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ARTICLE 2

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ABSTRACT

In the Fall 2014 semester the Mathematics faculty at Edinboro University instituted a mastery based course redesign of the remedial mathematics courses to address high failure rates in remedial and first college-level courses. This report will present the redesign model, changes made over time and results. The redesign objectives were to (a) increase student success at the remedial level, (b) increase student success in first college-level mathematics course, (c) remove course drift at the remedial level, and (d) decrease time spent at the remedial level. The redesign has been successful in meeting the objectives related to first college-level course and course drift. The success at the remedial level is mixed and further analysis is required to address the time spent at the remedial level.

Who We Are

Edinboro University is a public university located in Edinboro, Pennsylvania and is one of the fourteen member schools in the Pennsylvania State System of Higher Education. The following profile is a representation of the university during the first three years of the remedial redesign program. The undergraduate enrollment averaged approximately 4800 students. The acceptance rate for students at Edinboro University was approximately 98%. A large number of students at Edinboro are first generation college students with about 83% of the students being Pennsylvania residents.

History and Motivation

It is a problem uniting nearly all post-secondary institutions across this nation: students are coming to college unprepared for the curriculum. "It might take a remedial course just to fathom the statistics. At the City University of New York (CUNY) last year, 83 percent of students entering the system's community colleges had to take remedial courses in reading, writing, or math. In Bloomington, Minnesota, meanwhile, 75 percent of the incoming freshmen at Normandale Community College took remedial math, and almost 50 percent needed remedial writing" (Schachter, 2008). It is actually quite difficult to find consistent, current statistics across the nation in regard to the percentage of students who are enrolled in remedial classes their first year. Perhaps this is because institutions are not proud of those numbers, and thus do not wish to make it easily accessible for the public. One website, dedicated to convincing states to develop policy to make placement exams and procedures for remediation standardized, asserts that "Every year in the United States, nearly 60% of first-year college students discover that,

despite being fully eligible to attend college, they are not ready for postsecondary studies. After enrolling, these students learn that they must take remedial courses in English or mathematics, which do not earn college credits. This gap between college eligibility and college readiness has attracted much attention in the last decade, yet it persists unabated" (Beyond the Rhetoric, 2010). A government organization's website states: "In the United States, research shows that anywhere from 40 percent to 60 percent of first-year college students require remediation in English, math, or both. Remedial classes increase students' time to degree attainment and decrease their likelihood of completion. While rates vary depending on the source, on-time completion rates of students who take remedial classes are consistently less than 10 percent" (The Cost of Catching Up, 2016). Another article observes, "Developmental education has become an integral part of postsecondary education as evidenced by the fact that in 2000, more than 76% of all postsecondary institutions and 98% of all community colleges offered at least one developmental education course" (Williams, 2017). Many four-year institutions are shifting the responsibility of remediation to local community colleges, but we as a department at Edinboro value our remediation program and really want impact the success of these developmental students. Our redesigned model would have to allow us to make personal connections with these students in addition to instilling fundamental mathematical skills.

Edinboro University is far from alone in their attempts to solve the problem of low success rates in remedial courses, as well as low graduation rates among this population. One researcher summarizes that "findings of this research have driven efforts to devise, implement, and test models of mathematics remediation and supporting interventions that will improve the dismal rate at which students achieve college-level math competency and go on to complete postsecondary credentials" (Bahr, 2013). The strategy we wished to employ was supported by one case study, which observed that "effective remediation is believed to integrate multiple teaching and learning strategies and activities in instructionally and technologically enriched settings that are designed to promote student progress by focusing education on reflective and collaborative learning and achievement in a domain with particular attention paid to affective factors" (Lundberg, 2018). We believed that the introduction of technology in our classroom and the shift in focus from large group lecture to small groups and/or individualized mini-lessons would help us meet our goal of improving success in remediation. "Our analysis suggests that students, staff, and faculty view successful remedial math students not so much by placement score or level, but by the practices they take up in order to move through classes and programs" (Lundberg, 2018). We knew that we would have to sharpen more than mathematical skills; we would need to improve the study habits and mindset of these students in order to help them succeed.

In the years leading up to our newly launched modularized model in the fall of 2014, we faced high failure rates in remedial classes, high failure rates in subsequent college-level math classes, and a significant drift in the delivery of remedial math classes. Specifically, in the five years prior to the change, only 43% of our students were passing our Basic Algebra course with a C or better, and only 46% were passing Intermediate Algebra with a C or better. Pass rates in College Algebra were 52%. The department was convinced the remediation was not serving its purpose - preparation for college-level mathematics. The need for a leadership team to devise a more standardized course structure producing better results at both levels was apparent.

In preparation for redesign, two members of the leadership team attended conferences and collected general ideas about mastery-based learning and flipping the classroom. One

invaluable resource was the National Center for Academic Transition (NCAT). Their six principles for course redesign became the guidelines for our model (Six Principles of Successful Course Redesign, 2005). As a first step in the fall of 2011, our department adopted the *Introductory and Intermediate Algebra* materials by Hawkes Learning System (Wright, 2012) for all remedial math classes. In the fall of 2012, all remedial classes were scheduled in the computer lab. Delivery, class standards, and student success still varied greatly across sections. The desire and the need for uniformity was increasingly clear.

Mathematics Placement Process

During the period leading up to and through this redesign, students completed the Accuplacer Elementary Algebra test during summer orientation to determine placement in a mathematics course (Accuplacer, 2017). The score on this test dictated if the student would take Remedial Algebra or simply enroll in whatever mathematics course was required in the student's academic program. Consistently, about 50% of freshman have placed into Remedial Algebra.

The Model

Our redesigned model is a technology assisted, flexibly paced, mastery model, designed and delivered by the mathematics faculty of the university in a two-course sequence. The first course is Remedial Algebra, Math 020, and consists of the first six modules of content. The second course is Intermediate Algebra, Math 090, and consists of the last six modules. All students placed in remedial mathematics start at module 1. The model has two exit points available depending on the mathematics course required in the academic program of the student. Students who need Finite Mathematics or Mathematical Reasoning I may exit remediation after mastering the first six modules. Students who need College Algebra or Applied Mathematics for Business complete all 12 modules, due to the intensive algebra expectations in these courses.

All remedial classes meet in a large computer lab of roughly 80 computers where students use the Hawkes Learning software to complete their work. Each class section has an instructor, student lab assistant, and some combination of Math 020 and Math 090 students with enrollment capped at 35. When needed, "double sections" were scheduled where two faculty team-teach in the lab during the same class period for the entire semester with two lab assistants.

Due to the nontraditional format of the class, faculty unfamiliar with redesign principles needed additional support. The leadership team produced a reference handbook that included an introduction to the new philosophy and format, a common syllabus, grading guidelines for each mastery exam, attendance policy, procedures for managing the gradebook, and other related topics. To help ease the transition, each member of our redesign leadership team mentored colleagues via team-teaching, putting 2 faculty, 2 lab assistants and 70 students in the lab at the scheduled class time. This practice of pairing faculty new to the format with experienced faculty has continued each semester.

The course structure permits each student to move at a flexible pace through the course material. To earn a satisfactory grade, students are expected to complete 6 modules per semester, however it is possible for a motivated student to complete all 12 modules of content within one semester and receive credit for both courses. If a student is unable to finish all 6 required modules, but completes at least one module during a semester, the progress made carries forward to the next semester when the student enrolls in remedial algebra again. As an example, suppose a student was only able to master modules 1 through 3 by the time the

semester ended. In the following semester, this student would begin work in module 4. This allows students who fall short of mastering 6 modules in one semester to pick up where they left off in the next semester, rather than moving back to the beginning of the course as would be the case in a traditional algebra class.

Students must move through modules in order, meaning mastery of module 1 is required before the module 2 exam is available. In each module, a student must demonstrate proficiency on a mastery exam. Each module has an associated pretest and posttest, and mastering either exam allows the student to progress to the next module. Students may prepare for a module pretest using their own strategies for one attempt before additional interventions are required. If a student does not master a pretest, students have the opportunity to posttest as soon as several assignments are successfully completed. These assignments consist of a guided note taking assignment and mastery lesson certifications completed in the Hawkes courseware.

Changes and Reasoning

One problem noticed immediately in the first semester of the redesign was poor attendance, which correlated to poor overall student performance. The option of embedding it in the course grade was not possible, as the course is pass/fail, with that grade determined by whether or not the student mastered the target number of modules. Issuing automatic failure for poor attendance seemed increasingly punitive, and in violation of the spirit of flexibility. Beginning with the second semester, a pretest privilege was implemented which required good attendance to be eligible for module pretests. As an additional incentive, the bar for mastery on a pretest moved from 75% to 70%. This improved attendance from our first semester of redesign to the next. Other issues addressed in the first few semesters included small adjustments to mastery exams, grading guidelines, and content as well as providing additional opportunities for testing when deemed appropriate. These adjustments helped improve student success in subsequent semesters.

Another issue encountered was the lack of study skills in this population of students. To address this a supplemental study skills text, *Winning at Math*, was added to the syllabus as a recommended text. (Nolting, 2014) The leadership team then developed a series of mini-lectures for class delivery over the first third of the semester to coincide with topics from that text. Each mini-lecture lasted 5 - 10 minutes at the beginning of class with topics ranging from test anxiety, time management and goal setting, learning from mistakes and taking good notes. A series of bonus assignments related to these topics were also developed and made available. Students could complete an assignment and earn five bonus percentage points on a posttest.

Another important change was a policy we refer to as “continuous progress.” Originally, as long as a student stayed enrolled in the remedial math sequence, that student would always take progress from the previous semester forward to the next semester. However, students were signing up for the class and then never completing a module for an entire semester. The new policy required mastery of at least one module in order to carry progress forward to a new semester.

Our Results

At the onset of the planning for this redesign, we identified four goals to guide the project. In brief, evidence suggests this project is achieving some of these goals while improvement is needed relative to the others. Each section below presents a project goal and corresponding outcomes.

Goal 1: Increase student success at the remedial level.

This particular goal targets improved success rates in our remedial algebra classes. Prior to the redesign these courses experienced DFW rates over 50%, and we believed our modularized, mastery-based and flexibly paced structure would improve student success. Looking at the two tables below, we are still not pleased with the success rates in Math 020, but are encouraged by an increasing pattern of student success in Math 090.

TABLE 1: Math 020 Success by semester

Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016	Spring 2017
28%	35%	31%	43%	38%	42%

You might notice a pattern in the table above that represents what we call the "spring bump". The slightly higher numbers each spring semester can be explained by the fact that larger numbers of students begin remediation in the fall semester, and although we hope they complete the first 6 modules in a single semester, the flexible pacing factor often produces quite a few students who finish the course in the spring. We are not satisfied with these success rates in Math 020, and have continually worked to make improvements and adjustments in the hopes of increasing student success.

TABLE 2: Math 090 Success by semester

Spring 2015	Fall 2015	Spring 2016	Fall 2016	Spring 2017
46%	36%	40%	52%	59%

Turning now to Math 090, the fact that the first semester success number was 46% followed by a 10% drop is likely because in spring 2015 the vast majority of students in that group were the high achievers who successfully completed Math 020 in a single semester. Also in that mix would be students who did not complete the redesigned Math 020 class. Now that nearly all Math 090 students are products of our redesigned Math 020 class, the success rates appear to be on the rise.

There are a few things worth noting in the interpretation of the Math 090 results presented in Table 2. At first glance, a 46% success rate might not seem very successful at all. However, this is exactly the success rate for this class when delivered in a traditional manner prior to the redesign. An even closer look unveils some more interesting considerations. In this first semester, numerous students enrolled in the class did not complete the prerequisite course (Math 020) in our redesigned format. These students could have either completed Math 020 in a traditional format or transferred in credit for Math 020 from a different institution. Table 3 provides a breakdown of these two paths to Math 090 along with resulting grade in Math 090. To see a success rate in Math 090 that is 3 times higher for students completing the redesigned prerequisite course is phenomenal!

TABLE 3: Further Analysis of Spring 2015 Results in Math 090

Path to Math 090	Satisfactory	Unsatisfactory	Total	% Success
Redesigned Math 020	63	43	106	59%
Traditional/Transfer Math 020	10	44	54	19%

Goal 2: Increase student success in first college-level mathematics course.

Despite the challenges above in Math 020 in particular, the results related to the performance of students in their first college-level mathematics course are extremely encouraging to us. Due to the two exit points from remedial algebra that lead students into two different paths to complete the mathematics requirement(s) for their academic program, we will report results according to those two paths.

Path 1: One of two survey courses having Math 020 as a prerequisite. Quite a large number of academic programs in the liberal arts and education areas require students to complete one of two survey courses as the first college-level mathematics course. A random sample of students who completed 6 or more modules of remedial algebra and then went on to complete one of these survey courses was taken. The table below summarizes grades earned in those survey courses. A success rate nearing 80% is extremely encouraging given that prior to the redesign the success rates in these classes were in the range of 65 – 70%.

TABLE 4: Grade Summary in Survey Courses

Grade	Count	Percentage
A – C⁻	203	78%
D	39	15%
F	17	7%
Total	259	100%

If you also take into consideration that for some students, earning a D grade is good enough for their program, then the success rate here could actually be closer to 90%, far exceeding anything we would have anticipated from this project.

Path 2: College Algebra or Applied Mathematics for Business courses having Math 090 as a prerequisite. This set of results (see Table 5) has us especially excited. Prior to the redesign, pass rates in these courses have hovered around 50%. Our results suggest for students who completed the redesigned Math 090, over 80% then successfully complete these courses on the first attempt. This outcome is more than we would have imagined possible.

TABLE 5: Grade Summary in Math 105/150

Grade	Count	Percentage
A – C⁻	91	82%
D	14	13%
F	6	5%
Total	111	100%

Goal 3: Remove course drift at the remedial level.

Without a doubt, this project has accomplished a more consistent delivery of remedial algebra. The implementation of common course materials, calculator policy, assessment structure and assessments along with scoring guidelines across all sections provides assurances of the content all students are expected to master. Certainly, with a mastery level of 70%, there is individual variability in terms of the content any particular student may not have mastered, but we believe this model ensures each student can perform at the "C level" across all objectives in the course. Prior to the redesign, it would have been common for students to perform very well on certain course objectives while failing completely on others, and still earn a passing grade.

Goal 4: Decrease time spent at the remedial level.

This particular goal has been especially difficult to assess due to challenges associated with obtaining data on our campus. What we can say is that for students who approach the class using reasonable strategies coupled with an adequate work ethic, success results. The number of students who take advantage of moving more quickly than in a traditional model is quite low, even though we anticipated the free credits might serve as a motivating factor. Overall (although some of the slower moving students simply need the extra time), lack of motivation seems to be at the root of the issue with our students relative to this particular goal. This goal is in need of further examination.

Unforeseen Benefits

Although our pass rates in Math 020 are still not where we would like them to be, we still believe the redesigned format is the best possible solution for our students. Not only are they having better success in subsequent courses, but also there are other benefits. Most students begin remediation in their first semester or two, struggling with the transition to college. This course instills study skills like time management and organization. It is common for students to need multiple attempts to master some modules, but the boost in confidence and sense of accomplishment is unmistakable and contagious. Students realize hard work and perseverance pay off in the end, which is a mindset that will serve them well in many other arenas.

In a traditional classroom, students often get away with passive behavior. Our format is far more student-centered, allowing for active engagement with faculty and lab assistants. The instructors agree the new model provides increased interactions, with individualized support and guidance occurring frequently.

In addition to building strong relationships with the remedial students, faculty teaching in the redesigned classroom find themselves getting to know their student lab assistants on a more personal level. These lab assistants are usually upperclassmen with majors in math education or a related field. The experience of being in the classroom is most certainly beneficial to their careers, but the mentorship that develops with their cooperating teacher is also significant.

We are not content with our Math 020 pass rates, so we will continue to troubleshoot to improve those outcomes. Potential considerations include adjustments to common exams, the grading rubric, or supplemental resources (like our notetaking guides). This redesign has been in place for just over three years now, and the results thus far provide a solid foundation moving forward.

Recommendations

After going through the course redesign process we can advise other institutions wishing to attempt this endeavor to separate the process into two components. The first piece is to address the content and assessments, which in our case had to be aligned with the University goals and objectives for each course. Additionally, the team must make decisions such as the number of modules to use, the mathematical content to be included in each module, and the level at which to set the mastery bar. They must also work as a team to create the mastery exams. This portion of the redesign is highly dependent on the specific needs of an individual university and can vary. Despite the tremendous amount of time the planning phase required, this was the easier component to develop. The second piece, which aims to modify student engagement and behaviors, proved to be an ongoing challenge. A few areas that need to be carefully addressed by the redesign process include attendance, study skills, motivation and time management. It is absolutely critical to have a clear and meaningful attendance policy, and to develop strategies to get students who have missed too many classes to return to the classroom. Addressing study skills through mini lectures, bonus assignments, and making use of the text, *Winning at Math,* was extremely helpful for us. Keeping students motivated and using their time appropriately is vital. Due to the flexibly-paced nature of the course, students are tempted to wait an extra day or two to start the next module or take a mastery exam. Many students are hesitant to ask questions or take advantage of the free tutoring. Finally, students will consider their remedial class as a low priority compared to their other classes. Engaging the students each day in one on one conversations in class is an easy way to identify content, motivational, or time management issues that need addressed and offer a chance for faculty to provide the students with individualized advice.

In closing, we as educators understand the dynamic nature of any classroom. We thus continue to adapt and advance the various components of our remedial format to continually improve the program. We as a group appreciate the circumstances facing the under-prepared student, and do our best to be sensitive to their individual needs while working towards a common goal of college-level mathematical competency.

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Biographies

Dr. Melanie Baker is in her 9th year as a faculty member of Edinboro University. She received her doctorate in mathematics from Bowling Green State University in 2011, with a concentration in functional analysis. Dr. Baker enjoys teaching a large variety of mathematics, from Remedial Algebra to Real Analysis.

Dr. Douglas Puharic is in his 14th year as a faculty member of Edinboro University. He received his doctorate in mathematics from Bowling Green State University in 2006. Dr. Puharic enjoys playing board games and is willing to take on the challenge of teaching any class thrown at him.

Dr. Corinne Schaeffer a faculty member at Edinboro University with over 25 years of teaching experience in higher education. She received her doctorate in 2003 in mathematics education from the University at Buffalo. Dr. Schaeffer is interested in student-centered teaching strategies and the incorporation of technology in the mathematics classroom.