BLENDED INSTRUCTION USING CULTURALLY RELEVANT PRACTICES FOR UNDERREPRESENTED MINORITIES IN COLLEGE ALGEBRA CLASSROOMS

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Abstract

Significant research in K-12 education has shown that computer based learning (CBL) in mathematics positively impacts students' attitudes towards mathematics and greatly increases academic performance. However, little research has shown how CBL can have similar results in a postsecondary classroom for minority students. Furthermore, in an increasingly diverse nation, it is imperative for colleges and universities to adopt culturally relevant pedagogy to enhance CBL. This paper describes a blended instruction model using culturally relevant practices in a College Algebra class compared to a College Algebra class without such practices. Results show that students in the culturally relevant class demonstrated a better understanding of fundamental mathematics concepts, a greater appreciation of mathematics applications, and continued improvement in subsequent mathematics courses.

Keywords: mathematics software, multicultural education, computer based learning, killer courses, learning community, support services

Blended Instruction Using Culturally Relevant Practices for Underrepresented Minorities in College Algebra Classrooms

For teachers, technology—calculators, computers, software-- has long served as a useful tool in mathematics classrooms. In particular, computer based learning (CBL) has had a significant impact on the academic performance of at-risk and minority students (Schofield, 1994; Nguyen et al. 1995). Recognizing this, the Department of Mathematics and Computer Science at Central State University (CSU), adopted a blended instruction (BI) pedagogy by integrating Educosoft mathematics software into traditional lectures for College Algebra. The BI courses consisted of online lectures, homework, quizzes, and exams, and academic support in the form of online tutors or departmental tutors. After two years of implementing the software, CSU's results of a 10-12% increase in student success (grade "C" or higher) were comparable to studies conducted at the University of Idaho and Rio Salado College that targeted minority students, respectively, in Algebra and Pre-Calculus (Twigg, 2004). Seeking even better results, however, CSU sought to redesign its BI course to better serve its student base by incorporating into the course culturally relevant pedagogical practices, including a "caring" teacher, learning communities that create an interdependent "family environment," class/peer tutors, interdisciplinary group projects, positive feedback, cooperative learning, professional development sessions, and other supportive technology.

CSU, a Historically Black College and University (HBCU), is an open access institution in Wilberforce, Ohio, that seeks to prepare diverse students for a professional career and/or graduate study in any field (census.gov, 2008). At the time of this study, CSU had a population of approximately 2,500. 95% of the student body was African

American and more than 59% of the student population lived below the poverty level (census.gov, 2008). 12% of the student population majored in a STEM (Science, Technology, Engineering, and Mathematics) field, and, like similar populations nationally, the STEM population has struggled with gateway ‘killer courses’ like College Algebra, English, Biology, and Chemistry (Killer courses are defined as those courses that have a high failure, withdraw, and/or incomplete rate.). For remedial courses in mathematics (College Algebra and below), the success rate before 2007 was below 50%. In 2007, CSU’s Department of Mathematics and Computer Science received a Minority Science and Engineering Improvement Program (MSEIP) grant titled BISCA (Blended Instruction to Improve Student Success in College Algebra) to use Educosoft, a CBL system, in College Algebra classrooms. Since then, as indicated above, the success rate for College Algebra has risen by 10-12%. This success resulted in the use of CBL in other remedial courses, as well as in college level courses like Trigonometry and Calculus. However, for the past few years, the success rate in College Algebra has remained around 60%, indicating that computer software alone is not sufficient to produce significant success for minority students. Thus, to strengthen the BI approach, culturally relevant practices were incorporated into the College Algebra classroom to transition students from drill and practice to a better conceptual understanding of mathematical topics and concepts, resulting in a greater increase in students’ academic performance in College Algebra as well as in subsequent mathematics courses.

Literature Survey

The Census predicts that the United States (U.S.) will double its minority population by 2050. For the U.S. to remain a leading competitor in the world, a diversified STEM workforce is imperative. Consequently, the U.S. government has placed a strong emphasis on increasing the number of minority STEM graduates and professionals. Through considerable funding and changes to educational policies, the K-16 system has strengthened its recruitment, retention, and support of underrepresented minorities, particularly in STEM. In 2006, the National Science Foundation (NSF) reported that 21.5% of undergraduate freshmen majored in a STEM field. 20.5% were Caucasian and 20.9% were African American. Yet, in reviewing the graduation statistics of these two groups, only 8.3% of African Americans earned a STEM Bachelor’s degree compared to 64.7% of Caucasians. Thus, there is still work to be done to reach national goals. To address this discrepancy, educators and scientists have invested time and money to study certain social systems and learning environments that promise to enhance the educational experience for underrepresented minorities (Allen, 1992; Davis, 1991; Fleming, 1984). Ladson-Billings (1994) provided the clearest direction for educators calling for institutional use of culturally relevant practices in the classroom. The purpose of culturally relevant practices is to construct an environment where the minority student can reach his/her highest potential. HBCU’s are well known, of course, for providing nurturing and supportive campus environments for minority students. These environments increase students’ academic confidence and performance, and build social skills (Davis, 1991; Kozma, 1992). For hundreds of years, HBCU’s have successfully taken at-risk or underprepared students and, through their unique campus environments, have brought these students' skill levels to, or above, national norms.

What HBCU's are able to create outside of the classroom for students, like a sense of belonging, is difficult to duplicate in a classroom of a specific discipline where students' abilities and skills determine whether they belong in the class, or belong to the group of students pursuing that major. Moreover, in a large social system of colleges, schools, and departments, it remains difficult to maintain a culture of relevant practices that ensures a sense of belonging inside the classroom. The most profound techniques of doing so inside the classroom occur in K-12 classrooms. K-12 teachers interact with their students daily to form bonds that transcend on many levels, and despite societal influences or the school's campus environment, K-12 teachers have continued to develop strategies to overcome social and academic challenges for minority students. These strategies constitute culturally relevant practices:

> *Caring Teachers:* In Schofield's (1994) geometry study of student attitudes and perceptions of classroom support, over 70% of high school students preferred the assistance of their teacher to computer based tutors. Despite daily use, the computer based tutors served as a secondary resource for students in the classroom. Some of the benefits of the online tutors were: 1) students who were afraid or ashamed to ask for help in front of their classmates sought answers through the online tutors without anyone else's knowledge, 2) given online privacy, students felt more comfortable acknowledging their deficiencies and working independently to become more proficient, and 3) online intervention allowed students to control how much help they received from their teachers. As

a result, classroom behaviors towards mathematics were positive and more productive. The most striking finding of the study, however, was that even though the students enjoyed learning mathematics online and learned more online than they did through traditional lectures, the students still preferred to get help from their teacher than from the online tutor. Results from the study showed that the students preferred person to person contact, daily conversation (that did or did not include math), examples from the teacher relating concepts to their personal lives, and knowing that someone believed in them and was proud of their achievements; making the teacher the primary resource in the classroom. Howard's (2001) research**,** conducted at four urban elementary schools, demonstrated that African-American students prefer to learn in classrooms that have a family environment and are led by a caring teacher. Hill **(**1995) adds that both caring and authoritative environments are preferred by minority students. Lastly, Chapman (1986) explains that teachers, mentors, and advisors have the most influence on student success.

Change in Classroom Environment: A middle school study conducted by Allison and Rehm (2009) demonstrated that for minority students academic success can be achieved by solely changing the classroom environment, whereas previous studies had suggested a change in curriculum or special placement of students in another classroom was necessary to achieve these results. Through a comparison study, Allison and Rehm also showed that minority students were just as capable and successful as their Caucasian counterparts due to a change in the classroom environment. In a comparison study of seventh and eighth grade students in two different versions of a remedial math course: a computer based class or a strictly pencil and paper class, Nyugen et. al. (2005) found that computer based environments were the preferred social system and that students were more successful in these environments. In this study, the remedial course focused on basic operations involving real numbers, fractions, and decimals, and strengthened computational skills and mathematical procedures through word problems. No changes were made to the curriculum for either class. On the post-study test, students in the computer based class performed an average of 24% better than those students in the paper and pencil class. One interesting finding from the study showed that at least 65% of students in the computer based class when given the option to redo a homework assignment did so compared to approximately 10% in the paper and pencil class, and when given the option to redo a separate assignment on decimals and fractions up to three times, at least 69% of students in the computer based class retook the assignment three times to improve their homework scores or understand the concepts better, compared to none from the paper and pencil class. Similarly, in the geometry study, Schofield (1994) discovered new interests in homework and found that CBL sparked friendly competition among students to complete the online assignments and complete them with the highest score. Nativa (1988) found that students even worked ahead of the day’s lesson, learning new concepts and practicing new techniques through the online system. In each study, the specific environment was formed through a *learning community*. The community environment created a sense of belonging and led to the acknowledgment and pursuit of common goals in the classroom. Booker **(**2006) echoes what HBCU's had already learned for undergraduates--that one of the most significant factors for minority students' academic achievement was having a sense of belonging.

Positive Feedback: In a middle school study conducted by Ngyuen et. al, **(**2006), drill and practice on the computer coupled with instant feedback through scores and an online tutor increased student interest in mathematics. In fact, all of the students perceived that they were better problem solvers because of the online system. Minority students felt more confident, perceived they could do more challenging problems, and had less anxiety about exams when taken on the computer. In particular, minority males felt that immediate feedback developed their problem solving skills and encouraged them to evaluate their own progress more frequently.

Peer Mentors/Tutors: In Schofield's (1994) study, the friendly competition among students resulted in some students serving as "peer experts**."** Students began to tutor one another with the online system. This role allowed peer experts to demonstrate their knowledge by teaching their peers, multiplying the impact of everyone's learning. Peer experts also served as teaching assistants which allowed the teacher to spend more time creating bonds with other students, serving as a facilitator instead of a lecturer, and less time grading and preparing lessons.

The most dynamic study was a combination of several practices in the classroom. Grantham and Ford's (2003) high school study showed that positive feedback, frequent meetings with mentors and/or advisors, cooperative learning, professional development sessions, engaging activities, and high expectations were the leading strategies for academic achievement among gifted African-American students. Given this, CBL when combined with many culturally relevant practices created an environment which promoted academic success.

The department has taken key strategies from the above studies to create an atmosphere more conducive to learning for its students. Piloted in one computer based College Algebra classroom, the mathematics and computer science department has developed a comprehensive model to ensure student success.

Methods

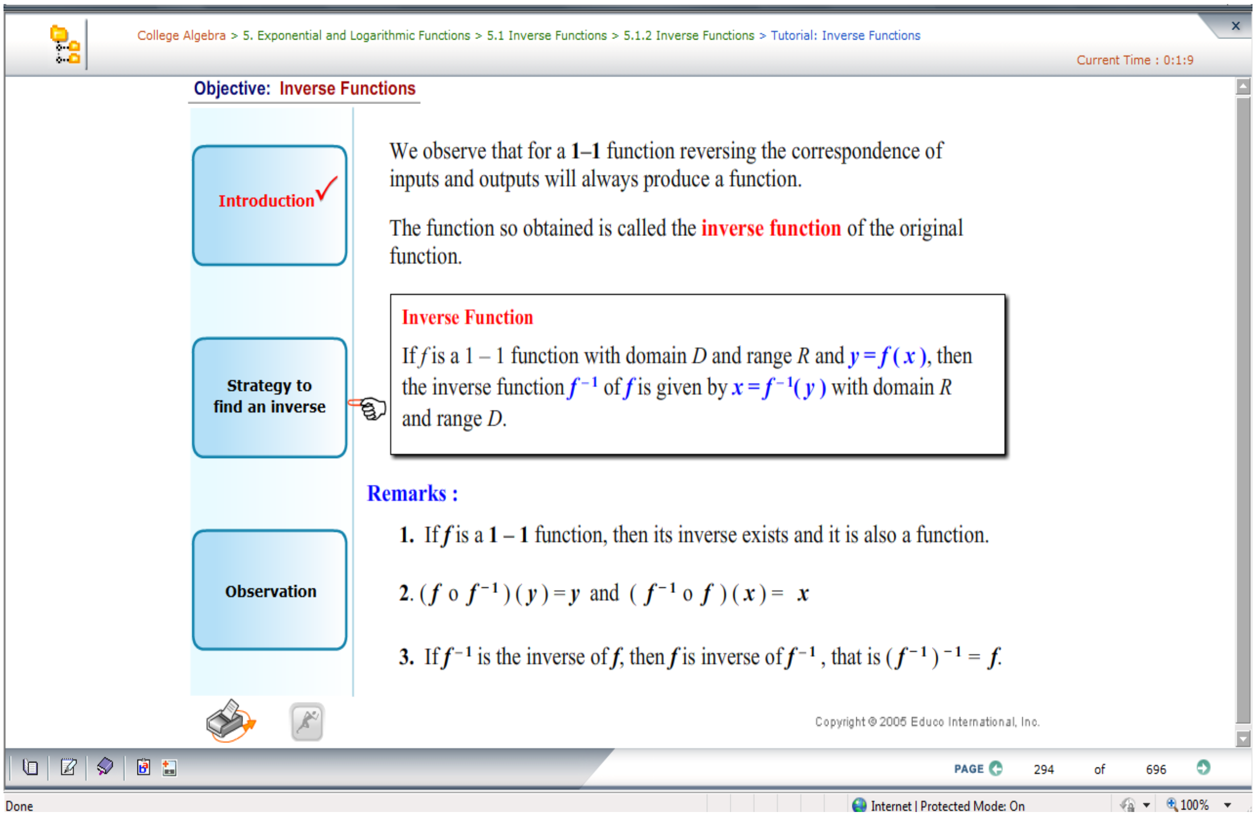
At CSU, the piloted model took place in one College Algebra classroom in the fall semester of 2008. In a comparison study, two College Algebra classes were taught using BI by the same mathematics professor. One class was offered Monday, Wednesday, and Friday (MWF) for 50 minutes, and the other class was offered Tuesdays and Thursdays (TR) for 75 minutes. The MWF class was open to all majors whereas the TR class was a learning community for the Just Undergraduate Mentoring Program (JUMP), a retention program for freshmen biology and chemistry majors. In the learning community, students took all of their gateway classes (Biology, English, Chemistry, and Algebra) together. Given the learning community component for the TR class, it became the pilot class. Culturally relevant practices (a caring teacher, learning community, class/peer tutors, interdisciplinary group projects, positive feedback, cooperative learning, professional development sessions, and other supportive technology) were incorporated into the classroom to create a more conducive environment for these majors. No culturally relevant practices**,** however**,** were implemented into the MWF class. The demographics were as follows: in the TR class, there were 12 students (2 males**,** 10 females), and all of them were African-American; in the MWF class, there were 21 students (10 males,11 females), and 95% were African-American.

BI Course Structure:

The College Algebra course, both the MWF and TR sections, covered five chapters: functions, logarithms, conic sections, matrices, and sequences. The BI course was taught with traditional and online lectures and student grades consisted of weekly online homework assignments, handwritten quizzes and exams, notebook checks, and attendance. Engaging activities such as group work, math games, and daily challenges, as well as peer teaching and grading were also used. Extra credit assignments were hand written and given often. For the TR class, student grades also consisted of three interdisciplinary group projects corresponding to the chapters on functions and logarithms. For the TR class, the online homework assignments served as drill and practice whereas the group projects tested students' conceptual understanding of the topics through real world problems.

One unique aspect of the BI course was mandatory tutoring. If a student received a “D” on any assessment (quiz or exam), then that student was required to meet with a tutor for a minimum of two hours until the next assessment (Assessments were biweekly and only covered two or three sections at a time.). If a student received an “F” on any assessment, then that student was required to meet with a tutor for a minimum of four hours until the next assessment. A tutor was assigned to each class and attended class lectures. On the days when assessments were passed back to students, the tutors made appointments with those students earning a “D” or “F.” Tutoring was done through the Educosoft system. Tutors would review online lectures and homework, and graded quizzes and exams (See Figure 1). Tutors were available to all students in the class whether through the class tutors, Educosoft proficient tutors offered through the department, or other tutoring services offered on campus. Students had to submit a form signed by the tutors that denoted the number of tutoring hours completed each week.

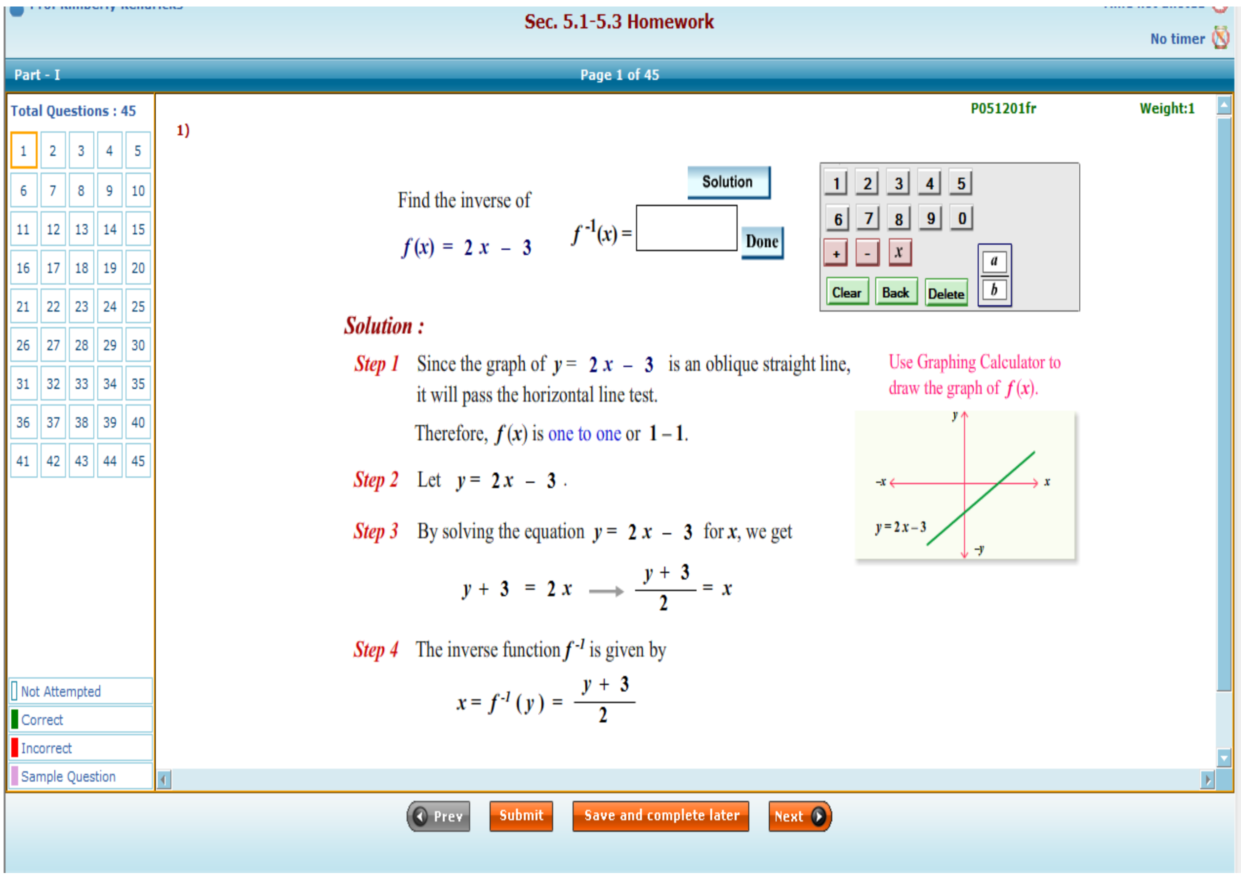
Figure 1: Example of Online Lecture Corresponding to the Homework Assignment Below.



The online homework was the second largest factor determining students' final grades. During the course of the semester, there were 7 online assignments. The weekly assignments consisted of 35-50 problems from two to three sections at a time. 80% of the problems were free response and 20% were multiple choice. Students were assigned 2-7 problems on a particular concept, and all homework problems were grouped by concept. Each conceptual set of problems was prefaced with an example from the problem set followed by a thorough explanation of how to solve the example.

Students could refer to this example or the online lectures for assistance. Immediate feedback (“Correct” or “Incorrect”) was given after students entered a solution into the system. Students could enter as many solutions as they liked for a problem until they earned a “correct” response. They could also monitor their progress in a vertical table that highlighted how many of the problems the student had gotten right, how many were wrong, and how many remained to complete (See Figure 2). In the first half of the semester, students could only take a homework assignment once, but during the second half of the semester, students could retake any assignment from the first half of the semester as often as they liked. This was done to remediate students on past concepts in preparation for the comprehensive final exam held at the end of the semester.

Figure 2: Example of an Online Homework Assignment



<u>Culturally Relevant Practices Adopted for the TR Class</u>

1) <u>Caring Teacher</u>- The teacher was a third year assistant professor of mathematics who had studied multicultural education, particularly pedagogy focusing on the African-American student, and used such practices in K-12 classrooms before teaching at the university level. Being a minority who initially struggled with math in middle school, the teacher could also relate to common challenges the students faced in the classroom.

2) Classroom Environment- The classroom environment was unique given that the students were in a learning community, were of the same race and socio-economic status, shared the same major (Biology or Chemistry), and the same goals for the class and their program of study.
3) Class Tutors/ Peer Tutors- The classroom tutor served as an undergraduate teaching assistant (UTA). The UTA designed classroom games, mini-projects, exam review packets, and graded students' in-class assignments. What was most unique about the UTA was that the UTA was a Biology major who had taken the College Algebra course using the online material and had performed very well.
4) Interdisciplinary Group Projects- Three interdisciplinary group projects demonstrating the use of mathematics in biology were used. The first project looked at graphing data, interpreting the graph, identifying where the graph increases and decreases, finding the maximum and minimum points, as well as the x-intercepts. Students could choose a variety of datasets from the harvest and sale of carrots to the number of HIV/ AIDS infections or related deaths. For the second project, students plotted scatter plots of given datasets and found the line best fit using linear regression. Students plotted cricket noise compared to temperature, planetary motion and distances to the earth, and genealogical data collected from the Genetics class. In the last project, students conducted an in-depth study on white blood cells and the effect HIV/ AIDS has on them. The students solved logarithmic and exponential word problems projecting the white blood count and life expectancy of particular human subjects.

5) Positive Feedback- Positive feedback was used in every form-through comments written on quizzes and exams, praises in and out of class from the teacher, UTA, and students, and through the online system.
6) Cooperative Learning- Students completed their online work individually or in pairs. Some homework and project grades were interdependent. That is, these grades were the average score of the pair or group working on the assignment.
7) Professional Development Sessions- All students were required to attend professional development workshops offered through the sciences department or the Center for Student Opportunities, an academic support program.
8) Other supporting technology- Each student was given a TI-89 calculator.

Results

At the end of the semester, 75% of the TR class passed College Algebra with a grade of “C” or higher, while only 62% of the MWF class passed with a grade C” or higher. There were three results of this new environment which led to this difference: one, the students in the TR class out performed students in the MWF class on the online homework, and when given the opportunity, retook more assignments to improve their scores; two, overall, the TR class performed better on written exams and quizzes; and three, TR students completing mandatory tutoring hours were more successful on subsequent assessments compared to the MWF students.

Online Homework:

Table 1 shows the number of online assignments and how many students in each class completed the assignment and retook the assignment when given the opportunity (Due to the number of activities in the TR class, only 7 online assignments were given to both classes. Seven handwritten assignments were also given.)**.** For the MWF class, only 29% of the students completed the first assignment. This was partly because the first assignment was due during the second week of school and most students had not bought the textbook or an online code to access the online material. Because the TR class was a learning community, their textbooks were provided before the semester began. Students in the MWF class were given a guest pass for two weeks to complete the assignment. By the second assignment, over 80% of the MWF class had bought a textbook or an online code, or used a guest pass to complete the assignments. Despite this, there were still more students in the TR class who completed the online assignments.

Table 1: Online Homework Completion & Retakes Out of 7 Assignments

Class	**# of students**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
MWF	**21**	6 (29%)	17 (81%)	14 (67%)	12 (57%)	14 (67%)	10 (48%)	11 (52%)
# who retook the assignment		7	7	2	5	6	6	6
TR	**12**	9 (75%)	12 (100%)	6 (50%)	11 92%)	12 (100%)	7 (58%)	6 (50%)
# who retook the assignment		3	2	1	1	1	2	2

The percentage of students in the TR class completing the online assignments decreased towards the end of the semester, whereas the percentage of students completing assignments in the MWF class remained fairly consistent. There were no additional activities assigned to the TR class towards the end of the semester. Both classes spent this time reviewing for the final exam, so the reason for this decrease in the TR class requires further study.

Table 2 shows the percentage of online problems that were correct for the seven homework assignments. Overall, the TR class scored higher on the online assignments than the MWF class. In fact, the TR class scored an 80% or higher on four out of the seven assignments, whereas the MWF class scored an 80% or higher on three out of the seven assignments. Very few students in the TR class retook an assignment, so the percentage of correct problems on retakes was not considered in this discussion. (Also, since there were only 2 students who retook the third assignment for MWF class, the percentage of correct problems was not considered.) However, for the MWF class, the percentage of correct problems increased when students completed the assignment twice (No problems from the first assignment were repeated if the student retook the assignment. Students encountered new problems on the same topics.). Although, there were only 5-7 students who retook six assignments, these students earned an 80% or higher on five out of the seven online assignments, demonstrating that continued practice on the computer increases student performance.

Table 2: Average Percent Correct of Online Homework Problems by Content (Values in parentheses denote the percentage correct of retaken assignments.)

Assignment	Content	MWF Class	TR Class
1	**Graphical Representation of a Functio Distance, Slope, Composite Functions**	73% (81%)	88% (92%)
2	**Inverse Functions, Exponential Functions, and Logarithmic Functions**	81% (86%)	82% (95%)
3	**Properties of Logarithms, exponential and logarithmic equations**	55% (40%)	63% (76.92%)
4	**Circles, Parabolas, and Ellipses**	59% (66.25%)	52% (100%)
5	**Systems of linear Equations and Systems of Non-linear Equations**	76% (88%)	68% (96.77%)
6	**Gauss-Jordan Method and Matrix Algebra**	92% (88%)	89% (98%)
7	**Multiplication of Matrices and Inverses of Matrices**	86% (88%)	93% (98%)

Classroom Assessments:

To enhance conceptual understanding, both classes were given four exams corresponding to homework assignments 2 *(exam 1)*, 4 *(exam 2)*, 5 *(exam 3)*, and 6 and 7 *(exam 4)* and two quizzes corresponding to homework assignments 1 and 3. On the first exam, the average score for the TR class was 80% ($\sigma = 8.04$) while the average for the MWF class was 73% (σ= 26.43). Similarly, for the fourth exam, the average score for the TR class was 75% (σ= 26.84) while the average for the MWF class was 70% (σ=32.17). Both classes scored below a 60% on the second and third exams which can be explained by the lower homework scores on these sections (see assignments 4 and 5). The MWF class did score 5-10% higher than the TR class on these exams which is consistent with the above homework data. On the two quizzes, the TR class averaged a 77.5% (σ=14.21) while the MWF class averaged a 66.5% (σ=19.18).

The handwritten homework assignments were not used to gather information about student performance. Two of the handwritten assignments were assigned problems from the textbook. The other handwritten assignments were review packets designed by the class tutors. Since these assignments were not consistent for each class, their results were not considered in this paper.

For the comprehensive final exam, both classes averaged 70%. The only difference was in the standard deviation: σ=13.07 for TR, and σ=27.59 for MWF.

Mandatory Tutoring

Over the course of the semester, the students in the MWF class received over twice as many mandatory tutoring assignments than the TR class. Of those assignments, only 44% of the MWF class completed their tutoring hours while 63% of the TR class completed theirs. As a result, students in the MWF class did not show as much improvement on subsequent assessments, and due to this, spent 27% more time on the online system than the TR class. The tutoring hours resulted in a 57% increase in students' grades on subsequent assessments for the MWF class, and a 67%

increase for the TR class. Thus, the mandatory tutoring significantly increased student performance.

Table 3: End of the Course Comparison of Completed Mandatory Tutoring Hours and Percent Increase for Six Course Assessments

Class	# of Students in the Class	# of Tutoring Assignments	# of Tutoring Hours Assigned	# of Tutoring Hours Completed	% of students who increased their scores on subsequent assessments
MWF	**21**	63	372	164	57%
TR	**12**	27	94	59	67%

In looking at particular student cases, it can be shown that those students who were the most persistent with completing their hours demonstrated continued success throughout the course.

Discussion

The learning community that characterized the TR class was the leading factor contributing to students' success and it provided the platform for the success of all of the culturally relevant practices. The *community* aspect of the class brought a sense of belonging by discipline which was missing from other courses. Without being asked, the students formed study groups to prepare for upcoming exams as well as to complete homework assignments. In fact, this was a strategy the students used in all of their courses. So, when students were asked to complete online assignments in pairs or to work as a group on the interdisciplinary projects, the students were already comfortable doing so. Actually, the students preferred working together. For class lectures, students asked to work with a classmate or to be placed in groups to do review exercises of the day's lesson or complete an exam review packet. Furthermore, making the grades of some of the homework assignments and the group projects interdependent reinforced the spirit of working together and resulted in the students completing more of the online homework assignments than the MWF students. This was inspired by (Williams et. al, 2002) who found similar success in a computer science class based on pair programming. Even when assigned mandatory tutoring hours, students in the TR class completed their hours in pairs or groups and the UTA even held exam review sessions for them. This explains why a greater percent of tutoring hours in the TR class were completed than the MWF class.

The TR class attended at least 4 professional development workshops that focused on writing a resume and statement of purpose, communication skills, dressing for success, as well as career options in the STEM fields. Attending these workshops kept the students' career goals at the forefront of their studies. The interdisciplinary projects reinforced this. Students enjoyed seeing knowledge learned in class lectures have a useful purpose in everyday life. Students used Microsoft Excel to graph functions and interpret them and their calculator as well as Microsoft Excel to plot a scatter plot and a line best fit. Through follow up word problems, students drew conclusions about their graphs and made predictions. In fact, the students liked using their solutions to make recommendations about problems experienced by everyday businesses and workers. Through internet research, one group hypothesized that low carrot sales in Ohio were due to the freezing climate which lasted longer than other harvest years. Another group found that AIDS infections decreased for young adults in some locales due to abstinence initiatives and the distribution of condoms at workshops, high schools, and colleges. The most interesting response was to the third project which studied white blood cells and the impact HIV/ AIDS had on them. The majority of students were Biology majors interested in pursuing a career in nursing or medicine. Each of the students knew of someone who was affected by HIV/AIDS, so the students took a particular interest in the project. The students learned about the different types of white blood cells, were able to classify a white blood cell count as normal or abnormal, and apply this knowledge to solve exponential and logarithmic equations and/or word problems. These projects, particularly the last project, increased student interest in Biology and illustrated a greater appreciation of mathematics and its uses in the real world. An added benefit of the learning community was their access to course resources. All of the TR students received a graphing calculator as well as their textbooks and any other course material at the beginning of the semester, so they had an advantage over the MWF class when the course began.

A second factor leading to TR's success was the class size. The TR class was almost half the size of the MWF class. The small group size allowed for more student-teacher interaction and more peer-to-peer interaction with very few interruptions. On the end- of- semester course evaluations, TR students said that they would have liked to have met for less time three days a week. They believed that they would have been just as successful meeting more frequently for a shorter period of time. Over the course of the semester, each class met for the same amount of time. Ironically, students in the MWF class said during the course that they would have liked to have been in a class that met longer than 50 minutes. Even though the class met three days a week, students in the MWF class shared that they were not able to discuss the lesson thoroughly enough during class time, and even when invited to the professor's office hours, students preferred to discuss their concerns during class. MWF students claimed that there wasn't enough class time devoted to class practice and discussion. Given this, adjustments were made by the professor to spend more time discussing concepts and less time lecturing. It was difficult to isolate the reasoning for the students' recommendations. In the future, a follow-up study can be done to compare two College Algebra classes using the BI model that meet on the same days and have roughly the same number of students in each class. A questionnaire can also be developed to evaluate student perceptions about the structure of the course.

Overall, the TR environment was dynamic and engaging. Kozma (1992) asserts that it is in these environments where computers are best used. The BI model also allowed for traditional and online lectures to be used more appropriately given the topics being taught. Even though the TR class called for both the student and teacher to assume new roles in the classroom (O'Callaghan, 1998), the role of the in-class tutors (UTA) should not be overlooked either. The UTA was for some students their first contact and helped to retain them in the course (Tait, 2004). In fact, TR's UTA spent more time in the class than MWF's tutor. All of these components, when working together, illustrated a greater conceptual understanding by students and led to an increase in student successOver 75% of the students in the TR class, for example, were retained in their discipline and 80% of them earned a "C" or higher in subsequent mathematics courses, whereas 90% of students in the MWF class were retained in their major, however, only 42% earned a "C" or higher in a subsequent mathematics course, further indicating that students in the TR class had a better conceptual understanding that benefitted continued study in mathematics. The success of this study has led to the use of culturally relevant practices in other mathematics courses in the department and the dissemination of their impact across campus.

Conclusion

This study illustrated that the traditional drill and practice of computer based classrooms are not sufficient for conceptual understanding and continued academic improvement for underprepared minority students in undergraduate mathematics classrooms. Additional support—such as tutors and mandatory tutoring—is necessary to integrate into computer classrooms to increase student understanding. Yet, even with this additional support, there was still a need to change the environment of the classroom to ensure the success of at-risk and minority student. Thus, the most important and efficient strategy for student success for this study was forming a classroom environment, like a learning community, that utilized culturally relevant practices. The structure of the BI model with the learning community was more conducive for minority students and was 15% more successful than the BI course without the learning community. By utilizing culturally relevant practices, students demonstrated a broader understanding of mathematics concepts, shared a greater appreciation of mathematics, and showed continued improvement in subsequent mathematics courses. This paper, then, serves as a model for universities and colleges alike that are interested in increasing the academic performance of minority students through CBL and a unique, culturally relevant learning environment.

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