize? Do students expect to copy or mimic their instructors in learning new skills? Do students value solving problems? Do they value multiple ways of thinking about mathematical ideas? How do they use technological tools to further their understanding? These questions also relate directly to student success and should be answered by comparing student survey results.

3. What are areas or topics of difficulty for Math 103 students? What are their misconceptions? What ideas about mathematics topics do they bring to a Math 103 class? What patterns do they notice and generalize?
   These questions not only relate to student success; they also relate to teacher success. Research commonly supports the importance of teaching responsively to students’ current understanding, and students’ ideas are constructed based on their current understanding. These questions should be answered by data generated through clickers. These questions will also serve as discussion points during the Methods course.

4. Are students’ success rates higher after completing this program? This question should be answered by examining departmental data.

5. What do new GIs believe about the nature of mathematics and their role in teaching it?
   Research often focuses on preservice teachers, or new teachers who have completed a program in education, but little research has been done in GI pedagogical learning. Do GIs believe mathematics is limited to a set of rules and conventions? Do GIs value problem solving? Do GIs base their identity and efficacy on their mathematical authority in the classroom? These questions should be answered through GI surveys conducted during the Methods course.

6. How do GIs relate their teaching to student learning? Do they reflect deeply about the questions students have before preparing their class sessions? Do they develop enough comfort in the classroom to ask extending or probing questions? Do they relate student learning to their emotional investment in their students, or to a critical examination of the classroom experience?
   These questions relate directly to the nature of student learning, and they should be answered by Methods course reflections, and faculty observations of GI teaching.

7. How do GIs implement ideas generated in the master class? Do they turn questions into statements to tell students, instead of ideas to explore? Do they replicate the skill-building exercises supported in MML, or focus on larger questions? Do they recognize the “big ideas” of Algebra or do they focus on discrete examples?
These questions relate directly to the nature of Goal 2, and they should be answered by faculty observation of GIs’ teaching. Following are examples of observations found in the currently used protocol.

1. This lesson encouraged students to seek and value various modes of investigation/problem solving.

   Teacher:
   - Presented open-ended questions
   - Encouraged discussion of alternative explanations
   - Presented inquiry activity for students
   - Encouraged students to work together without direct instruction

   Students:
   - Designed their own investigation

2. Instructional strategies and activities respected students’ prior knowledge and preconceptions.

   Teacher:
   - Preassessed students at the beginning of the lesson
   - Actively solicited student ideas
   - Referred to previous activities
   - Refocused lesson based on student needs

This proposed experiment is designed to answer questions about students’ and GIs’ learning experiences. Date generated through the technology can also be used to make program decisions in successive quarters. If at-risk students can be identified early, an appropriate intervention can be designed. As the project unfolds and student needs are more closely identified, it is hoped a stronger collaborative component can be written into the Methods course. For example, considering the nature of Math 103 students and their learning might be incomplete without the perspective of instructors who teach these same students in developmental English coursework.

The Proposed Budget

The budget for this project funds the following project components of time and equipment:

- Salary and benefits for half-time summer employment for the project lead, Jane Lane, to develop the course redesign, ‘boot camp’, and the Methods course. (She will be teaching a pilot version of the course half-time as well.)

- All necessary equipment for the ‘clicker’ component. This includes 3 mobile sets of laptops and carts, projectors and audio equipment. Three sets are necessary: one for the project lead (since such equipment will be necessary to continue planning and evaluating all quarter) and two sets for the GIs to share throughout the day. A central storage location is planned where the carts can be easily accessed.

- Enough clickers to conduct this experiment with all students enrolled in Math 103 Fall Quarter. Since this is an experiment, this budget request is for Fall Quarter only.

This project will use assistance from the Teaching and Learning Center staff, from the publisher of MML, and clicker software, but these elements add no cost to the project.
**Instructor/Student Engagement in Math 103: Strategic Planning Pool Grant**

**Expenditure Category**

**Personnel**

- **Project Lead (Jane Lane)**
  - Salary: $4,003
  - Benefits: $721
  - **PI Total**: $4,724

**Equipment**

- **Mobile Cart (3@$225)**: $675
- **Laptop (3@$1800)**: $5,400
- **Projector (3 @$1800)**: $5,400
- **Audio DVD, Amp, Speakers (3 @$250)**: $750
- **Cart Miscellaneous (3@$125)**: $375
- **Cart Total (3 carts)**: $12,600

**Clicker System**

- **Responders (285@$25)**: $7,125
- **Grand Total**: $24,449