Abstract

Higher education institutions have taken to redesigning high-enrollment, introductory courses to improve student learning outcomes, student success, and degree completion. This paper presents findings from the assessment of course redesign by focusing on the case of developmental math at a large community college. The college adopted modularization, a common course redesign method in which concepts are disaggregated into modules and delivered through computer software. Preliminary results from the quantitative analysis of student performance in redesigned courses have been mixed. The study discusses faculty and student views and experiences with modular math redesign in order to complement and help illuminate the results from the quantitative analysis. Using evidence from five focus groups, one with faculty and four with students, the paper provides insights on how to help faculty and students ease into their new roles and reshape those roles for an enhanced, more engaging, and more effective teaching and learning experience.

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Assessing Course Redesign: The Case of Developmental Math

Nationwide, colleges and universities have embraced course redesign to improve various aspects of higher education, including, but not limited to, student learning outcomes, student success, and degree completion (Twigg, 2003, 2013). New instructional technologies, policymakers' emphasis on accountability, and private foundations' work to increase college completion have converged to create widespread interest in course redesign (Rassen, Chaplot, Jenkins, & Johnstone, 2013). Course redesign usually entails changes in the curriculum and in the delivery of instruction using some form of information technology (Education Advisory Board, 2013; Twigg, 2003). Typically, course redesign initiatives have targeted college-level introductory, high-enrollment courses.

In the case of community colleges, course redesign efforts have commonly focused on developmental education. Studies have shown that nearly 60% percent of community college students are not sufficiently prepared for college-level courses and must enroll in at least one developmental course (Bailey, 2009). Most students who require developmental education are usually placed into some level of developmental math. Data from 26 institutions participating in the Achieving the Dream network showed that on average 62% of their fall 2002 cohort were referred to at least one developmental math course (Zachry-Rutschow et al., 2009).

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As the federal and state governments pay more attention to student success and degree completion, reforming developmental math has become a priority for community college leaders. One of the most common approaches to revamp developmental math is modularization. Modularization disaggregates math coursework into separate modules, which are often delivered to students through computer software. The rationale for this reform is to accelerate students' completion of their developmental math requirements.

Modularization has shown promising results, but low pass rates for some groups of students and other challenges remain (NCAT, 2009). Addressing these challenges will require careful assessment of redesign efforts, including ongoing consultation with faculty and students. As a step in this direction, this paper incorporates faculty and students' views and experiences in the assessment of modular math redesign in order to complement and help illuminate the preliminary analysis of student performance in redesigned courses. Findings are based on five focus groups, one with faculty and four with students, at a large community college. Lessons are relevant for any institution committed to the needed process of fine-tuning the modular math redesign after its initial adoption. Lessons are also applicable beyond developmental education, to two-year and four-year institutions, which have recently adopted or are looking into instructional technology for the redesign of college-level introductory, high-enrollment courses.

Developmental Math Education in Community Colleges

Modularization disaggregates math coursework into separate modules, which are often delivered to students through computer software. The rationale for this reform is to accelerate students' completion of their developmental math requirements.

Traditionally, developmental math courses are taught in a sequence that includes basic arithmetic, elementary algebra, and intermediate algebra. Depending on the students' placement test scores, their developmental sequence may require up to three or four semesters of courses before reaching college-level coursework. Many students end up failing or withdrawing from these courses, dropping out before they have completed their sequence, or fail to enroll in developmental math altogether. Consequently, only 30% of community college students complete their developmental math sequence and even less get to enroll in college-level math (Attewell, Lavin, Domina, & Levey, 2006; Zachry-Rutschow et al., 2009). Remediation comes at a high financial cost to students and institutions, and negatively impacts student success and college completion.

With mounting pressure from the federal and state governments with regard to college completion, community colleges have started to reform developmental math. Most reform initiatives, such as compression, boot camps, summer bridge programs, and mainstreaming, focus on accelerating students through their developmental math sequence (Bailey, 2009; Bragg, Baker, & Puryear, 2010; Edgecombe, Cormier, Bickerstaff, & Barragan, 2013; Epper & Baker, 2009; Sherer & Grunow, 2010). For example, compression combines two or more courses in the developmental sequence into one semester (Edgecombe et al., 2013). Boot camps and summer bridge programs provide students with intense math coursework during the summer, before their first college semester starts (Sherer & Grunrow, 2010). Mainstreaming simultaneously enrolls students in their college-level course and their developmental course, where they receive supplemental instruction (Edgecombe et al., 2013; Hanover Research, 2013).

Modularization

Consequently, only 30% of community college students complete their developmental math sequence and even less get to enroll in college-level math.

The focus of our article is the acceleration approach known as modularization. One of the reform initiatives that use modularization, the National Center for Academic Transformation's Emporium Model, has been implemented at multiple colleges and universities around the United States. A few states, such as Virginia, have adopted variations of this method to launch a state-wide redesign of all developmental math courses in community college. The hallmarks of this method are heavy reliance on computer-aided instruction (lessons, tutorials, homework, quizzes, and exams) and breaking down math concepts into separate modules for students to complete.

Students in modularized courses must demonstrate mastery of each module in order to advance and progress through their developmental math sequence (Hagerty & Smith, 2005; Twigg, 2013). The model allows for self-pacing, as students have the opportunity to accelerate their developmental process or spend more time on certain competencies. Different types of instructional software (e.g., Pearson's MyMathLab, Enable Math, ALEKS, etc.) are used to deliver lectures, pre-tests, post-tests, tutorials, homework, and quizzes (Epper & Baker, 2009). Because the instruction is computer-based, most versions of this model split instructional time between smaller classrooms equipped with computers and larger computer labs. In the classroom and computer labs, students work at their own pace on math tutorials, assignments, and assessments, and can receive individualized support from their math instructor or tutors.

Institutions have seen some positive, preliminary results from implementing modular developmental math. Allowing students to enroll only in the modules needed for their program of study and placement scores has increased the overall completion rate of developmental math. However, the benefits vary based on students' prior math knowledge. Students who need the least amount of remediation (placed into elementary or intermediate algebra) have higher success rates than under the traditional models, whereas those students who start in basic arithmetic are the least likely to benefit from this approach (NCAT, 2009).

Beyond performance gaps, researchers and practitioners have come across other challenges with modularization. Some faculty and students struggle to adjust to new roles and expectations, older students with weaker technological skills find it hard to navigate computer-aided instruction, and many students do not fully understand the new expectations about performance, workload, and homework (NC Community College Creating Success, 2012). Furthermore, the feedback provided by the software is too generic for students to understand how to arrive at the correct answer and for faculty to identify students' gaps in understanding (Bickerstaff & Lachniet, 2014). These challenges underscore the importance of establishing an ongoing process of assessment, customization, and refinement after the initial adoption (Bickerstaff, Monroe-Ellis, & The Scaling Innovation team, 2012). A key aspect of this process is continuing consultation with students and faculty.

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Capturing Student and Faculty Voices, Views, and Experiences

Our paper builds on a tradition of scholarship centered on the notion of faculty and students as stakeholders whose voices need to be heard in education research and reform (Manor, Bloch-Schulman, Flannery, & Felten, 2010; Mitra, 2004; Nodine, Jaeger, Venezia, & Bracco, 2012; Public Agenda & WestEd, 2012). Capturing student and faculty voices can reveal unintended consequences of reform initiatives. For example, by gathering feedback from students on redesigned developmental math courses, researchers found that the new course structure created barriers and exit points that slowed down students' progression (Fay & Cormier, 2014). Furthermore, collecting feedback from students and faculty can highlight the misalignment between each other's expectations. In a recent study, for instance, researchers showed that students expected more guidance from faculty, but faculty members were unaware because students failed to ask for help (Bork & Rucks-Ahidiana, 2013). Most importantly, encouraging faculty and students to talk about their own views and experiences can open up opportunities for self-awareness. Through such opportunities, faculty and students can learn about themselves, reflect on their own role, and achieve greater agency and responsibility in teaching and learning (Cook-Sather, 2002).

This paper incorporates faculty and student experiences in the assessment of modular math redesign at a large community college. The assessment was guided by three questions:

1. How do faculty and students perceive the notion of mastery?
2. How do faculty and students feel about the practical requirements set by the redesign to help students achieve mastery?
3. How do faculty and students experience computer-aided instruction?

By delving into faculty and student responses to these questions, the assessment seeks to shed light into unplanned effects of the modular redesign, while pointing to areas of agreement and disagreement between students and instructors. In addition, the assessment brings to the fore what faculty and students identify as their own needs for successful teaching and learning. Highlighting those needs is important not only as an exercise in self-awareness but also as an opportunity to adjust and reshape the modular redesign in ways that make it more engaging and more effective. Lessons from the assessment can be helpful for other colleges currently striving to find solutions to the long-standing and newly emerged challenges faced by developmental math students and faculty. More generally, these lessons can be useful for institutions that have implemented or plan to implement technology-mediated redesign of college-level introductory, high-enrollment courses.

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Modular Math Redesign at a Large Community College

The research was conducted at a large community college, with over 13,300 credit students, located in the suburbs of a culturally and ethnically diverse metropolitan region. Since 2011, the college has been part of Achieving the Dream, a national network of colleges and state policy teams that share knowledge and resources with the purpose of advancing institutional reform, reducing gaps in student achievement, and improving college completion. As part of the plan presented to Achieving the Dream, the college redesigned its developmental math curriculum by adopting the modular approach in order to help students succeed and accelerate through the developmental sequence.

By delving into faculty and student responses to these questions, the assessment seeks to shed light into unplanned effects of the modular redesign, while pointing to areas of agreement and disagreement between students and instructors.

Before the redesign, the college had three developmental math courses, each lasting one semester. With the redesign, there are fourteen modules spread across three developmental courses, but students who complete all the modules in one course before the semester ends can immediately start working on the following course. Students take the ACCUPLACER placement test to determine which developmental course(s) they require. In addition to in-class assistance, provided by the instructor and a tutor, tutoring is available to students seven days a week.

Instruction is computer-based; students use software to go through tutorials, complete homework, and take quizzes and exams associated with each module. Before each module, students have the opportunity to take a diagnostic test and, if they pass it, they can move on to the next module. Those who do not pass go through all the steps necessary to master the module. Mastery for each module is set at eighty percent or higher. Students are required to take course notes on each module before they can take module exams. If students fail a module exam, they must complete a correction sheet and show it to the instructor before retaking it.

The redesign was piloted for two semesters starting in fall 2012, with full implementation in fall 2013. During the pilot, the course schedule distinguished modular courses with an "M" and students were able to choose whether to enroll in traditional or modular courses. Twenty-three percent of students who enrolled in their first developmental math course selected the modular approach, while 77% opted for the traditional format. The assessment of the pilot included two components: a quantitative component centered on the analysis of student performance and a qualitative component focused on the study of faculty and student views and experiences. These two components were designed as complementary strategies to conduct a comprehensive evaluation of the impact of course redesign on student success (Small, 2011).

These results suggest that, at the outset, students in traditional courses appear to outperform students in modular courses. But looking at performance in the subsequent course in the sequence tells another story. Students in the modular format might struggle initially, but those who pass seem more likely to learn and retain the concepts and skills needed to succeed in higher level developmental math courses.

Preliminary Results from the Quantitative Assessment of Modular Math

Pass rates were used to compare the performance of students who took their first ever developmental math course in fall 2012. Overall, students who took traditional courses performed better; they had a pass rate of 68% compared to 28% for students who enrolled in modular courses (see Table 1, for course pass rates). One reason for the large gap in performance between the two course formats can be explained by how passing is defined in modular courses. Unlike what happens in traditional courses, students must earn a B or higher to pass a modular course. If the same definition applied to students in traditional courses, the pass rate would drop to 37%. Even though the recalculated traditional pass rate is still higher than the modular course pass rate, the gap is significantly smaller. This pattern holds when individually comparing each course level.

Table 1
Success in First Developmental Math Course, Fall 2012

Developmental Math Course Format	% Pass Rate (ABC)	% Pass Rate (AB)
Traditional Courses- All	68%	37%
Traditional Pre-Algebra	71%	37%
Traditional Introductory Algebra	73%	44%
Modular Courses- All	--	28%
Modular Pre-Algebra	--	28%
Modular Introductory Algebra	--	36%

Note. Dashes indicate that pass rates cannot be calculated for a particular course.

In addition, pass rates were used to examine the performance of students who enrolled in the next developmental course in the sequence, the following semester. This analysis was confined to those students who had earned an A or B on their first developmental course in either the traditional or the modular format. Students who had earned an A or B in a modular course the previous semester were more likely to pass their next course in the developmental sequence compared to students who had earned an A or B in a traditional course. Fifty-four percent of those who had initially succeeded in modular courses passed the next course in the sequence, compared to just 34% of those who had initially succeeded in traditional courses.

These results suggest that, at the outset, students in traditional courses appear to outperform students in modular courses. But looking at performance in the subsequent course in the sequence tells another story. Students in the modular format might struggle initially, but those who pass seem more likely to learn and retain the concepts and skills needed to succeed in higher level developmental math courses. Based on the quantitative component of the assessment, early results of the modular math pilot have been mixed. With more semesters of data, a larger and more complete picture of the outcomes of modular math will emerge.

For example, the requirement of submitting correction sheets after failing a test ensured that students would review the test and practice before retesting rather than just retesting to take another chance.

In the meantime, the preliminary results from the quantitative analysis highlight the need to examine in depth how faculty and students experience the redesign. Specifically, the preliminary findings on student performance suggest two lines of inquiry. First, given students' initial struggles in redesigned classes, what elements of the redesign do faculty and students identify as challenging? And second, in light of the more promising results in students' outcomes at a later point in time, what elements of the redesign do faculty and students perceive as helpful for learning and retaining knowledge? We explore these issues in the qualitative component of the assessment, which we discuss in the remainder of the article.

Qualitative Assessment Methodology

This article centers on the qualitative component of the assessment, which consisted of five focus groups, one with faculty members and four with students enrolled in modular math classes. The selection of cases was guided by purposeful sampling, "a strategy in which particular settings, persons, or events are selected deliberately in order to provide important information that can't be gotten as well from other choices" (Maxwell, 1996, p. 70). Consistent with this strategy, the study focused on faculty and students' experiences with introductory algebra, which is the second or intermediate-level course in the developmental math sequence. Focusing on this course was the logical first step in the inquiry, as it would ease the task of identifying common patterns in participants' experiences with the modular approach.

We decided to postpone the inclusion of pre-algebra, the lowest-level course in the developmental sequence, for a later stage in the research. This decision was based on the analysis of longitudinal evidence on the overlapping developmental needs of entering students. The analysis suggested that pre-algebra students' difficulties with the modular approach would likely be confounded or overshadowed by more general challenges with learning of basic skills, including reading and writing. We also decided to postpone the study of intermediate algebra, which is the third- most advanced course in the developmental sequence, because this course is placed under a different department and their instructors may follow different guidelines.

Furthermore, instructors believed that computer-aided instruction encouraged a more active student role and greater student responsibility in the learning process.

Focus groups were scheduled in spring 2013, and each lasted approximately one hour. Most of the instructors who had taught at least one semester of introductory algebra in the modular approach (seven individuals) participated in the faculty focus group. Participants in the student focus groups were not selected individually, but based on their class section. Four class sections of introductory algebra were selected to cover different days of the week and different time slots, adding to 30 participants. The student demographics in these four sections resembled those of the overall population of students enrolled in introductory algebra. Similar to the overall population, students in the four selected sections were majority female (70%) and predominantly African American (74%), and they had a median age of 20. The four focus groups with students were conducted in class, with IRB approval. Each focus group was approached as an opportunity to replicate and refine the findings from the previous one, leading to data saturation (Small, 2009).

Focus groups were transcribed and analyzed with NVivo qualitative research software. The analysis proceeded in stages, following the iterative process outlined by Lichtman (2013). First, each transcript was reviewed to develop incipient themes and categories. These themes and categories were then used for initial coding in NVivo. Once the initial coding was completed, the material coded into each theme and category was examined in greater depth, resulting into the revision and refinement of the entire coding system. Finally, NVivo's analytic capabilities were used to analyze the degree of overlap and discrepancy between faculty and students' views.

Qualitative Assessment Findings

Instructors' Views and Experiences with Mastery and Related Practical Requirements

Even when they recognized the opportunities for student growth opened up by the redesign, instructors had difficulty coming to terms with their new monitoring and supporting roles.

As explained in the previous section, students in the redesigned course are expected to master all the concepts and skills included in each module before moving on to the next. In order to help students achieve mastery, the redesigned course has in place practical requirements such as attending class, submitting course notes based on the tutorials, and reviewing test problems with incorrect answers before retesting. Focus groups findings show that instructors agreed with the notion of mastery and generally supported the requirements introduced by the redesign to help students achieve it.

Instructors' views about the notion of mastery have been shaped, in part, by their previous experiences with traditional math courses. Those who had previously taught in the traditional format were concerned about persisting "learning gaps" in students completing developmental math courses. In the traditional course, students were able to pass even if their knowledge of the material was uneven or incomplete. Furthermore, although students were asked to take a comprehensive exam at the end of the course, the bar was not set high enough to ensure that every student passing the class would have fully acquired all the core concepts and skills. As told by one instructor comparing the traditional and the redesigned course:

> In a final exam [in the traditional course] you usually take the questions for the whole course to make sure the student knows what they are doing because they may have passed one chapter with a ninety and the next chapter with a sixty. So at the end of the course you want to make sure that they have a moderate knowledge of everything. We are kind of saying with this redesign that that's not good enough, this is like the ABCs of math and they've really got to master every single part of this.

Instructors suggested that computer-instruction by itself may not provide students with all the learning opportunities they need to become proficient in Math. Instructors expressed interest in complementing the software with critical thinking activities, group work, and real world applications of Math concepts.

In addition, instructors welcomed the practical requirements introduced by the redesign to help students achieve mastery. From instructors' point of view, these requirements were important pedagogical tools because they helped students retain new knowledge and made it "inescapable" for them to develop successful learning habits.[2] For example, the requirement of submitting correction sheets after failing a test ensured that students would review the test and practice before retesting rather than just retesting to take another chance. Similarly, the requirement of submitting course notes based on the tutorials ensured that students would watch and pay attention to the complete tutorials rather than skipping parts or paying only intermittent attention. As an instructor explained:

> In this case in this modular class they have to go through all steps on the tutorial. They cannot miss any part, because of the notes. Because after they read the tutorial they have to put the definitions of the concepts on the notes. They cannot avoid it, they have to do it. I noticed that several of the students who were trying to take the diagnostic test with eighty-five percent they were using notes when they were going through it. They didn't have to complete their notes if they successfully completed the diagnostic test; they used the notes just to be sure that they did not miss anything.

[2] The notion of making certain behaviors inescapable for students is prominent in the findings from the Community College Survey of Student Engagement, in reference to student use of advising and other services (CCSSE, 2010).

Instructors' Views and Experiences with Computer-aided Instruction

While instructors embraced the notion of mastery and related practical requirements, they were more ambivalent about another key component of the redesign, computer-aided instruction. Instructors acknowledged that computer-aided instruction went a long way in addressing one of the main challenges in developmental classes, the fact that students come to class with different levels of knowledge and skills. As shown by research on placement, the most commonly used tests do a poor job in accurately placing students in the right class, with many students ending up either "over-placed" or "under-placed" (Scott-Clayton, 2012). This means that in the traditional format, instructors would have a hard time calibrating their lectures to keep the material relevant and challenging for the entire class. Computer-aided instruction squarely addressed this problem by allowing students to make progress at their own pace. As one instructor explained:

In contrast to the instructors, students did not fully comprehend the notion of mastery or the reasons why it was important for math learning.

> The main difference is that before in the traditional class I was struggling trying to find the balance between students with the good background and bad background. It was really difficult; there were several students that couldn't understand because they don't know the previous material and there are students who know everything and so both of the groups will not pay attention if I don't explain more. Right now all students are coming into class and they [get] challenged exactly the level they are.

Furthermore, instructors believed that computer-aided instruction encouraged a more active student role and greater student responsibility in the learning process. From instructors' point of view, computer-aided instructions put students "in the driver's seat," which helped them become more knowledgeable and better prepared for the next courses in the Math sequence. Moreover, computer-aided instruction helped students' become better learners in general; computer-aided instruction fostered in students new time management and organization skills and a greater sense of responsibility for their own learning, which were needed to succeed not only in Math but also in their whole college experience. As told by one instructor:

For most students, the amount of work expected in the redesigned class came as a surprise. Some found it hard to reconcile the time needed to work on their math class with other commitments, including other course-work, job responsibilities, and family life.

> In our classes in the developmental area, a lot of times these students are taking developmental English too and maybe even developmental reading so their peer group is sort of all developmental students which look like grade thirteen, high school or an extension. This course is like a rude awakening because in the past we had trouble making them aware that this is college and you have a lot of responsibility for your own learning so this is like a hammer on the head, this is it, it's like dropping them right in the middle of it and saying you've got to assume responsibility from this point on.

Even when they recognized the opportunities for student growth opened up by the redesign, instructors had difficulty coming to terms with their new monitoring and supporting roles. Instructors' main responsibilities in modular classes included first, monitoring each student's work with the aid of the software to determine how much progress the student was making and whether the student was ready to take the module test. As part of this monitoring work, instructors had to take attendance, review students' notes, homework, and correction sheets, and print students' permission slips to take or retake the module test. Second, instructors were charged with walking around the class, with the help of the tutor, to answer questions and assist students who were struggling with the course material.

Although the model called for instructors to provide students with one-on-one assistance in class, in practice, instructors had limited time for this type of individualized interaction. Instead, instructors found that they were spending much of their time monitoring attendance, tracking student progress, and collecting students' notes, homework, and correction sheets. The high volume of administrative work left little time to connect with students. In fact, some instructors noticed that it now took them longer to learn students' names. Their new administrative duties challenged instructors' professional identity and left some longing for greater involvement in the learning process. Take, for example, the comments by one instructor:

> I'd rather have a secretary do some of the work…I really felt that I was a secretary most of the time keeping track of everything. I would rather have more time to work with the students.

Much like the faculty, students felt ambivalent about computer-aided instruction. Students did see some advantages in receiving instruction from computer software rather than from an instructor.

In addition, instructors' comments highlighted what they considered shortcomings in computer-aided instruction. Instructors suggested that computer-instruction by itself may not provide students with all the learning opportunities they need to become proficient in Math. Instructors expressed interest in complementing the software with critical thinking activities, group work, and real world applications of Math concepts. In addition, instructors echoed students' complaints that the software took knowledge for granted and skipped steps when demonstrating how to arrive to a particular solution. As one instructor detailed:

> Because the computer will skip certain methods in between, assuming that you understand it… The professor would tell you the reason why you go from this step to this step what happened from here to here, but the computer will move from here to here, will not really explain what happened in between there. Some of the students get stuck there, and ask their peer why they leap from here to here, they don't know what happened.

Students' Views and Experiences with Mastery and Related Practical Requirements

In contrast to the instructors, students did not fully comprehend the notion of mastery or the reasons why it was important for math learning. Students noticed that the redesigned class was much more challenging and time consuming than the traditional class, but they did not seem to see clear benefits in the higher standards set by the redesign. In fact, the difficulty level of the tests at the end of each module was a frequent source of complaints. Some students explicitly stated that they preferred the traditional class because it was possible to get a good grade without doing well in the final exam, as long as the student completed all the homework. As a student who preferred the traditional format pointed out:

> Because even if you did all the work on the computer, at the end if you didn't pass the final at least you had a good grade that would help you carry through onto the next.

For a small number of students, computer-aided instruction brought additional, unexpected benefits: the realization that they did not need to rely on a teacher to learn math.

Students also voiced strong objections to the course requirements set by the redesign to help them achieve mastery, such as attending class, submitting course notes, and reviewing test problems before retesting. For some, these requirements stood in the way of making progress and completing the modules in the expected timeframe. Many students felt particularly upset about the requirement of submitting correction sheets before retesting. Students had to figure out by themselves why they had gotten a wrong answer on the test and then use the correction sheets to show how to arrive at the right solution. After that, the instructor had to review the correction sheets and give students a permission slip to take the test again. From students' point of view, the whole process amounted to an obstacle course of tedious exercise and unnecessary delays:

> Personally I did some test last week, and I failed it, I had to stay home one week just to get another attempted. That's my own time! Because I need to do (the) correction sheet, do notebook check, it's too much. And then the teacher comes up to you and checks to see if you understand what you are doing and if you don't understand then she gives you more work to do.

Requirements such as submitting class notes and completing correction sheets added to the regular homework associated with each module. For most students, the amount of work expected in the redesigned class came as a surprise. Some found it hard to reconcile the time needed to work on their math class with other commitments, including other coursework, job responsibilities, and family life. Students varied in their accounts of how much time they spent working on math outside of class, but they generally agreed in describing the workload for the class as heavy and, in some cases, overwhelming. See, for example, the advice offered by a student to anyone planning to take the same class in the future:

> Don't have no job, don't have no other classes, don't have no food to cook, nothing. And make sure you have a laptop, some wireless internet and a little refrigerator in your room and that's about it, other than that, nothing, nothing.

It is important to note that some students found strategies to make the workload for the redesigned class more manageable without feeling that every other sphere of their lives had to be compromised. These students acknowledged that the redesigned class was more demanding compared to other classes and left no room for "procrastinating" or "fooling around." However, they learned that they could fulfill the class requirements and make progress with the modules by strategically using available college resources and carefully planning their time. These students had a different type of advice for anyone taking the class in the future. Rather than "removing everything else from your life," they recommended getting additional help when needed by using the tutoring center and even dropping by other sections of the same class. Furthermore, their advice for other students included planning how much work to do each week in order to finish all the modules on time, by the end of the semester. In the words of another student:

Instructors found in the redesign a remedy to the challenge of tailoring instruction to students with different levels of math knowledge and skills, while students welcomed the opportunity to exercise greater control on the pace of content delivery.

> Try to get to through the modules as fast as you can. Try and set a schedule like: this week I will try to get through this whole module, and this week, and next week. If you spend too much time on them, then at the end of the semester you find yourself rushing.

Students' Views and Experiences with Computer-aided Instruction

Much like the faculty, students felt ambivalent about computer-aided instruction. Students did see some advantages in receiving instruction from computer software rather than from an instructor. Mainly, they valued the opportunity to learn at their own pace. Students could control how fast or how slow content was delivered within each module and they could stop at any time to ask for help. For some, this was a welcomed change, as they did not need to worry about getting lost while the teacher kept moving ahead. Furthermore, even if passing the course required completing a certain number of modules, students who did not reach that goal could continue the following semester wherever they had left. As a student pointed out, this contributed to reducing stress:

Unlike instructors, students perceived the course practical requirements as hurdles that stood in the way of completing the modules on time.

> I kind of understand the modular thing; I'm not going to lie, in some ways I like that. I don't think I am going to get to eight [modules], I don't see it in my future before the end of the semester. I feel a little bit better knowing that I won't fail it completely and that I could pick up at six or seven, wherever I end up, next semester.

For a small number of students, computer-aided instruction brought additional, unexpected benefits: the realization that they did not need to rely on a teacher to learn math. As a student explained, teaching oneself math did not come about without struggle or even frustration (see Silva & White, 2013). But the result was a strong sense of empowerment:

> I feel like I'm a genius. Sometimes you get the answer wrong and maybe frustrating but I think for you to teach yourself math is a big step in our life. Instead of letting the teacher teach you it's like you don't even have to be a teacher, you be your own teacher and computer, say, it's assistance.

More frequently, though, most students felt discomfort with computer-aided instruction. Many missed having a teacher demonstrate how to solve problems on the board and being directly observed by the teacher when working on a problem. While some called for a complete return to the traditional model, others were more open to the possibility of maintaining computer-aided instruction, but with stronger instructor involvement. These students expected more opportunities for interaction with the instructor as well as greater instructor involvement in explaining the material and checking students' level of understanding of the material presented. In the words of a student who reported having enjoyed a redesigned class the previous semester:

> When I was in 0031 I passed with an "A," like flying colors, zoom, gone, done, but the thing was I had a professor that made sure we understood things. He

> had us work it out in front of him, to check it and see if it was right...If we needed something or whatever, he would go over the modules before we took the diagnostic test, and I'm just not seeing that anywhere.

Stronger instructor involvement in introducing the material and in checking students' level of understanding could also help overcome what students perceived as a deficit in the software. As instructors had noted, students pointed out that the software often made inaccurate assumptions about students' preexisting knowledge and did not go through all the necessary steps to arrive at a solution. For example, a student observed:

> Sometimes I feel like when you go through the tutorials, it teach you and everything but sometimes I felt like it's not helping me a little bit because sometimes it skips steps and I wonder what did I miss, so I have to go back over it again.

Discussion and Recommendations

The qualitative analysis helps to illuminate these findings by revealing some of the challenges that students faced in modular classes, namely, problems following the explanations presented by the software and difficulties developing time management strategies to handle the course workload and finish the modules on time.

By incorporating the study of faculty and students' views and experiences in the assessment of math redesign, the assessment showed expected and unexpected consequences of this approach. The two groups identified advantages in the redesign, which largely fitted into the benefits expected by reformers. Instructors found in the redesign a remedy to the challenge of tailoring instruction to students with different levels of math knowledge and skills, while students welcomed the opportunity to exercise greater control on the pace of content delivery. At the same time, the assessment showed unintended—and one could argue, less desirable—features and consequences of the redesign. These included difficulties encountered by instructors to connect with students, and even to learn students' names, and gaps noted by instructors and students in the explanations delivered via instructional software.

Although there was significant common ground between instructors and students' perceptions, their views also differed in important ways. Instructors embraced the notion of raising the bar and believed that requirements such as submitting course notes and completing correction sheets helped students retain knowledge and become successful learners. By contrast, students did not quite grasp the rationale for the redesign's emphasis on mastery and the resulting high standards for module tests. Furthermore, unlike instructors, students perceived the course practical requirements as hurdles that stood in the way of completing the modules on time.

Another way to look at these findings is to consider how they complement the preliminary results from the quantitative analysis of student performance. As the quantitative analysis had shown, at the outset, students in modular classes seemed to perform comparatively worse than students in traditional classes. The qualitative analysis helps to illuminate these findings by revealing some of the challenges that students faced in modular classes, namely, problems following the explanations presented by the software and difficulties developing time management strategies to handle the course workload and finish the modules on time. Furthermore, the analysis of student outcomes in the following semester suggested the possibility that the modular approach would help students retain math knowledge. Support for this notion is found in instructors' insights on how course practical requirements such as submitting course notes and correction sheets leave students with no choice but to pay attention and review their work.

Heeding to faculty and students' views would require a set of adjustments. The low hanging fruit lies in addressing the gap between instructors and students' perceptions of the notion of mastery and related practical requirements. Following North Carolina's example (NC Community Colleges Creating Success, 2012), institutions need to adopt a clear, consistent, and accurate communication campaign to let students know how redesigned courses work and why students are expected to achieve mastery in each module. Such communication campaign needs to be continued in class, through conversations with the instructor about the purpose of course requirements such as attendance, course notes, and correction sheets.

But merely informing students about the redesigned class may not suffice to create and sustain student engagement. The analysis of students and instructors' experiences suggests a persistent desire for closer interaction and more direct involvement by the instructor in the learning process. Even when most of the content delivery may be left to the software, instructors could still play a role in creating engaging learning opportunities that are not provided by the software. Instructors could set time aside each week for opportunities to apply math concepts in the real world, explanations that connect the dots across the modules, group-based work, and activities or assignments for students to demonstrate how they think about math and whether or not they understand the material[3]. This would not only contribute to covering what instructors and students perceive as deficits in the software, but also help instructors and students ease into their new roles, and even reshape those roles for an enhanced, more engaging, and more effective teaching and learning experience.

Increasingly, some of the features of course redesign discussed in this paper, such as computer-based instruction and self-paced learning, are spreading beyond developmental education. Both two-year and four-year institutions are adopting computer-based instruction and self-pace learning for their college-level introductory, high-enrollment courses. As pointed out by previous studies, successful implementation of these innovations requires much more than selecting the right software package and equipping the classrooms. Successful adoption calls for new ways to prepare instructors and actively guide, support, and motivate students (Education Advisory Board, 2013). The present study suggests that these tasks, which are essential to make the redesign work, need to be informed by local, institution-specific knowledge, which can only be gathered in situ through qualitative techniques such as focus groups with faculty and students.

The analysis of students and instructors' experiences suggests a persistent desire for closer interaction and more direct involvement by the instructor in the learning process.

While the results of this study offer valuable lessons on how to refine and improve modular math redesign, further research is needed. Future research should compare the views of students placed into different levels of developmental math and the perceptions of students belonging to different age groups. In addition, additional research should examine similarities and differences in how students experience redesigned math classes, depending on how many courses they have completed in the modular format.

[3] Personal conversation with Susan Bickerstaff, CCRC; see also Bickerstaff & Lachniet (2014). Introducing these kinds of activities may require pairing down the homework required for each model, a recommendation put forward by Fay & Cormier (2014).

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