

EFFECTS OF REQUIRING STUDENTS TO MEET HIGH EXPECTATION LEVELS
WITHIN AN ON-LINE HOMEWORK ENVIRONMENT

by

WILLIAM J WEBER, JR.

B.A., Fort Hays State University, 1997
M.A., Fort Hays State University, 2001

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Curriculum and Instruction
College of Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2010

Abstract

On-line homework is becoming a larger part of mathematics classrooms each year. Thus, ways to maximize the effectiveness of on-line homework for both students and teachers must be investigated. This study sought to provide one possible answer to this aim, by requiring students to achieve at least 50% for any on-line homework assignment in order to receive credit. Research shows that students respond well to reasonably set high expectations, and coupling this with one of the primary advantages of on-line homework, the ability to rework assignments, provided the basis for this study. Data for this experimental study was collected from the spring semester of 2008 until the fall semester of 2009, and included student exam scores, the number of on-line assignments above and below the 50% threshold, and the number of times students accessed help features of the on-line homework system when given the ability to do so. Analysis at both the whole-class and cluster levels attempted to discern the effectiveness of the intervention. Results indicated that significantly fewer students settled for on-line homework scores less than 50% in the experimental semesters where the 50% requirement was in place than in the control semesters in which the requirement was absent. Certain clusters of students seemed to benefit even more than others from this higher expectation, leading to the possibility of differentiated instruction or differentiated interventions in the future. In addition to fewer sub-par on-line homework scores, students also demonstrated other positive traits, such as accessing the on-line help links more within the experimental semesters.

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Dedication

I dedicate this dissertation to the most important people in my life; my wife, Tiffany, and my children Morgan and Sheldon for all the love and support you have shown me throughout this process. I also dedicate this dissertation to my parents, Bill and Elaine, who instilled in me at a very young age the value of education. I love you all.

CHAPTER 1 - Introduction

On-line homework in mathematics courses is more common today than it has ever been, as evidenced by the growing number of textbook publishers who now have some type of on-line homework system attached to their textbooks. On-line homework provides math teachers with options not available in traditional pencil-paper homework, such as immediate grading and feedback, more practice (quantity and frequency), and it can eliminate the easiest form of cheating by offering randomized variables and coefficients with exercise sets (Bonham, 2001). These characteristics, often viewed as positive ones, make the idea of implementing on-line homework within a math classroom appealing to many teachers, and the researcher has observed a growing population of math teachers interested in on-line homework at various conferences and workshops.

If so many math teachers are interested in on-line homework, two important questions arise. First, does on-line homework help students to learn the mathematics, or in the least, does on-line homework not hinder student learning in mathematics? Studies conducted by Cheng (2004) and Bonham (2001) have suggested that the answer to the above question is positive for on-line homework advocates in that small, though not statistically significant, gains were shown by users of on-line homework. These studies certainly promote that on-line homework did not hinder student learning, and this aspect, coupled with the efficiencies provided by on-line homework, make on-line homework a reasonable option for math teachers. Since on-line homework appears to have a sound base for its implementation, then the second question of how on-line homework can be made as beneficial as possible to students and teachers becomes applicable. Significantly less research has been done in this area, and the primary purpose of this study was to determine whether requiring students to meet certain expectation levels in order to receive credit within an on-line homework environment might provide one answer to the second question. The secondary purpose of the study was to investigate how various clusters of students, as defined by Manspeaker (unpublished dissertation), responded to the expectation levels, in an effort to help determine which clusters of students are most positively affected by the types of expectations imposed within this study.

Direction of the Study

If math teachers are going to use on-line homework in place of pencil-paper homework, both at the secondary and post-secondary levels, ways to make the on-line homework as effective as possible with respect to student learning must be researched. One possible adaptation was to take advantage of the on-line homework system's ability to provide students with extra practice for exercises which are incorrect the first time. On-line mathematics homework systems usually create exercises by considering a structure, such as $Ax + B = C$, then randomly selecting values for A, B, and C, with the recognition that the answer will always be $x = (C-B)/A$. Thus, if a student was to incorrectly answer the exercise with $A = 2$, $B = 3$, and $C = 4$, the computer could quickly generate a "new" exercise (same structure, different coefficients) by assigning new values to A, B, and C, giving the student another opportunity to practice the skill being assessed. Critics may contend this type of practice leads to a "drill and kill" approach, however, the only exercises being "drilled" are the ones incorrectly answered by the student. The researcher likens multiple attempts at a task to many things in life, where the experience of failing the first time may provide new insight, leading to success in the future.

Since teachers have the ability to provide students with multiple attempts to correctly answer a question pertaining to a concept, teachers should have higher expectations than in a traditional homework setting, in which multiple attempts and immediate feedback are not feasible options, due to time constraints. Thus, the notion of requiring more from students in an on-line homework setting is a reasonable enhancement when compared to homework completed in a pencil-paper setting. For this study, the researcher required the participants to correctly answer at least 50% of the on-line homework questions in order to receive credit for the assignment. Any attempts on an assignment which were not at least 50% were deemed unacceptable, and upon receiving feedback from the on-line homework system, students were notified that they would not receive credit for the assignment, but that they had the opportunity to attempt the assignment again. Due to instructor preference in the spring semester of 2009, any scores less than 50% were actually not changed back to 0%. However, in the fall semester of 2009, these unsatisfactory scores were changed to 0%.

Another advantage of many on-line homework settings, including the system used in this study, was the ability for students to access help features before re-attempting an assignment. The help features of an on-line homework system act like a virtual tutor, and the primary

advantage is 24-7 availability. The feature available to students in this study was the ability to see any incorrectly answered question's solution correctly worked. Having this help feature available allowed a student the chance to recognize his/her mistake immediately, as opposed to waiting for an appointment with an instructor or tutor. As a result, after submitting an on-line homework assignment, any student could view correctly worked solutions to any incorrectly answered questions, then could attempt the assignment again, until a satisfactory score was achieved.

To summarize, the participants in the study attempted an on-line homework assignment. Any score of at least 50% was recorded within the grade book as a score corresponding to the percentage of points earned for that particular on-line homework assignment. Any score of less than 50% was recorded within the grade book as above, but a message appeared to the student saying they will receive no credit for that particular assignment. During the spring 2009 semester, the score was not changed, but in the fall 2009 semester, the score was changed to 0%. In either case, the student was given the opportunity to complete another on-line homework assignment that was similar in structure, but with different variables and/or coefficients, in an attempt to improve his/her score. Only the highest score for any one particular assignment was recorded, as long as the work was completed by the due date given by the instructor of the course.

Data Analysis

The primary data analysis within this study was centered on the quantitative effect of the higher expectations on student performance. From comparable semesters, the researcher compared the total number of on-line homework final scores less than 50%, number of help "hits", as well as average grades on unit exams and final exams. In addition to considering entire course statistics, the researcher also considered how clusters of students compared from semester to semester; using the same performance measures as above. Data from the spring and fall semesters of 2008 was used as the controls to compare to the data from the spring and fall semesters of 2009, which comprised the experimental groups. Data from the spring semester of 2009 was only compared against data from the spring semester of 2008 (likewise the fall semester of 2009 was only compared to the fall of 2008) since course instructors anecdotally noted differences between the spring and fall semesters.

Problem Statement

With the vast amount of technology now available to both students and teachers, a fundamental question arises: does the technology help students learn? It is certainly more efficient to give a mathematics assignment on-line, but efficiency should not be the primary goal of education. Therefore, this study was designed to investigate whether requiring students to achieve a certain proficiency level in order to receive credit when completing on-line homework in a college mathematics course had an impact on overall performance within the course, especially on the final exam. The second portion of this study investigated the effect of the higher expectations on various clusters of students, in an attempt to determine which type(s) of students this intervention most positively impacted. The results from this study may be used to help shape decisions concerning on-line homework in future semesters, and may also lead to new questions of how to best utilize on-line homework for all students, regardless to which cluster they belong.

Research Questions

The primary research question for this study was “Does a change in expectation, such as requiring a certain proficiency level in order to receive credit for an on-line homework assignment, affect overall student performance within the course?” The secondary question was “Which clusters of students did the change in expectations help most, and for which clusters of students did the change in expectations appear insignificant, or a deterrent?” To answer these overarching questions, the following specific questions were posed:

1. Did the fact that students needed to score at least 50% to receive credit affect the total number of scores less than 50%?
2. Did the fact that students needed to score at least 50% to receive credit affect the number of times students accessed help features within the on-line homework system?
3. Did the fact that students needed to score at least 50% to receive credit impact exam scores, especially the final exam?

Analysis of these specific questions, at both the whole-class level and the cluster level, helped to form a picture of what the answer may be to the overarching questions posed above.

Significance of the Study

Due to the many efficiencies and multiple learning opportunities it provides, the researcher believes on-line homework will be a fixture in math classrooms for many years to come. Therefore, the research community must determine how best to utilize on-line homework within math classrooms, so as to provide students with the most beneficial learning experience. For this study, the researcher chose to focus attention on one possible use of on-line homework within a math classroom: the use on-line homework as a reasonable way to set higher expectations for students. Research (Weinstein 2002) has shown that students usually perform up to expectation when requested to do so, and with the on-line homework system's ability to provide multiple learning attempts, students can now be expected to reach a certain level of proficiency before receiving credit for an on-line homework assignment. At the present time, the researcher is unaware of any studies similar to this which have been conducted, and with the overall lack of on-line homework studies in general, this study may set the stage for further research concerning on-line homework and how to make it most effective as a learning aide for students.

Delimitations of the Study

The primary delimitation used to help control confounding variables in this study was to only consider the effects on the students within the studio college algebra course at Kansas State University, as opposed to the traditional college algebra course. This was due to the fact that on-line homework had been used in the studio college algebra course for both the fall and spring semesters of 2008, thus providing the researcher with data from a control group. Another delimitation was to separate the data from the fall and the spring, so that any traits from a traditional group of "1st semester freshmen" (who are typically the students taking a college algebra course) are not compared to a group of students who have been in college for at least 1 semester.

Limitations of the Study

The limitations on generalizing the results of this study include the fact that this study was only conducted at one Midwestern university, so generalizing the results to students at all universities or any other level (junior college, high school, etc.) would not be appropriate. A

second limitation of this study was that only one specific on-line homework system was employed. In principle, most on-line homework systems theoretically accomplish the same objectives, however, differences in the interface, user-friendliness, and help features may produce different results if this study was replicated with another on-line homework system. A third limitation of this study was that the study was conducted only in one course, college algebra, and more specifically, in a type of college algebra course with a slightly different makeup than a traditional lecture/recitation college algebra course. The course is titled studio college algebra, and a more thorough description of the course, along with comparisons and contrasts to a traditional lecture/recitation college algebra course can be found in the definitions section below. Consequently, even generalizing the results of this study to a traditional lecture/recitation college algebra course may not be appropriate.

One final limitation of this study occurred within the clusters. Some of the 37 input variables used to determine to which cluster each student belonged were on-line homework scores from the first unit of the studio college algebra course. This created a possible conflict within the data analysis portion of the study, since the researcher was interested in determining how each cluster responded to the higher expectations, even though the on-line homework was partially used to define the clusters. Even though this limitation does not provide for an ideal data analysis setting, the researcher believes the limitation was minimal, due to the fact that data from the entire semester's on-line homework scores was being analyzed, and not merely the first unit's on-line homework scores upon which the clusters were partially built.

Definitions

Part of the goal of this study was to see how different *clusters* of students reacted to the higher expectations placed on them due to the on-line homework. The decision upon how to group students into clusters was determined based on analysis completed by Manspeaker. In this analysis, she collected 37 distinct pieces of data about each student, including online homework scores, attendance, and scores from each question of the Unit 1 exam, and used these as the input data. A singular value decomposition was then employed to reduce the system from 37 variables down to a 4-dimensional setting. The AGglomerative NESTing (AGNES) clustering technique algorithm was next adopted to determine the number of "clusters" created with this 4-dimensional data. AGNES revealed that the data from the studio college algebra students

yielded 5 data clusters, and finally the procedure of Partitioning About Medoids (PAM) was implemented to determine which students fit into each of the five clusters. Once students were placed into a specific cluster by PAM, Manspeaker then used a stratified approach to select students for personal interviews, in an attempt to determine the common characteristics of the students within each cluster. Her brief descriptions of each cluster follow, with a more complete description in Appendix A.

Cluster A is composed of a group of hard working students who have a positive attitude about mathematics and a good work ethic. Their high ACT scores indicate they are well prepared to take the course. They do very well on all of their assignments and exams, and they attend class regularly throughout the semester. Not only do these students perform well, they enjoy mathematics and very much like taking the Studio version of the course. They work hard, are self motivated, and are not afraid to seek help from a variety of sources. They are able to demonstrate their knowledge effectively, and can make connections between the different concepts they learned in class.

Cluster B's students tend to treat the Studio College Algebra course like a low paying job. They do only what they think is expected of them, then are "paid" for their efforts with a passing grade. They come into the course reasonably well prepared, and tend to earn a B grade on their first exam. They continue to do average work in the course by attending most classes, completing their assignments, and staying in the B/C range on their exams. Although they don't like math, these students have generally positive opinions about the Studio College Algebra course. They particularly enjoy using Excel in the studio sessions and the integration of other types of technology in the course.

Students in Cluster C are well prepared and intelligent, but are bored and frustrated with the material presented in College Algebra. They tend to drop the course or underperform. Their average ACT score is the highest of all the groups, but their average first exam score is in the middle of the groups, a high C. Their scores drop for subsequent exams, ending with a low C for the Final. Almost 22% of these students drop the course, and only 65% earn a C or better. These students expressed high confidence in their mathematical abilities, and they thought the class was easy and the emphasis on review boring. Students in this group would do much better in a higher level class where they are challenged with new concepts and problems.

Cluster D's students do not like math, do not enjoy Studio College Algebra, and overwhelmingly drop or fail the course. They stop attending class and turning in their assignments regularly after the first few weeks. Their Exam 1 average is around 50%, and those students that do not drop the course fail the subsequent exams as well. This group has a drop-out rate of 27.6% and only 41% of these students earn a C or better in the course. These students had overwhelmingly negative views about mathematics, and their opinions got worse after taking Studio College Algebra. They relied heavily on tutors to help them with their homework and to study for exams.

Cluster E is made up of students who have a good attitude toward mathematics, try hard to succeed in the course, but still perform poorly. These students are generally not well prepared for the course, but they attend class regularly and turn in all of their homework assignments. Despite this, their first exam scores are among the lowest of the five groups (C/D), and they maintain this low average throughout the semester. They continue to struggle heavily and only 62% of them end up earning a C or better in the course. Although these students enjoyed taking Studio College Algebra, they have low confidence in their abilities and are easily intimidated by large class sizes and "word problems." During the interviews, students demonstrated fairly solid conceptual understanding of the material, much more than their exam performances would indicate.

The term *on-line homework* as used in this study refers to any assignment given by the course instructor which is computer-generated and submitted electronically. Each student receives different questions to answer, although the questions are structurally similar. The first time answers to a particular problem set are submitted, they are marked correct or incorrect by the computer and the student is given a chance to rework any incorrect answers before resubmitting. After the work has been resubmitted, the student receives a grade along with the correct answers and links to help features to see how to correctly solve the problems. The student can retake the on-line homework as many times as desired before the due date, and receives the highest score achieved over all attempts.

The *studio college algebra* course at Kansas State University is a course which allows students to earn credit for college algebra, but it is structured differently than a traditional college algebra course. A traditional college algebra course at KSU has 2 lecture and 1 recitation session per week, while the studio college algebra course has 1 lecture, 1 recitation, and 1 studio session

per week. The course was designed to be an alternative college algebra course, created especially for those students in which college algebra was either a terminal math course or those students who needed it only as a prerequisite for statistics or business calculus. For those students who would be taking a more formal calculus course necessary for further study in the hard sciences, the traditional college algebra course was recommended (Bennett 2010).

As mentioned above, the studio college algebra course replaced 1 lecture session per week with a studio session. The focus of the studio sessions was on developing conceptual understanding of the material learned in lecture by applying the ideas within problems and modeling situations. The students typically work in small groups of two or three, and are encouraged to communicate the mathematics learned, in both verbal and written form. Written work from the studio sessions is also graded, providing another opportunity for students to receive feedback (Bennett 2010). It is because of these important differences that the researcher did not compare results from studio college algebra courses to the traditional college algebra courses, even though both courses currently use on-line homework. The course material and assessments used in studio college algebra are the same as the material used in the traditional college algebra course offered at Kansas State University; the laboratory experience merely provides students with another opportunity to learn the material presented within the course from an application viewpoint. For the semesters in this study, the on-line homework counted as 10% of the overall grade for the course.

Thus far, the studio college algebra course has shown success in the realms of student achievement and student satisfaction. The rate of students receiving a grade of C or better has consistently been higher than the rate within the traditional college algebra course, and scores on student evaluations have demonstrated that students are more satisfied with their college algebra experience than before the studio college algebra course was implemented. This is despite the fact that placement within the studio college algebra course has been more random than anticipated. Even though the course was designed for a certain subset of all students needing college algebra credit, it has not been the case that advisors have consistently placed the students in the appropriate section (Bennett 2010). This fact should give some credence to the benefit of the studio college algebra course.

Summary

On-line homework is quickly becoming the new trend in mathematics homework, even though relatively few studies detailing its effectiveness exist. This study attempts to provide one possible answer to a way in which on-line homework can be utilized effectively within mathematics curricula, by forcing students to take advantage of the ability to rework incorrect problems by requiring them to achieve certain levels of proficiency in order to receive credit for the assignment. The obvious aim of the study was to explore if students practice more on problems initially answered incorrectly, do they learn more material, and are they able to score higher on assessments related to the material?

The second component of this study was to determine which clusters of students benefitted the most from the higher expectations implied by requiring a certain level of proficiency before receiving credit for an on-line homework assignment. Just as in any classroom, a certain intervention may work well for one cluster of students, but not for another cluster. The researcher tried to determine which clusters were positively impacted and which clusters were negatively impacted by the intervention, in an attempt to inform the research community for further studies in this area.

CHAPTER 2 - Literature Review

The purpose of this study was to provide insight into whether requiring students to meet certain expectation levels in order to receive credit within an on-line homework environment affected student behavior and student results within a studio college algebra course. After completing an on-line homework assignment, any student who scored less than 50% (the minimum proficiency level) received a message stating that his/her score was 0% for that particular on-line homework assignment. It was the goal of the researcher to determine the impact of this requirement on students, both at the whole-class level and at the small group level, where students with similar traits were placed into the same group, called a cluster.

This chapter begins with a review of the literature related to on-line homework. On-line homework in mathematics courses has been gaining popularity by the day, as the researcher has witnessed by the increasing number of presentations by individuals and textbook publishers at mathematics and technology conferences. There are a wide variety of opinions with regard to the effectiveness of on-line homework; some educators believe it should be adopted, while others feel it might actually hinder learning. The researcher begins by discussing what is meant by on-line homework, then considers what research states are the advantages and disadvantages of on-line homework, and finally reviews the literature concerning on-line homework and learning.

The second major topic of discussion in this literature review is related to how students respond to higher expectations. Due to the structure of the on-line homework environment, the researcher believes it is reasonable to expect more from students than within a traditional class setting. However, the relevant question is whether research supports or rejects this type of teacher expectation, thus, an analysis of the relevant literature in this area was warranted.

The third and final major topic in this chapter discusses clustering of students. Part of this study involved analyzing groups of students with similar traits after the first unit of course material, which separated the students in the studio college algebra class into clusters. By separate, the researcher does not mean to physically separate the students; rather, the researcher is referring to data analysis where the results of one cluster are compared to the results from

another cluster. Therefore, an analysis of what is meant by the term cluster and its essential components, especially how the clusters are created, was necessary.

On-line Homework

Automated grading systems, of which on-line homework systems are a direct consequence, originally were developed as a means of efficiency. An on-line math assignment can quickly be scored by the machine on which it was completed, and even today, this feature of immediate feedback is still considered an advantage of automated grading systems for both the students and the instructor when compared to traditional pencil-paper assignments (Bonham, 2001). For the purposes of this project, on-line homework was defined as any assignment which was submitted electronically to an automated grading system, which then scored the assignment, and returned the result to the student. The process of submitting, scoring, and returning the result to the student was almost instantaneous, hence the term immediate feedback.

In addition to the grading efficiency and immediate feedback, on-line homework has also gained popularity because of the computer's ability to be programmed to generate different exercises for different students, and its ability to allow students multiple attempts at similar exercises. These ideas will be discussed further in the next section of this chapter, but are mentioned now as an illustration of how on-line homework has evolved into more than merely a means of efficiency. With these ideas in mind, it is time to consider the advantages of on-line homework in more detail.

Advantages of On-line Homework

The implementation of on-line homework is still a relatively new phenomenon, and so a large body of research to draw from currently does not exist. However, some studies have been done which describe both the advantages and disadvantages of on-line homework in comparison to traditional pencil-paper assignments. Shea-Schultz (2002) commented, though, that unless the focus is on the learner, any type of technology used in education will have very little impact on student performance. Thus, it is important to consider the advantages of on-line homework, and the researcher considered these advantages in this section.

For students, one advantage of on-line homework is noticed when they submit an assignment and immediately receive a score for the assignment. This is in comparison to physically turning in the assignment, then waiting for it to be manually scored and returned; a

process which could reasonably take one week to complete. The advantage here is temporal, and it seems obvious that any student or instructor would agree that the sooner a student can receive feedback on submitted work, the better for all involved (Kulik 1988). A student who receives immediate feedback on submitted work then has the knowledge of knowing whether his/her work was done satisfactorily, or if some form of remediation for that concept is immediately necessary (Weibel 2003). In the traditional setting on where feedback was not immediate, this remediation may eventually take place, but sometimes only after the concept has been further built upon, thus causing not only the initial concept to be unmastered, but likely the concepts following it as well.

For the instructor, the advantage of immediate feedback is recognized in that lesson planning for the next class can be adapted, based on the students' scores. With pencil-paper assignments, the graded work is usually not returned for a few days, and by the time the instructor has access to an analysis of the graded work, new material has already been covered. Going back to review any concept which did not score well on the graded work at this time will not have the same impact as it would if it could be covered earlier. As mentioned above, not only will there be an understanding gap in the initial concept, but also there will likely be an understanding gap in the scaffolded material as well. Thus, immediate feedback from on-line homework provides a temporal advantage to both the students and the instructor which is rarely provided by pencil-paper assignments.

For both the students and the instructors, the type of feedback given by the automated grading system can also provide advantages. The current trend of on-line homework systems is to not only judge whether an answer is correct or incorrect, but to also give instructional feedback, almost like a virtual tutor or grader. Bennett (1999) says "of all the advantages that computers will deliver to education, the foremost will be their capacity to act as individual tutors. On an incorrect submission, the student will not only see the problem has been missed, but will also see some direction as to why the mistake was created. This level of instruction can be as little as giving a clue pointing to the possible error or as complete as showing the student the entire solution to the problem. As stated by Cole (2003), the potential for personalized, detailed, and rich feedback to the students at a small cost to the instructor in terms of time spent grading is an advantage that should not be overlooked. This allows students the opportunity to continue working on an assignment, no matter what time of day it is, since the virtual help to the problem

doesn't have fixed office hours or recitation sessions. Sometimes, the student may be making a minor error when working a problem, and with the help provided in the on-line homework, that student may be able to recognize and fix the error. According to Shea-Schultz (2002), people learn by making mistakes and correcting them. Allowing the student to continue working that problem on the assignment with helpful feedback, as opposed to waiting until the next tutoring session is available, may help students to learn the material at a time convenient for them.

Another advantage of an automated grading system is that it can “eliminate the easiest form of cheating by offering randomized variables in questions for each student to solve” (Bonham 2001). In a typical on-line homework problem set, each student will receive a group of problems with the same structure, but with different variables and/or coefficients. This can be as simple as presenting one student with the problem of solving for x in $2x = 8$ and another student with the problem of solving for x in $3x = 9$. The preceding is an example of using the computer to generate random numbers for an algorithmically equivalent exercise, and it is the primary use of on-line homework within this study. Thus, if two students are working together to complete an assignment, student #1 will not be able to directly copy the work of student #2, but will have to notice both the similarities and differences of his problem as compared to student #2's problem, thus moving the student to a higher level of thinking and understanding instead of merely copying down the process. Anecdotally, the researcher has noticed a shift in the types of questions students now ask when they use an automated grading system. The emphasis is now usually focused on either the structure of the problem or a specific aspect of the problem (what happens to the 4 in this problem?), as opposed to the more general (how do you work problem #2?). It is possible that the student may have wondered what happened to the 4 in the problem all along, but at least now the question posed is more pointed and direct.

More advanced on-line homework systems may also keep track of the type of exercises students have missed earlier in the course, and supplant these same types of exercises within later assignments, or even theoretically be programmed to produce more challenging exercises or problems for different groups of students. For this study, however, there will be no variation within the structure of the exercise; the on-line homework system will be used to generate different numbers within algorithmically equivalent exercises, score the assignments, and return a score to the student.

Another advantage of automated grading systems is their ability to allow students more practice (Bonham 2001). Most on-line homework systems now have an option of allowing the students multiple attempts to correctly answer a problem. Some systems will allow multiple attempts at the same problem (with the same variables and coefficients), while others will give a problem with the same structure, but with different variables and/or coefficients. The system used in this study has a combination of the two settings described above; the students will get 2 chances at the problem with the same variables and coefficients, and if unsuccessful on these first 2 attempts, they will receive a new problem with different coefficients. This is an obvious advantage over pencil-paper assignments, due to the inherent temporal constraints these types of assignments impose. In fact, within the Bonham study (2001), the time spent on homework by the students using the on-line homework system was between 30 minutes-1 hour per week greater than the students who were turning in their assignments on paper. Although by itself more time spent on homework does not guarantee more learning, one could venture to hypothesize that more time spent on homework would certainly not hinder learning. The old adage of “practice makes perfect” appears to now have a chance to verify itself once again within the on-line homework setting.

Disadvantages of On-line Homework

Although there appear to be many advantages to on-line homework when compared to pencil-paper homework, some disadvantages also exist. Most of these fall under the term used by Roth (2008) of “unintended consequences”. Explained more thoroughly, these are effects of the on-line homework system which actually impede student learning, or in the least, do not aide in student learning. Some specific examples of Roth’s “unintended consequences” are described below.

The first of these “unintended consequences” is that of an input error by the student. Communicating a mathematical answer in written work and in the electronic world can be somewhat distinct. Sometimes, these errors are merely typographical, while other times they can be formulaic (Roth 2008). By formulaic, the researcher is referring to the difference between an input of $7-10/5$ and $(7-10)/5$, where the first formula calls for division followed by subtraction, and the second formula calls for the subtraction first, then the division. In written form, the student can quite easily communicate to the instructor that the subtraction is to take place before

the division, even without using parentheses. However, this cannot be communicated without the parentheses in the electronic version. Thus, a student who has not learned how the on-line homework system “thinks” may experience frustration at what he/she believes is a correct submission, when the computer scores it as incorrect.

Another “unintended consequence” relates to how students utilize help features within the system. Ideally, help features are placed within an on-line homework system to help students after they have demonstrated difficulty solving a particular problem. It has been made known to the researcher by some of his students and noted by Roth (2008) that sometimes they will use the help menu for an on-line homework problem as a crutch instead of an informative tool. In opposition to truly thinking about the problem to be solved, the student will purposely miss the exercise enough times to be allowed access to the help menu. Then, the student will use the help menu to see the exercise with the entire solution worked out. Finally, the student will be given a new exercise (same structure, different coefficients), and merely replace the old coefficients with the new coefficients in order to obtain the correct answer for the new exercise. The student is obviously taking advantage of the computer’s inability to create a new “problem” (just a new exercise), with the short-term goal of getting an on-line homework exercise correct. Some may argue that this is what can currently be done with examples in a textbook, but the researcher believes this is one step beyond. Having the students recognize an example in the textbook as equivalent to an exercise, versus having a computer automatically generate an algorithmically equivalent exercise by the push of a button, are on two different levels in the mind of the researcher. The researcher personally views the preceding as similar to students who would copy a pencil-paper assignment; there are short-term benefits, but in the long-term understanding will be hindered.

As a summary to the last two sections of this chapter, more positive research has been published of the advantages of on-line homework than its disadvantages. Although some of the advantages are merely logistical and temporal, these can play a huge role in helping students understand concepts. Even though on-line homework systems do create some “unintended consequences” which may hinder learning, the advantages appear to be more substantial. It is for this reason that the researcher believes that students will continue to see an increase in the amount of teachers turning to on-line homework within math classes, both at the college level and the secondary level.

On-line homework and learning

Although the advantages described above speak positively of certain aspects of on-line homework when compared to pencil-paper assignments, the ultimate question for educators is whether, holistically, the on-line homework systems help students learn the material. Studying on-line homework and its effect on learning is a relatively new field, so very few studies have been done in this area. According to some of the recent studies, though, the jury is still out. Both Cheng (2004) and Bonham (2001) say that no significant difference was found when comparing exam scores from students who used on-line homework to students who used traditional pencil-paper assignments in their controlled studies. However, in the Bonham study (2001), it was noted that the effort involved in grading the paper exercises was much more thorough than in a typical course. Thus, for large enrollment classes where thorough grading of pencil-paper work may not be possible due to time or money constraints, the on-line homework would present an advantage to the students, in the fact that all students could receive some type of feedback for each of their assignments. Although it would be nice to be able to trumpet the effectiveness of on-line homework with respect to learning, not enough research has been done in this area to make such a claim. Hopefully, the study proposed in this dissertation will help to build the body of research in this area.

One focal point of the Cheng (2004) study, which applies to the proposed study in this paper, was to compare ungraded homework sections of a physics class to sections in which on-line graded homework was utilized. The results of this study indicated that graded homework was a significant factor in increasing student understanding. Thus, if giving students some type of feedback is known to be advantageous to student learning, and if there are time or money constraints limiting that type of feedback on traditional pencil-paper assignments, there is a direct line of connection showing the advantage of on-line grading systems over pencil-paper assignments.

Cheng (2004) also looked at subgroups within his study, broken down by final grades. He came to the conclusion that the percentage of students with final grades of A, B, or C rose dramatically when ungraded homework was replaced with on-line graded homework, while the difficulty of the course exams was kept constant. Within his study, Cheng also mentions that there are fewer and fewer Teaching Assistants to grade work, and with the budget cuts currently

facing schools thrown into the mix as well, on-line homework becomes more of a positive option when compared with other alternatives.

Although the Bonham (2001) study does focus primarily on the pros and cons of on-line homework, there is also a research piece comparing the performance of students using on-line homework to those submitting their work on paper in a traditional manner. He summarizes that students from the on-line homework sections consistently scored higher on exams, but that the difference in scores was not statistically significant. If nothing else, the claim can be made that on-line homework did not cause the students' exam scores to decrease, giving on-line homework some further research value.

To summarize this section, very little work has been done in the area of on-line homework and its learning value. The studies which have been conducted have shown some positive aspects to the idea, but overall, more research needs to be conducted in this area. In the least, on-line homework does not appear to be hurting students' understanding or performance on exams, making it reasonable to continue using on-line homework within classrooms.

High Expectations for Students

Setting high academic expectations has been one of the key strategies of school reform movements (Tomlinson 1992). Intuitively, it is not unreasonable to surmise that in order for an individual to achieve something, that individual should have a view of the end result in mind. Thus, it becomes important for teachers to plainly define these high expectations for their students, so that the student may have a clear picture of the expectation placed in front of him/her. The high expectation may then act as a "goal" for the student, which a study by Jussim (1989) has shown can help drive students to higher achievement.

Stated another way, the academic expectations teachers impose on their students have been shown to act as a sort of self-fulfilling prophecy (Brophy 1998 & Rosenthal 1968). Coupling this prophecy with the ability of on-line homework systems to produce multiple learning opportunities, it is reasonable to believe that students can achieve more academically in an on-line homework setting than in a setting without these components. It was with this in mind that the genesis of this study came to be: expect more from students, then see how they react behaviorally. The remaining portions of this section set to describe exactly how higher

expectations can lead students to academic performance they may not have experienced without the higher expectations.

What are High Expectations?

Bandura (1994) described an expectation as a “firm belief that the goal will be achieved”. It is important to note that this is true for both the teacher and the student. Goals which are difficult to achieve raise performance, but only when students accept those goals and believe they can attain them (Locke 1990). Therefore, it is crucial for teachers who impose high expectations to make certain these expectations are attainable for the population of students being served. Within this particular study, the researcher set a goal or expectation that in order to receive credit for any online-homework assignment, the student would need to score at least 50%. Considering that 50% is still considered unsatisfactory work in most courses, especially the studio college algebra course within this study, the researcher deems this goal to be not too high an expectation for all students within the course.

A topic which also arose within the high expectation literature was that of student effort. The literature clearly states there are many pitfalls when rewarding low-achieving students for effort rather than high quality work (Corbett 2002), and that this practice sets the stage for later failure (Tomlinson 1992). This idea, in combination with the previous paragraph, makes it especially important for teachers to make careful decisions on the level of the expectations, and then to follow through with their implementation, even in the case of a student who shows great effort but does not produce the desired results.

It has also been shown important for the students to have buy-in to the higher expectations. Osguthorpe (2009) commented that “until student expectations increase, their performance will remain the same.” In today’s competitive world, students cannot be satisfied with the same performance levels as previous groups of students; they must be pushed to achieve more. The researcher believes that for this study, the students did believe in the achievability of the higher expectation, allowing the researcher to dismiss lack of effort due to the higher expectations as a possible obstacle to genuine data.

Research on High Expectations

A classic study on high expectations occurred in the late 1960’s, which gave some credence to the fact that the expectations teachers have for students can become self-fulfilling

prophecies. Rosenthal (1968) and his team led teachers, at the beginning of the school year, to believe that some students would be “late bloomers”. These students would start the year slowly, but would show significant gains academically by the end of the school year. Actually, though, Rosenthal and his team chose the students at random, but by the end of the year, this group of supposed “late bloomers” demonstrated higher IQ gains than did the other students within the class. This study caused quite a buzz in the research world, and many attempts to replicate it proved unsuccessful. The question remained an open one; do teacher expectations of students really impact student learning?

Most of the literature on high expectations says that when students are challenged with higher expectations than normal, the students will “rise to the occasion” and meet the expectation, given that the expectation is a reasonable one, as discussed in the previous section. Rosenthal (1978) found consistent evidence that high teacher expectations can and do influence student behavior in the positive direction, and that low teacher expectations influence student behavior in the negative direction. Weinstein (2002) devotes an entire chapter to a case study of an intervention with a student who had been labeled as a low-ability reader, but when higher expectations were given to the student, his reading ability rose to the level of the expectation. There exist more examples within the literature of similar stories, but the big picture here is that there exists a set of studies which document the value of high expectations for students.

Weinstein (2002) also mentioned that high teacher expectations for their students can shape the lives of their students both in school work and beyond; it begins to become a life skill for the learner. Once a set of expectations has been reached, a new set of even higher expectations develops, and the process continues to drive the learner to bigger and better things. This type of goal-setting becomes engrained within the learner, so that the expectations do not need to be teacher-imposed, but are learner-imposed.

To summarize this section on high expectations, research supports the use of high expectations within learning environments, provided the expectations are set at a reasonable level. Also, the students need to buy-in to the expectations, or else they will not strive for them. The expectation of at least 50% in order to receive credit in this study was not deemed too high by the researcher, since 50% is still considered unsatisfactory in most courses.

Clusters

In addition to considering whole-class statistics, the secondary purpose of this study was to investigate the behavior of different clusters of students with respect to the higher expectations. It was hypothesized by the researcher that some students may react more positively to the higher expectations than other students, and the concept of clustering the students into subgroups of the entire class attempted to validate this claim. Clustering, though, is a specific form of data mining, so a formal look at data mining must occur before clustering can be described sufficiently.

By definition, data mining is the “use of algorithms to extract information and patterns” from data (Dunham 2003). Data mining seems to have arisen from the fact that with all the new information which becomes available each year, it is becoming harder and harder to find useful information from the large masses of data. Among its many applications, data mining is used to classify data into predefined classes, predict the future actions of individuals or groups, and cluster data into groups based on the input data itself (Dunham 2003). For this study, the use of data mining was two-fold. First, it was used to help classify students into clusters, which were developed based on 37 variables from the student’s performance in unit 1 of the studio college algebra course. These 37 variables were derived from each student’s on-line and written homework scores, studio lab scores, attendance, and exam scores on each problem of the unit 1 exam. Second, data mining was used to attempt to discern student reactions to the higher expectations, as students from the same clusters were compared before and after the intervention of higher expectations, to predict what type of impact the intervention had on the students. Future uses of data mining with on-line learning environments may include identifying and grouping students who use on-line hints as a crutch instead of a learning tool (Yudelson 2006), identifying learners with low motivation (Cocea 2006), or, in general, grouping students so that differentiated instruction can occur.

Within this study, the data mining concept of clustering was most relevant. Clustering is similar to classifying students into groups, but the key difference is that the groups are not predefined ahead of their placement; they are generated based solely on the input data (Dunham 2003). This approach to classifying students has the distinct advantage of being unbiased, since the computer algorithm which clusters the students has no preconceptions about the students, the

input data, nor the clusters into which it places the students. There exist a wide variety of techniques for clustering the data; the researcher will consider two of these methods now.

K-means is an iterative clustering method which moves data points among clusters until the set converges around a predetermined amount of means (Dunham 2003). Borrowing an example from Dunham, consider the data set with the entries {2, 4, 10, 12, 3, 20, 30, 11, 25} with 2 means ($k = 2$). The *k-means* algorithm begins by selecting the first two data points as its initial means (also called centroids), so $m_1 = 2$ and $m_2 = 4$. The remaining data points are now assigned either to the cluster with m_1 or m_2 as the mean for the cluster, depending on which mean the data point is closer to. Thus, after 1 iteration, the two clusters are $K_1 = \{2, 3\}$ and $K_2 = \{4, 10, 12, 20, 30, 11, 25\}$. Notice that the data point 3 was equally close to both m_1 and m_2 , so it was arbitrarily chosen to be placed in the first cluster. Now the means for each cluster are recalculated, and another iteration takes place. Thus, m_1 now equals 2.5 and m_2 is now 16. Reassigning the data points gives new clusters of $K_1 = \{2, 3, 4\}$ and $K_2 = \{10, 12, 20, 30, 11, 25\}$. Table 2.1 summarizes the entire process.

Table 2.1 Centroid Calculations

	m_1	m_2	K_1	K_2
Iteration 1	2	4	{2, 3}	{4, 10, 12, 20, 30, 11, 25}
Iteration 2	2.5	16	{2, 3, 4}	{10, 12, 20, 30, 11, 25}
Iteration 3	3	18	{2, 3, 4, 10}	{12, 20, 30, 11, 25}
Iteration 4	4.75	19.6	{2, 3, 4, 10, 12, 11}	{20, 30, 25}
Iteration 5	7	25	{2, 3, 4, 10, 12, 11}	{20, 30, 25}

Notice that since there is no change in either K_1 or K_2 from Iteration 4 to Iteration 5, the means will not change, and the process has converged. Therefore, the data are clustered around the centroids 7 and 25 according to the clusters given in Iteration 4.

While the method of *k-means* does order data into k clusters, it does have disadvantages. The primary disadvantage is that of outliers. Any time means are used in statistics, outliers stretch the means, giving false impressions of central values. Thus, an alternative method was used in this study, called Partitioning Around Medoids or PAM for short. The medoids referred to here act like medians instead of means, making this technique less sensitive to outliers. Medoids are the actual data points which minimize the distance between themselves and the non-

medoids which belong to the same cluster as the medoid. Although the run-time for PAM is slightly more than for the k -means algorithm, the fact that outliers are of less concern usually outweighs this additional run-time.

PAM, as described in Dunham (2003), begins just like k -means by randomly selecting k data points to be used as medoids. The entire data set is then clustered by which medoid it is closest to, and then medoids are recalculated based on the new data within each cluster. Again, this process is iterative, and the actions of recalculating medoids and regrouping continues until convergence occurs, at which point the clustering problem is solved. An example of PAM is summarized in Table 2.2.

Table 2.2 Medoid Calculations

	med_1	med_2	K_1	K_2
Iteration 1	2	4	{2, 3}	{4, 10, 12, 20, 30, 11, 25}
Iteration 2	3	12	{2, 3, 4}	{10, 12, 20, 30, 11, 25}
Iteration 3	3	20	{2, 3, 4, 10, 11}	{12, 20, 30, 25}
Iteration 4	4	20	{2, 3, 4, 10, 12, 11}	{20, 30, 25}
Iteration 5	10	25	{2, 3, 4, 10, 12, 11}	{20, 30, 25}

There are some points to make with the above table. First, for med_1 on Iteration 2, either 2 or 3 could have been the medoid. Even though the true median of 2 and 3 is 2.5, medoids must be data points. In this situation, we calculate the mean of the cluster and determine which data point is closer to the mean, letting that data point act as the medoid. Since both 2 and 3 are equally distant from the mean of 2.5, either could act as the medoid. (Also note that even had 2 been chosen in Iteration 2, med_1 still equals 3 in Iteration 3.) This same principle applies to med_2 in Iteration 3, since K_2 had an even number of data points in the 2nd Iteration. Since the average of K_2 in Iteration 2 is 18, and the middle values of the cluster are 12 and 20, 20 is chosen to be the medoid due to it being closer to 18 than 12 was.

One final point is that in Iteration 5, med_1 could be either 4 or 10. Either way, the clusters themselves are not altered, and the total distance between the medoid 4 and the data {2, 3, 4, 10, 11, 12} is equivalent to the distance between the medoid 10 and the data in K_1 .

While this strictly quantitative approach to classifying students into clusters does have advantages and disadvantages, identifying the meaning of the newly created clusters may be the

most important and difficult piece of the puzzle (Dunham 2003). Usually only an individual very comfortable with the data would be able to make such determinations of meaning, especially in light of the fact that multiple clustering results can occur within the same data set. For this study, Manspeaker made these determinations based on personal interviews with students from each cluster.

To summarize, the process of clustering is used to group students with like characteristics. The processes above describe one-dimensional clustering schemes, although the processes could be generalized to produce similar results with the 4-dimensional data from this study. Once the data have been clustered, the difficult part of identifying the meaning of each cluster commences, and it usually takes an individual very familiar with the data to make such determinations.

CHAPTER 3 - Methodology

Overview

The overall goal of this study was to provide further insight into the question “Does a change in expectation, such as requiring a certain proficiency level in order to receive credit for an on-line homework assignment, affect overall student performance within the course?” The researcher attempted to provide an answer to this question by requiring a proficiency level of at least 50% in order to receive credit for student on-line homework within all studio college algebra courses at Kansas State University (KSU) during the spring 2009 and fall 2009 semesters. Any student who did not achieve at least 50% on a given homework assignment received a message stating that he/she will receive a score of 0% for that assignment. At the end of the semester, the researcher then compared data from the spring semester of 2008 (in which the proficiency level was not imposed) to the data collected during the experimental semester, the spring of 2009. A similar comparison also was made from the fall semester of 2008, which was the control group, to the fall semester of 2009, which was the experimental group. Formal statistical analyses were then used to look for trends within the comparable data, and analyses concerning both the positive and negative effects of the expectation change were explained.

Research Design

The research design used in this study was experimental. IRB approval from KSU was requested and granted. The students in the spring 2009 and fall 2009 studio college algebra courses at KSU comprised the experimental groups. The control groups consisted of the students who enrolled in studio college algebra in the spring 2008 and fall 2008 semesters, before the proficiency level was implemented. For the purposes of this study, any student who was enrolled in studio college algebra at KSU in the spring 2008 or fall 2008 semester after the 20th day of the class and submitted work on time was included in the data collection for the control group, and any student who was enrolled in studio college algebra at KSU in the spring 2009 or fall 2009 semester after the 20th day of class and submitted work on time was included in the data collection for the experimental group.

Data analysis for this study was quantitative, and considered the ramifications of the expectation change on the students. Sub-questions used to help answer the overarching research question included:

1. Did the fact that students needed to score at least 50% to receive credit affect the total percentage of scores less than 50%?
2. Did the fact that students needed to score at least 50% to receive credit affect the number of times students accessed help features within the on-line homework system?
3. Did the fact that students needed to score at least 50% to receive credit impact exam scores, especially the final exam?

Analyses of the above sub-questions provided insight into the overarching question of the effect of a proficiency level for on-line homework in the studio college algebra course, and the results may be used to help shape future decisions regarding on-line homework in studio college algebra at Kansas State University. In addition to looking at whole class trends, each student was also placed into a subgroup called a cluster. A detailed multiple-variable analysis was done for each student, and the results were used to place each student within a cluster. Data was then collected from each cluster, in an attempt to determine the impact of the proficiency level requirement on the different clusters of students by considering data from the same three sub-questions as the whole-class data.

Setting

This study was conducted at Kansas State University in Manhattan, Kansas. Kansas State University is a large Midwestern university with an annual enrollment of roughly 20,000 undergraduate students (KSU Website). Of these students, there are typically around 200-350 students enrolled in studio college algebra each semester. This university was chosen because the on-line homework system needed for the study was already in place for the studio college algebra course. In addition, the data needed to answer the sub-questions posed above was already set to be collected for the spring and fall 2009 semesters, and the data from the spring and fall 2008 semesters, used as control group data, was already collected. In addition, the clusters utilized within this study were already defined beginning in the fall semester of 2008. These factors made Kansas State University the ideal place to conduct this type of study.

The course chosen for this study was the studio college algebra course. It was chosen primarily because the on-line homework system has been used within the course longer than the traditional college algebra course. The studio college algebra course was designed to try to help with the low passing rates of students enrolled in the traditional college algebra course at KSU. The material covered within the two courses is similar, but instead of meeting once a week for lecture and twice a week for recitation, the studio college algebra course meets once a week for lecture, once for recitation, and once for a “studio lab”, in which real-world applications of the college algebra are made evident to the students through self-guided lab work related to the lecture from that particular week. The studio college algebra course is fairly new to KSU, and thus there were small changes made to the course each semester. This fact does introduce the possibility of any improvement of scores within this study to be attributable to the confounding variable of the morphing of the course, although the researcher feels the changes to the studio college algebra course during its growth to its current state were not as significant as the variable of interest within this study.

Population/Sample

The participants in the experimental portion of the study were students enrolled in studio college algebra at Kansas State University in the spring or fall semester of 2009. All students enrolled in studio college algebra were asked to satisfy the proficiency level requirements described in the research design section in order to receive credit, since the proficiency level request was a university-wide application in all studio college algebra sections. The university-wide application of the proficiency level had the effect of “blinding” the participants in the study, as they did not realize they were part of a research project, and only thought the proficiency level was a natural consequence of enrollment in the studio college algebra course. Blinding the students in this manner helped with the authenticity of the data collected, and helped to minimize any confounding variables which can arise when participants are aware of their involvement within a research project. The participants in the control portion of the study were students who were enrolled in studio college algebra at Kansas State University in the spring or fall semester of 2008. The collection of studio college algebra students from the spring 2008, fall 2008, spring 2009, and fall 2009 semesters composed the sample for this study. Studio college algebra is typically composed of about 80-90% freshmen, especially during the fall semesters. The data

collected from this study will theoretically be applicable to the entire population of all Kansas State University students enrolled in future semesters of the studio college algebra class, although implications for students enrolled in the more traditional college algebra courses was also considered as well as implications for other universities who might choose to utilize a similar on-line homework system.

Data Collection

For the purposes of this research project, the term “on-line homework assignment” refers to any assignment given in the studio college algebra course falling under the description of “on-line homework” on the course syllabus. All of the on-line homework assignments for this course were skill-based, algorithmically generated exercises, and they were scored immediately after the student submitted the work. With the instantaneous feedback given from the computer scoring, the student received a percentage score for the assignment. The student then had the opportunity to rework any missed exercises (or parts of exercises), with only the knowledge of which exercises were correct and which exercises were incorrect. Once the student had completed and submitted this 2nd attempt at the incorrect exercises, the computer again scored all the exercises, and gave a percentage score for the on-line homework assignment. The student now had the option of using help tools, primarily, clicking a link to see the step-by-step process of solving any incorrect exercises. Finally, the student had the option of accepting this percentage score, or starting the assignment over again, with new algorithmically generated problems similar in structure to the skills assessed in the initial grouping of exercises. Students received as many new sets of exercises as they wished, with only the highest percentage score from any one group of exercises recorded as the student’s grade for that particular on-line homework assignment, keeping in mind that any score below 50% for students prompted a message stating they received a 0% for that particular on-line homework assignment. For the spring 2009 semester, the students only received the message; their scores were not changed to 0%’s in the grade book. For the fall 2009 semester, the students not only received the message, but their scores were changed to 0%’s in the grade book. Other sources of data which were collected included:

1. percent of on-line homework scores less than 50%,
2. exam score means, and
3. number of times the help link feature was accessed

Data Analysis

To answer the question of “Are there significantly fewer on-line homework scores less than 50% in the spring 2009 semester than in the spring 2008 semester”, the researcher used a chi-squared goodness of fit test with a 0.05 significance level, letting the expected values come from the spring 2008 semester, and the observed values come from the spring 2009 semester. The chi-squared test was chosen since it takes the data values from a control group, and scales them to the same sample size as the experimental group. From there, a comparison is made to determine whether there is a significant difference between the scaled values from the control group to the observed values within the experimental group, using the chi-squared distribution. A similar analysis was completed for the fall 2008 vs. fall 2009 semester data. It was the hope of the researcher before the data was analyzed that the p-value would be less than 0.05, indicating significantly fewer scores of less than 50% on the on-line homework within the semester in which the proficiency level was stipulated.

When considering the question of “Does the proficiency level affect the number of times students access help features within the on-line homework system”, the researcher used a one-tailed hypothesis test on a mean with a 0.05 significance level, letting the null hypothesis be the number of help “hits” during the control semesters. The t-test was chosen as the statistic since it compares the control group mean to the experimental group mean to determine how unusual the experimental group mean is under the assumption that the control group mean (the null hypothesis) is accurate. It was the hope of the researcher before the data was analyzed that the null hypothesis would be rejected in favor of the “greater than” alternative hypothesis, indicating a significant increase in the average number of times students in the spring and/or fall 2009 semesters accessed the help link feature.

To answer the question of “Does the proficiency level for on-line homework impact exam scores, including the final exam”, the researcher used a one-tailed hypothesis test on a mean with a 0.05 significance level, letting the null hypothesis be the mean exam score for students in the spring 2008 semester (the control group). A similar test was conducted for the fall semester data, letting the fall 2008 semester be the control data.

The answers to the above sub-questions helped the researcher draw some conclusions on the answer to the overarching research question of “Does a change in expectation, such as requiring a certain proficiency level in order to receive credit for an on-line homework

assignment, affect overall student performance within the course?” It was the hope of the researcher that even if statistically significance results were not found, the proficiency level might create “desirable” habits for students, such as unmitigated use of help features made available to them, or beginning an assignment many days before it is due as compared to waiting only a few days before it is due to start.

Reliability of Results

The data collected in this study was considered reliable due to the following factors. First, the students were unaware they are part of an experimental study. This had the effect of blinding the students, thus keeping them from acting differently as someone might, consciously or subconsciously, knowing he/she was part of a research study. This ensured that the students’ actions taken during the study were no different than the actions they would have taken had they not been part of a study. Second, similar assessments were used for both the control and experimental groups. This gave the researcher the confidence that the results from the on-line homework and exam scores would provide accurate data depicting the outcome of the intervention imposed within this study.

Validity of Results

The data collected in this study was considered valid due to the following factors. First, the sample size was sufficiently large. This helped to minimize the effect of random chance or the inequality of the control and experimental groups. Both groups completed the study without knowledge of participation, which yielded results attributable to the variable in the study (the expectation change) and not other confounding variables. Second, the data being analyzed was coming from comparable semesters (i.e. data coming from spring semesters was only being compared to other data from spring semesters, and data from fall semesters was only being compared to other data from fall semesters). Although not the rule, it is fairly common for a fall college algebra class to be composed mostly of first-semester freshmen, making this a different group than a spring semester college algebra course. These two factors ensure that the results obtained in the data analysis were strong with respect to interval validity, as well as providing a foundation for the possibility of applying the results of this study to future semesters, external validity.

Summary

The purpose of this study was to provide insight into whether requiring students to meet certain expectation levels in order to receive credit within an on-line homework environment affected student behavior and student results within a studio college algebra course. Will students who are asked to achieve a certain level actually achieve that level, or will they “shut down” and rebel against it? Data collection from comparable semesters yielded reliable and valid results which were used to guide the researcher in data analysis of this topic, and provided the researcher with valuable information which can be used to determine the course of action with respect to on-line homework and expectation levels in future semesters.

CHAPTER 4 - Results

This chapter is composed of two parts. First, results from the data collected for the entire studio college algebra classes were compared to determine the effects of the 50% on-line homework score to receive credit requirement. Data from the spring and fall semesters of 2008 were used as control data, while the spring and fall semesters of 2009 produced the experimental data. Due to possible differences in the student populations between the spring and fall semesters, spring 2008 data was only compared to spring 2009 and the fall 2008 data was only compared to the fall 2009.

Second, data from each of the five clusters were compared. Since the data for the clusters commenced in the fall semester of 2008, only data from the fall 2008 and fall 2009 semesters will be compared. A comparison of this type can be made, since it was determined through personal interviews by Manspeaker that the five clusters created from the fall 2008 semester were the same as the five clusters created from the fall 2009 data.

Whole-Class Data

On-line homework

To answer the question “did the fact that students needed to score at least 50% to receive credit affect the total number of scores less than 50%”, data counting the number of instances less than 50% and greater than or equal to 50% were compiled. The results for the on-line homework (OLHW) are summarized in Table 4.1 and Table 4.2.

Table 4.1 Spring OLHW (Overall)

	OLHW<50%	OLHW≥50%
Spring 2008	139	1024
Spring 2009	242	2809

Table 4.2 Fall OLHW (Overall)

	OLHW<50%	OLHW≥50%
Fall 2008	541	5242
Fall 2009	420	5215

Data from Table 4.1 and 4.2 were analyzed using a chi-squared test. The chi-squared test was chosen here because within its calculations, observed values from an experimental group are compared to observed values from a corresponding control group (scaled for sample size variation), and their differences are compared to determine if statistical significance is evident. At a statistically significant level, both the spring [$X^2(3051)=46.854, p<.01$] and fall [$X^2(5635)=24.029, p<.01$] semesters showed significantly fewer instances of students settling for on-line homework scores less than 50%.

A subset of the above data was also investigated, due to the fact that in the spring semester of 2009, students were told at the beginning of the course that any on-line homework scores less than 50% would be given no credit. However, due to instructor preference, this action was not enforced, and when students checked their on-line homework grades after Unit 1 (OLHW #1-5), the possibility existed that they could realize no action was taken, perhaps impacting their behavior for the rest of the semester (OLHW #6-19). Results from the two subsets are given below in Tables 4.3 and 4.4.

Table 4.3 Spring OLHW (Unit 1)

	OLHW<50%	OLHW≥50%
Spring 2008	14	345
Spring 2009	18	891

Table 4.4 Spring OLHW (#6-19)

	OLHW<50%	OLHW≥50%
Spring 2008	125	679
Spring 2009	224	1918

From the on-line homework in Unit 1, students had statistically significantly fewer on-line homework assignments less than 50% [$X^2(909)=8.937, p<.01$]. However, the same can be said for the on-line homework assignments from Unit 2 through the rest of the semester [$X^2(2142)=42.261, p<.01$]. Student results indicate that fewer on-line homework assignments were less than 50%, even after the possibility existed that they may recognize the scores less than 50% would not be changed to a score of no credit.

The data from the fall semesters were also split into disjoint subsets of material from Unit 1 and the rest of the course. At the beginning of the fall 2009 semester, students were told they would not receive credit for any on-line homework assignments less than 50%, but this time, the action was carried out as stated at the beginning of the course. Results from these subsets are given in Tables 4.5 and 4.6 below.

Table 4.5 Fall OLHW (Unit 1)

	OLHW<50%	OLHW≥50%
Fall 2008	51	1706
Fall 2009	46	1593

Table 4.6 Fall OLHW (#6-19)

	OLHW<50%	OLHW≥50%
Fall 2008	490	3536
Fall 2009	374	3622

From the fall semester Unit 1 on-line homework, students did not show statistically significantly fewer on-line homework assignments less than 50% [$X^2(1639)=.054, p>.10$]. On the other hand, there were significantly fewer on-line homework assignments less than 50% for the course material after Unit 1 [$X^2(3996)=29.550, p<.01$]. The results indicate that students realized after Unit 1 that on-line homework scores less than 50% were being given no credit, and a change in behavior may have occurred.

Exam Data

To answer the question “did the fact that students needed to score at least 50% to receive credit impact exam scores, especially the final exam”, data were collected for the three unit

exams and the comprehensive final exam. The average, standard deviation, and sample size for each exam are given in Tables 4.7-4.14.

Table 4.7 Exam 1 (Spring semesters)

	Average	Stan. Dev.	Sample Size
Spring 2008	76%	19%	77
Spring 2009	76%	17%	198

Table 4.8 Exam 2 (Spring semesters)

	Average	Stan. Dev.	Sample Size
Spring 2008	64%	21%	77
Spring 2009	67%	24%	196

Table 4.9 Exam 3 (Spring semesters)

	Average	Stan. Dev.	Sample Size
Spring 2008	68%	21%	66
Spring 2009	62%	24%	185

Table 4.10 Final Exam (Spring semesters)

	Average	Stan. Dev.	Sample Size
Spring 2008	66%	17%	65
Spring 2009	69%	20%	182

Table 4.11 Exam 1 (Fall semesters)

	Average	Stan. Dev.	Sample Size
Fall 2008	83%	15%	383
Fall 2009	73%	17%	365

Table 4.12 Exam 2 (Fall semesters)

	Average	Stan. Dev.	Sample Size
Fall 2008	72%	21%	360
Fall 2009	60%	20%	336

Table 4.13 Exam 3 (Fall semesters)

	Average	Stan. Dev.	Sample Size
Fall 2008	68%	21%	345
Fall 2009	73%	20%	325

Table 4.14 Final Exam (Fall semesters)

	Average	Stan. Dev.	Sample Size
Fall 2008	69%	18%	337
Fall 2009	72%	20%	327

For the examination analysis, a t-test was used to determine if statistical significance was attained. In the spring semesters, Exam 1 [$t = -0.50, p > .10$] and Exam 3 [$t = -1.934, p = .06$] actually had lower averages in the experimental semester than in the control semester, while Exam 2 [$t = .946, p > .10$] and the Final Exam [$t = .940, p > .10$] had class averages higher during the experimental semester. However, none of the results were statistically significantly in either direction.

In the fall semesters, Exam 1 [$t = -8.347, p < .01$] and Exam 2 [$t = -7.741, p < .01$] had statistically significantly lower averages in the experimental semester than in the control semester. For Exam 3 [$t = 3.060, p < .01$], the experimental semester yielded a statistically significantly higher exam average, and although the Final Exam [$t = 1.600, p > .10$] average was also higher during the experimental semester, it was not statistically significant at the 5% level.

To summarize, four of the eight comparisons actually yielded lower exam scores after the intervention of higher expectations with respect to the on-line homework, and two of these four were statistically significant. The other four of the eight comparisons did produce semesters with higher exam averages during the experimental semester than during the control semester,

although only one of these four instances yielded a result which was statistically significantly higher.

Exam Data Covering On-line homework

In addition to considering the exam data from the entire test, the researcher was also interested in considering the exam data which was directly related to the on-line homework exercises. An item analysis for each on-line homework assignment and exam was conducted to match questions from each of these assessments. As an example of what the researcher considered “matching questions”, in the on-line homework students were given the question “Solve the equation $-9x - 10 = -8x - 1$ ”, while on the exam, students were asked to “Solve for x : $24x - 13 = 13x + 31$ ”. The results from this analysis are given in Tables 4.15 – 4.17.

Table 4.15 Exam 1 Similar Questions (whole class)

	Average	Stan. Dev.	Sample Size
Fall 2008	93%	7%	330
Fall 2009	90%	9%	362

Table 4.16 Exam 2 Similar Questions (whole class)

	Average	Stan. Dev.	Sample Size
Fall 2008	76%	27%	312
Fall 2009	71%	28%	327

Table 4.17 Exam 3 Similar Questions (whole class)

	Average	Stan. Dev.	Sample Size
Fall 2008	70%	18%	302
Fall 2009	74%	20%	316

Unit 1 [$t = -5.249, p < .01$] and Unit 2 [$t = -3.292, p < .01$] had experimental semester averages which were less than the control semester averages, and in both cases the results were statistically significant. However, Exam 3 [$t = 2.320, p = .02$] showed a statistically significant increase in exam average when similar questions from on-line homework and exams were compared.

Help Hits

To answer the question “did the fact that students needed to score at least 50% to receive credit affect the number of times students accessed help features within the on-line homework system”, data were collected counting the number of times the help feature was accessed for each on-line homework assignment. The number of help hits per student from the spring and fall semesters of 2008 was then compared to the corresponding semester in the spring and fall of 2009 to determine if significantly more help hits per student were accessed in the experimental semesters than within the control semesters. A matched pair t-test was used to compare the data, and the results are given in Tables 4.18 & 4.19.

Table 4.18 Help Hits per Student (Spring)

OLHW Number	Spring08/student	Spring09/student
1	0.375	0.564
2	0.208	0.489
3	1.100	1.154
4	0.985	1.152
5	0.188	0.308
6	2.523	3.066
7	2.035	2.169
8	0.758	0.585
9	1.774	1.899
10	1.000	0.807
11	3.213	2.796
12	1.843	1.306
13	1.344	1.472
14	3.852	3.481
15	2.167	1.654
16	3.412	2.122
17	3.431	3.220
18	1.771	1.293
19	1.408	1.185

Table 4.19 Help Hits per Student (Fall)

OLHW Number	Fall08/student	Fall09/student
1	0.306	0.560
2	0.386	0.460
3	0.932	0.870
4	0.839	1.009
5	0.194	0.419
6	2.744	2.698
7	1.747	1.803
8	0.597	1.897
9	1.575	2.172
10	0.716	0.688
11	2.597	2.760
12	1.257	1.257
13	1.483	1.373
14	2.914	3.959
15	2.080	1.930
16	2.615	3.176
17	3.060	3.321
18	1.385	1.913
19	1.125	1.485

For the spring semesters, there were actually less help hits per student in the experimental semester [$t = -1.485$, $p > .10$], although the difference was not statistically significant. In the fall semesters, there were significantly more help hits per student [$t = 3.063$, $p = .01$] in the experimental semester than in the control semester.

Data were also analyzed for the first unit (OLHW #1-5). During both the spring [$t = 4.35$, $p = .01$] and fall semesters [$t = 2.311$, $p = .08$], there were more help hits during unit 1 in the experimental semesters than in the control semesters, and the result from the spring semester was statistically significant.

Cluster Data

In addition to considering whole-class statistics, data were also analyzed for the five distinct clusters of students developed by Manspeaker. This section is composed of three parts. First, an analysis of each cluster with respect to the number of on-line homework scores less than 50% is presented. Second, each cluster's exam score averages are compared to determine if any cluster scored significantly higher during the experimental semester. Finally, the clusters are compared to decide whether certain clusters accessed the help menus more often than other clusters during the experimental semesters.

On-line homework

Each of the five clusters was analyzed to determine the impact of the higher expectations on the percentage of on-line homework assignments which ended up scoring less than 50%. The summarized results are given in Table 4.20.

Table 4.20 OLHW by Clusters

	Cluster A		Cluster B		Cluster C		Cluster D		Cluster E	
	<50%	≥50%	<50%	≥50%	<50%	≥50%	<50%	≥50%	<50%	≥50%
Fall 08	125	1615	63	1191	77	845	43	313	130	657
Fall 09	64	2107	151	1647	65	319	24	181	86	813

Chi-squared tests were then used to analyze each cluster to test for statistical significance. Cluster B [$X^2(1798)=42.904, p<.01$] and Cluster C [$X^2(384)=36.896, p<.01$] actually had a significantly higher percentage of scores below 50% in the fall semester of 2009 than in the fall of 2008. Also, Cluster D [$X^2(205)=.027, p>.10$] had a nearly identical percentage of on-line homework scores below 50%, so it did not yield a statistically significant result. Cluster A [$X^2(2171)=58.422, p<.01$] and Cluster E [$X^2(899)=31.510, p<.01$] did yield statistically significant results, as both of them involved groups of students who had significantly fewer on-line homework assignments less than 50% in the experimental semester.

Exams

An analysis of each cluster within each exam was performed. The results are summarized with Table 4.21, where SS+ indicates a statistically significantly higher score in the experimental

semester, SS- indicates a statistically significantly lower score in the experimental semester, + indicates a higher exam average, but not statistically significant, and – indicates a lower exam average within the experimental semester, but not statistically significant.

Table 4.21 Exam Breakdown by Cluster

	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E
Exam 1	SS-	SS-	SS-	-	-
Exam 2	-	SS-	-	-	-
Exam 3	SS+	-	-	+	+
Final Exam	+	-	-	-	+

From Exam 3 [$t = 2.228$, $p = .03$] the t-test yielded results which were significant at the 5% level for Cluster A. This was the only exam which was significantly higher in the experimental semester, although Cluster E also scored higher on Exam 3 [$t = 1.134$] and the final exam [$t = .423$] and both Cluster A [$t = 1.796$] and Cluster D [$t = .04$] scored higher on the final exam.

Exam Data Covering On-line homework

Even though most of the data from earlier in this chapter showed that there did not exist statistically significant gains for students on exam questions directly related to the on-line homework, the researcher was interested to see if certain clusters of students did show gains in this area. Tables 4.24 – 4.26 summarize this data.

Table 4.22 Clusters with Similar Questions (Exam 1)

	Average	Stan. Dev.	Sample Size
Cluster A (Fall 08)	98%	3%	102
Cluster A (Fall 09)	95%	5%	124
Cluster B (Fall 08)	97%	4%	77
Cluster B (Fall 09)	96%	4%	110
Cluster C (Fall 08)	96%	5%	58
Cluster C (Fall 09)	82%	16%	44
Cluster D (Fall 08)	91%	14%	39
Cluster D (Fall 09)	78%	16%	58

Cluster E (Fall 08)	77%	17%	54
Cluster E (Fall 09)	77%	25%	26

Table 4.23 Clusters with Similar Questions (Exam 2)

	Average	Stan. Dev.	Sample Size
Cluster A (Fall 08)	83%	23%	101
Cluster A (Fall 09)	84%	21%	119
Cluster B (Fall 08)	83%	25%	74
Cluster B (Fall 09)	69%	28%	106
Cluster C (Fall 08)	79%	28%	57
Cluster C (Fall 09)	59%	40%	36
Cluster D (Fall 08)	69%	34%	32
Cluster D (Fall 09)	56%	30%	50
Cluster E (Fall 08)	54%	36%	48
Cluster E (Fall 09)	63%	34%	16

Table 4.24 Clusters with Similar Questions (Exam 3)

	Average	Stan. Dev.	Sample Size
Cluster A (Fall 08)	77%	17%	100
Cluster A (Fall 09)	84%	17%	120
Cluster B (Fall 08)	80%	19%	72
Cluster B (Fall 09)	73%	20%	103
Cluster C (Fall 08)	69%	16%	55
Cluster C (Fall 09)	64%	25%	30
Cluster D (Fall 08)	61%	24%	28
Cluster D (Fall 09)	65%	21%	48
Cluster E (Fall 08)	47%	20%	47
Cluster E (Fall 09)	59%	27%	15

Within the exam questions covering material similar to the on-line homework, only five of the fifteen comparisons yielded exam score averages higher in the experimental semester than in the control semester. Of these five, only Cluster A's average from Exam 3 [$t = 2.700$, $p < .01$] provided a statistically significant result. The researcher feels it was important to note, though, that three of the five clusters had higher exam averages on the Exam 3 material covered in the on-line homework, and that Cluster A and Cluster E each had higher exam averages on both the Unit 2 and Unit 3 exams.

There were also some results significantly lower during the experimental semester. On Exam 1, Cluster A [$t = -4.956$, $p < .01$], Cluster C [$t = -5.618$, $p < .01$], and Cluster D [$t = -4.062$, $p < .01$] all scored significantly lower during the experimental semester. On Exam 2, Cluster B [$t = -4.964$, $p < .01$], Cluster C [$t = -3.646$, $p < .01$], and Cluster D [$t = -2.575$, $p = .015$] all scored significantly lower during the experimental semester. Cluster B also scored much lower on Exam 3 with [$t = -2.161$, $p = .03$].

To summarize, Clusters B, C, and D all scored significantly lower on 2 of the 3 exams, while Cluster A scored significantly lower on 1 exam and significantly higher on 1 exam. Cluster E did not have any averages significantly different from the control semester results.

Help Hits

In an attempt to determine whether some clusters utilized the help menu more than others, an analysis of each cluster was performed. Data was collected from each cluster to determine how many students were offered help versus how many of these students actually clicked on the help link. It is important to note here that any student who scored 100% on the first attempt, or any student who did not attempt the assignment, were not offered help by the on-line homework system. Thus, the data looked at the number of students who were offered help by the on-line homework system, and from these, how many students selected the help versus how many students did not select the help. The data are summarized in Table 4.27, where the column Help refers to the number of students who accessed help when it was offered, and the column NoHelp refers to the number of students who did not access help when it was offered to them.

Table 4.25 Help Hits by Cluster

	Cluster A		Cluster B		Cluster C		Cluster D		Cluster E	
	Help	NoHelp	Help	NoHelp	Help	NoHelp	Help	NoHelp	Help	NoHelp
Fall08	723	446	466	272	359	250	147	122	404	230
Fall09	1004	395	885	467	190	123	93	66	468	207

Even though the data from earlier in this chapter stated that there were significantly more help hits per student at the whole-class level in the fall semesters, this does not imply that each cluster individually was significant. This was in fact the case, as Cluster A [$X^2(1399)=58.318$, $p<.01$] and Cluster E [$X^2(899)=9.193$, $p<.01$] demonstrated significantly more help hits in the fall 2009 semester than in the fall 2008 semester, when the help was provided as an option to them. The remaining three clusters all accessed the help link more than was expected from the control (fall 2008) data, but not enough to provide statistically significant results.

In summary, students from all five clusters accessed the help link more often than expected in the fall 2009 semester than in the previous fall semester, when the higher expectation was not in place. Two clusters even showed a statistically significant result, accessing the help link many more times than expected.

CHAPTER 5 - Conclusions

Project Overview

The purpose of this study was to investigate the effects of requiring students in the studio college algebra courses at Kansas State University to achieve at least 50% for any on-line homework assignment in order to receive credit for the assignment. The idea for this project evolved from the viewpoint of the researcher that on-line homework is becoming more common in math classrooms, and thus ways to make on-line homework as effective as possible must be researched. The adaptation of scoring at least 50% to receive credit suggested in this project was envisioned as a method of coaxing students into homework habits which might aid in their learning. These habits include starting the assignment early because multiple attempts at the assignment are possible, repeating poor assignments because learning has not occurred, and utilizing help features when help from tutors, GTA's, or instructors is not available. On-line homework assignments offer all of these possibilities, but students must be trained to maximize the potential of on-line homework.

Requiring students to achieve at least 50% for on-line homework assignments was a possible first step in this direction. Given that the students now have opportunities not available in a pencil-paper homework setting, more can and should be expected of them. Research backs this claim, provided the expectations are reasonable and the students feel they are attainable. Considering that 50% is usually a failing grade in most academic endeavors, especially at the college algebra level, the researcher believes this expectation, while higher than no requirement at all, is not too high an expectation for any student desiring to pass college algebra. Thus, two positive attributes have appeared at the forefront of this study: on-line homework and higher expectations for students.

Although the researcher believes this intervention of at least 50% should benefit all students, the researcher realizes that some students benefit more from certain types of interventions than others. The final portion of this study attempted to determine which clusters of students benefitted from this intervention, which students did not benefit from it, and for which clusters of students the intervention had no impact in either the positive or negative direction. The initial task of this portion of the study was completed by Manspeaker when she divided the

students from each semester into five clusters. After personal interviews, she determined the clusters from the different semesters were identical, making it possible for the researcher to compare the clusters of students from comparable semesters. The fall semester of 2008 was used as a control group to compare to the fall semester of 2009 in both the whole class and cluster statistics, and the spring semester of 2008 was used as a control group to compare to the spring semester of 2009 for only whole class statistics, since the practice of clustering the students did not commence until the fall semester of 2008. Data from these four semesters was collected in an attempt to answer the overarching research questions of “Does a change in expectation, such as requiring a certain proficiency level in order to receive credit for an on-line homework assignment, affect overall student performance within the course?” and “Which clusters of students did the change in expectations help most, and for which clusters of students did the change in expectations appear insignificant, or a deterrent?” To answer these overarching questions, the following specific questions were posed:

1. Did the fact that students needed to score at least 50% to receive credit affect the total number of scores less than 50%?
2. Did the fact that students needed to score at least 50% to receive credit affect the number of times students accessed help features within the on-line homework system?
3. Did the fact that students needed to score at least 50% to receive credit impact exam scores, especially the final exam?

The answers to these questions provided the researcher with the information necessary to complete the project.

The project ended with an analysis of the meaning of the data, implications for the students and instructors in future studio college algebra courses at KSU, and recommendations for future studies related to this one.

Conclusions from Whole-Class Level

On-line homework

The first sub-question asked “Did the fact that students needed to score at least 50% to receive credit affect the total number of scores less than 50%?” The answer to this question seemed to be an overwhelming “yes”! Data comparing the spring 2008 semester to the spring

2009 semester resulted in a p-value of less than 1%, as did the data comparing the fall 2008 semester to the fall 2009 semester. Although the researcher was not surprised by this, since the intervention of this project was directly related to this data set, it is important to note as an entire class, the students responded positively to the higher expectation.

The researcher was also interested to consider the data separated into on-line homework from Unit 1 compared to the rest of the semester. In the spring semester of 2009, the students were told they would receive no credit for any on-line homework scores less than 50%, although this practice was never fully implemented, due to instructor preference. During Unit 1, the students had significantly fewer on-line homework scores less than 50%, and the researcher was interested to see if this trend would continue in the remaining portion of the semester, after students had the opportunity to notice that their scores less than 50% were not being changed to 0%. Despite this fact, students still had significantly fewer on-line homework scores less than 50% in on-line homework throughout the entire semester. This leads the researcher to believe that even by merely telling the students they will not receive credit for any on-line homework scores less than 50%, even if this action is not carried out, does have an impact on student behavior.

For the fall 2009 semester, Unit 1 did not have significantly fewer on-line homework assignments less than 50% when compared to the fall 2008 semester; in fact, there were more on-line homework scores less than 50% than expected from the control group. However, as the semester progressed, there became fewer on-line homework assignments less than 50%; so many that there ended up being significantly fewer scores less than 50% when the entire semester was considered. In this semester, the practice of actually changing the scores to 0% was in effect, and it is possible that after the students saw some of their scores changed to 0%, they either remembered the policy or realized it was actually going to take place.

Overall, the intervention of requiring students to score at least 50% in order to receive credit for on-line homework in studio college algebra appeared to be effective in changing student behavior in a positive direction.

Exam Scores

Although it was nice to see gains in the area of on-line homework, the researcher was also interested to see if students were able to learn the material well enough to improve exam

scores, since exams usually comprise the greatest percentage of a student's grade in a typical math class. The second sub-question asked, "Did the fact that students needed to score at least 50% to receive credit impact exam scores, especially the final exam?" Unfortunately, when considering the four exams from the spring semester and the four exams from the fall semester, only one of these eight exams had an average which was statistically significantly higher during the experimental semester than the control semester: exam 3 during the fall semesters. Since one significant score from eight sources is approaching what one would expect just by random chance, the researcher was hesitant to draw any positive conclusions from this data. In addition, there were 2 exam averages which were significantly lower than during the control semester. Therefore, it did not appear the intervention of needing to score at least 50% to receive credit with on-line homework assignments had an impact on student exam scores, as the results proved to be rather random. The researcher reached this conclusion based on the fact that none of the results from the spring semester were statistically significant, while Exams 1 and 2 from the fall semesters were significantly lower during the experimental semester, and Exam 3 from the fall semesters was significantly higher.

With respect to the exam questions which were similar to the on-line homework, only the fall semesters were analyzed. This is due primarily to the fact that the researcher wanted an overall viewpoint to compare to the cluster data, but since the clusters had not been established for the spring 2008 semester, there would be no cluster data in which to compare the overall spring data.

For the fall semesters, each exam demonstrated a statistically significant result, but again, it was rather random. Exams 1 and 2 were both significantly lower in the experimental semester, just like they were on the entire exam. Exam 3 was significantly higher in the experimental semester, which was also true for the entire exam. Thus, the researcher again concluded that little information could be gained from the exam analysis, either at the entire exam level, or at the level comparing only the similar questions from the on-line homework to the exam.

One possible reason for the exam scores not changing is that students are given multiple attempts to get on-line homework scores correct, whereas on an exam, only one opportunity is granted. It is possible students don't take the first attempt at on-line homework seriously, since they are well aware of the opportunity to complete it again if so desired. A possible adaptation of this study for the future may be to allow a finite number of attempts per assignment; to keep the

advantages of reworking for learning, as well as putting some pressure on the students to strive for correct answers on earlier attempts.

Help Hits

In addition to providing students with instantaneous feedback, another primary advantage of on-line homework systems is their ability to provide help, anytime and anywhere. Getting students to realize the potential value of this, though, is not trivial, since most students are still currently comfortable with traditional methods of remediation. Therefore, the researcher was interested to see if students would utilize the help links more often due to the fact they needed to achieve at least 50% to receive credit.

The final sub-question to be answered was “Did the fact that students needed to score at least 50% to receive credit affect the number of times students accessed help features within the on-line homework system?” The results of the data analysis were very encouraging, as students in both experimental semesters which were studied showed an increase in the amount of times per student they accessed the help links during Unit 1, although only the spring semester result was statistically significant. Unfortunately, this positive trait only continued in Units 2 and 3 with the students in the fall semester. The researcher believes this could mean the students start the semester with desirable habits; however, it appears they must continue to be encouraged to continue them throughout the semester.

When the exam scores were combined with the number of help hits, though, an interesting trend emerged. In general, students in the control semesters had higher exam averages than the students in the experimental semesters during the first half of the semester. However, this trend reversed itself during the second half of the semester, as students from the experimental semesters started having higher exam averages. In fact, both experimental semesters had higher averages on their final exams than did the students in the control semesters. The researcher sees this as a very positive sign for the on-line homework requirement of at least 50% to receive credit, since it is quite possible that the material covered in the studio college algebra course was not all entirely new to some students. Unit 1 focused on linear functions, which is the primary topic of discussion in a high school algebra I class. However, as the semester progressed, especially in Unit 3, students typically encounter material in the studio college algebra course they have not been exposed to before. This leads the researcher to believe

that requiring the students to achieve at least 50% may have led students to access the help links more often, which then may have led them to a higher Unit 3 exam average. The researcher would also like to believe the intervention of this study was part of the reason for the higher final exam averages, even though there does not exist data to support this supposition.

Conclusions from the Cluster Level

On-line homework

When looking at the individual clusters and considering the first sub-question of “Did the fact that students needed to score at least 50% to receive credit affect the total number of scores less than 50%?”, it became apparent that some clusters benefited from this intervention, while others did not. Based on the definitions of the clusters, the researcher surmised before the data was collected that Cluster B, which viewed the course as a job, may be the cluster which benefited the most from this intervention. The premise for this conjecture was that the higher expectation was just part of their “job”, and thus, they would follow through with the expectation. This turned out to not be the case, although Clusters A and E both demonstrated significantly fewer on-line homework assignments less than 50% in the experimental semester, while the other three clusters did not. When looking at the defining characteristics of these clusters given in Appendix A, Cluster A was composed of the students who seemed to perform well under any circumstances, so it was not surprising to see this cluster meet the higher expectations. Cluster E was composed of students who are hard-working, but don’t always score very well on exams. This also seems like a group who might benefit from the intervention, since they work hard, but maybe not the most efficiently. They seem to take advantage of the extra opportunities to rework homework, but may be merely benefitting from the repeated exercises being similar enough in structure. They may not be “learning” the material; they may just be reworking problems enough times to get them right once for the purpose of the on-line homework grade. However, this does not benefit them on an exam, since they only receive one opportunity per problem on the exam.

Clusters C and D also did not benefit in on-line homework scores from this intervention, and it should be noted that Clusters B and C both had significantly more on-line homework assignments less than 50% in the experimental semester. This leads the researcher to believe that the Cluster B and Cluster C from the fall 2008 and fall 2009 semesters were not equivalent to

begin the semester, since one would not expect there to be significantly more scores less than 50% , when the intervention can only benefit the number of scores less than 50%. Within their definitions, though, Cluster B did not like the on-line homework to begin with, so it is not surprising the intervention of asking them to repeat low scoring assignments was not successful. Cluster C felt that less homework should be assigned, so asking them to repeat a low assignment, which they may falsely believe they comprehend, was also not surprisingly unsuccessful.

Exam Scores

At the outset of this project, the researcher was most interested in trying to find ways in which to help students “learn” the material in the studio college algebra course. Part of demonstrating that a student has learned the material should include the ability to score highly on exams. The researcher felt that reworking incorrect on-line homework submissions, at least to a certain level, might aid the student in this learning process.

As mentioned earlier, some clusters respond well to a certain intervention, while others may not. This appears to be the case with the students in this study, as only the students from Cluster A demonstrated significantly higher exam scores, and this result occurred on only one of the last two exams of the semester. The researcher believes the reason for Cluster A’s success in this realm was due to them using the advantages of the on-line homework system described earlier in this paper properly, such as using the help links as learning guides, as opposed to a “crutch” or a guide. Even though the researcher initially had targeted Cluster B at the outset of this project, it was encouraging to see another cluster, which happened to be the largest cluster in terms of sample size, benefit from this type of intervention.

The intervention does seem to have helped Cluster E as well, since this cluster’s exam averages were less than the control semester’s averages for both Exam 1 and Exam 2, but were higher for both Exam 3 and the Final Exam. The researcher realizes none of these results for Cluster E were statistically significant, however, it was worth noting that for Exam 1, Cluster E’s average in the experimental semester was 7% lower than the control semester, but by the end of the semester, their final exam average was 9% higher the their peers from the control semester.

In addition to considering entire exam averages for each cluster, an analysis of how each cluster performed with respect to the exam questions similar to the on-line homework was also performed. Again, Cluster A was the only cluster which scored significantly higher. However, it

was also noteworthy that Cluster E scored higher on both Exam 2 and Exam 3. This may be due, though, to the small sample size of Cluster E in the experimental semester.

Help Hits

Within the clusters, students participating in this study were observed for the number of times they accessed help links when given the opportunity to do so. The researcher believed before the study that the more often students accessed an outside resource, like a help link, the better chance a student might learn the course material. Two clusters of students accessed the help link provided significantly more times in the experimental semester than in the control semester: Cluster A and Cluster E. The researcher believes there is a strong connection between this result and the result from the number of on-line homework scores less than 50%, since these same two clusters also showed statistically significant results in that area as well. The researcher surmises that these two clusters of students initially worked through an on-line homework assignment, and once it was submitted for a grade, each of these clusters had a strong enough work ethic to access the help link to try to learn why they missed any questions. The researcher then believes these students went back into the on-line homework and completed the assignment at least one more time; working until they received a score of at least 50%. The conjecture here is that the students who “work hard” might be the ones who benefitted the most from this intervention, since the process of accessing outside resources, such as help links, and reworking assignments are both time intensive, and would not be traits expected from students who don’t “work hard”.

Summary

With respect to clusters, it appears Cluster A received the most benefit from this intervention. Considering that Cluster A was the largest cluster, the researcher was pleased that it appeared a large percentage of the studio college algebra class was positively impacted by this intervention, even though this cluster of students was already the most successful cluster entering the course. The researcher feels it is worth noting that even though Cluster A might perform well under any intervention, the fact that improvements were shown is significant. One might expect these students to already strive for high on-line homework scores, even without being directly held accountable. Apparently, that is not the case, though. It appears these students need to be

explicitly reminded of the high expectations placed upon them just as any other group in order for them to reach those expectations.

Surprisingly, Cluster E also seemed to derive some benefit from this intervention, although it appears the benefit was mostly due to their work ethic, which happened to be a necessary condition within the intervention. Cluster E also demonstrated a rather large turnaround on exam scores, as they started out 7-9% below their counterparts in the control semester on exams 1 and 2, but ended up scoring nearly 8% higher on the 3rd exam. This rather large turnaround was intriguing to the researcher, especially considering that the only significant change from the fall 2008 semester to the fall 2009 semester was the intervention of this study. More research would need to be conducted to see if this turnaround was due to the intervention, or the material covered in these units, or if it was attributable to some other variable.

The researcher also judged that the cluster targeted in this study, Cluster B, as well as Clusters C and D, did not succeed as much from this intervention for the same reason Cluster E did: work ethic. The students in Cluster B, who view the course as a job, may not feel it is part of their “job” to strive for high expectations, but merely to complete the task to what they perceive as a satisfactory level. Although the researcher has no evidence to support this, it does not seem unreasonable that this lack of pride exhibited by Cluster B may be the reason these students end up in Cluster B as opposed to Cluster A.

Within this setting of studio college algebra and on-line homework, it may be difficult to positively impact Cluster C and Cluster D.. Cluster C gets easily bored with the material of the course, thus, asking them to do more to reach a higher level of understanding is not surprisingly unsuccessful. Cluster D doesn't mind the on-line homework, but they do not benefit from the studio portion of the college algebra course. Perhaps Cluster D may benefit from being enrolled in a more traditional course which includes on-line homework. Future studies need to find alternative ways to impact these students.

Contributions of the Study

As mentioned at the beginning of this paper, not much research has been done in the area of maximizing the effectiveness of on-line homework. The researcher hopes that the intervention studied here might provide an initial stepping stone for on-line homework users and researchers across the world, as well as future semesters at KSU. Realizing that students are accepting of a

50% minimum level is a benefit to future research design. Hopefully, researchers will see the rewards for students of researching this line of thought, and will continue to seek ways to take full advantage of the on-line environment, both from the student and instructor viewpoints.

For the current teachers, seeing another study in which a reasonable high standard was set and successfully achieved by the students is beneficial. Another benefit to current teachers was the results of the clustering scheme used in this study. Often, teachers are reminded that students learn via different modes, and the results of this study might provide some insight into possible interventions for both the students who benefitted from this intervention and maybe some ideas for the students who did not benefit from the intervention.

Recommendations for Future Research

The researcher believes this study was only the beginning in a possible line of research questions which could be explored. Future studies could include changing the minimum level of expectation from 50% to a higher value, in an attempt to determine just how high the standard can be set before students deem it unreasonable. Considering that 50% is still considered unsatisfactory in most courses, the researcher believes this mark could definitely be placed higher, and still produce similar results to the ones from this study.

Future research on this topic may also include looking for ways to help other clusters succeed in a college algebra course. The initial design of this study was an attempt to help Cluster B, since this group of students had experienced moderate success within the course but needed another aid to allow them to succeed at a higher rate. Determining the exact reason why Cluster B did not share in the success might be discernable through personal interviews with members of Cluster B.

Another possible avenue of research could be to slightly change one or more of the constants within this problem. This might include attempting to replicate this study at another University, using a different on-line homework system, or looking at a different course. Different settings, on-line homework systems, or courses may provide more general answers to the questions posed within this study, or possibly provide new insights into the ideas presented in this paper.

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Appendix A - Cluster Descriptions

The clusters developed by Manspeaker within this study each have unique characteristics. Appendix A provides a full description of each cluster.

Cluster A

This is a group of hard working students who have a positive attitude about mathematics and a good work ethic. Their average Composite ACT score is 22.38 and their Math ACT score is 21.44, so they are well prepared to take the course. These students do well on their first exam, but what separates them from everyone else is that they also do very well on all their other assignments and attend almost every class session. The Exam 1 problems on which these students excel are the standard problems that are most focused on in class, as well as the graphing and conceptually based problems. These students continue to do well on the subsequent exams and average an A or B on the final. Very few of these students drop the course and the percentage of students that earn a C or better is 97.1%. A separate set of pre and post exams showed that these students grew the most conceptually out of all of the groups.

Student interviews revealed that these students think that mathematics is used often to solve problems and has applications in art, to explain phenomena, and to improve society in general. Most think math is useful to themselves and their future careers, but are not sure if the specific skills they learned in College Algebra will apply to their future lives. By far, they think the most useful part of Studio College Algebra is recitation. The instructors are helpful and they appreciate being able to go over homework problems. These students like the overall class and its structure, even though they often struggle to understand the concepts. The online homework and studio is well liked, as well as lecture. The technological aspects of the course are also appreciated, including the convenience of online homework and that the lecture notes are posted online. That said, these students often have problems seeing how the studio part of the course fits in with the general class goals and get frustrated with online homework glitches.

These students study and work on their homework from 1-3 hours per week. They seek help from a variety of sources, including friends, the instructor, the textbook, and class notes.

They make sure to do their homework before recitation and use the online homework hints often. When asked to describe functions and perform certain tasks, these students demonstrated solid conceptual understanding of functions, their characteristics and applications. Their use of mathematical vocabulary was good to fair. They were also able to make connections between three different representations of the same function, either on their own or with prompting. Although these students could identify an increasing trend in a linear regression model, most students mistakenly identified this trend as representing an “average” of the dependent variable.

Cluster B

These students tend to treat the Studio College Algebra course like a low paying job. They do only what they think is expected of them, then are “paid” for their efforts with a passing grade. They come into the course reasonably well prepared with an average Composite ACT score of 22.6 and Math ACT score of 21.8. Students in this group perform fairly well on the first exam, averaging a B grade. They score well on standard problems that are reviewed many times in class, but not so well with problems that require extra reasoning. Their exam performance remains steady throughout the course, staying in the B/C range. They attend most classes at the beginning, but their attendance drops as the semester goes on. Students in Cluster B complete and turn in most of their assignments, but they do not score as highly as those students in Cluster A. Not many of these students dropped the course (6%), but only 85% of the total group earned a C or better. A separate set of pre and post exams showed that these students demonstrated moderate conceptual growth.

When interviewed about the Studio College Algebra course and mathematics in general, these students said that mathematics is very important for solving problems and explaining how things work. However, they don’t believe that everyone needs to learn mathematical skills, including themselves. Their confidence in their own mathematical abilities is low, they dislike math in general, and so they are trying to just “get through the class.” Although they don’t like math, they have generally positive opinions about the Studio College Algebra course. They particularly enjoy using Excel in the studio sessions and the integration of other types of technology in the course, such as iclickers. They think recitation and lecture are the most helpful parts of the course because the instructors are knowledgeable and supportive. Their least favorite part of the course is the Online Homework.

Students in this group spend an average of 1 to 2 hours a week studying or doing homework. If they have questions, they are likely to ask a friend or go to the instructor. These students take notes during lecture and refer to them often later. These students try to get their homework done before recitation so they can ask questions. During interviews, when these students were asked to perform tasks to demonstrate their knowledge, they were very dependent on prompting. The students were able to make connections between different representations of functions, but only after the interviewer gave hints. Their range in vocabulary use was wide, as was their ability to name specific functions. The students often performed memorized procedures without any justification. They could not describe any situations in which functions would be used. However, the students could interpret a linear regression model fairly well.

Cluster C

Students in this group are well prepared and intelligent, but are bored and frustrated with the material presented in College Algebra. They tend to drop the course or underperform. Their average Composite ACT score is 23.29 and their Math ACT score is 22.34, which is the highest of all the groups. However, their first exam scores are in the middle of the groups, a high C. They do well with applied problems and questions focusing on graphing, but they are sloppy with procedures and nonstandard algorithms. Their scores drop for subsequent exams, ending with a low C for the Final. These students have decent attendance scores and fairly high online homework scores, but do not perform as well on the other assignments, especially the written homework. Their attendance drops after the first few weeks. Almost 22% of these students drop the course, and only 65% earn a C or better. Also, only half of the students in this group took the pre and post exams that measure conceptual growth, and those that did showed very little increase in conceptual knowledge.

During interviews, students in this group thought mathematics was useful for a variety of reasons, especially to solve problems. However, they believed that math was only useful to some people, and although many expressed confidence in their mathematical abilities, they did not enjoy math. They thought math was not personally useful and that they would not be using math in the future careers. These students thought the class was easy and the emphasis on review boring. However, they still expressed frustration with different aspects of the course, including their own performance. Studio and recitation were their favorite parts of the course and they

enjoyed using Excel and other forms of technology. The recitation and lecture instructors are helpful. Their least favorite parts of the course were lecture and homework. Most students thought there should be less homework assigned, and disliked having to do so many applied problems. They also thought the exams were too tough, especially because they had to justify their answers.

These students sought help from written sources, like the textbook, notes, and online homework hints as well as from friends. They did not seek help from the instructor or tutors. Some students confessed to not studying much. They worked on homework anywhere from 1 to 5 hours a week. When asked to demonstrate their knowledge during the interviews, these students were very good at describing functions and making connections between different representations. However, they didn't always use proper mathematical vocabulary, and weren't able to come up with examples of functions or uses for functions. Their interpretations of a linear regression model were insightful and accurate.

Cluster D

These students do not like math, do not enjoy Studio College Algebra, and overwhelmingly drop or fail the course. Their Composite and Math ACT are on the low of the scale, being 21 and 20.6 respectively. These students were likely to attend class the first day, and to turn in their first assignments. Then they stop coming to class and do not turn in further homework or studio assignments. Their Exam 1 average is around 50%, and those students that do not drop the course fail the subsequent exams as well. Although they perform poorly on most of the exam problems, they are particularly bad at graphing and interpreting graphs. This group has a drop-out rate of 27.6% and only 41% of these students earn a C or better in the course. Those that took the pre and post tests measuring conceptual growth demonstrated that they learned very little.

These students had overwhelmingly negative views about mathematics, and their opinions got worse after taking studio college algebra. They believe that mathematical ability is inherited or intrinsic, not learned, and that only some people (not them) need to know mathematics. They have very little confidence in their abilities and doubt they will ever have to use skills they learn in this course in their careers. In particular, students expressed a dislike of graphs and fractions. This group thinks that recitation is the most helpful part of the course,

because they get help with their homework. They all expressed frustration and they struggle with completing their assignments. Some students enjoyed working with a partner in Studio and thought the online homework was convenient. Most did not like lecture due to its size. Online homework was not popular either, mostly because of the different due dates and the fact that the problems change after every second attempt.

These students all had tutors, who helped them with their homework, and to study for exams. If they needed help understanding a problem, they went to their friends or tutor, but not the instructor or text. One student admitted to not doing their homework until after most of the problems had been done in recitation. These students' level of conceptual knowledge was very low. Students did not volunteer much information, although they were able to make some connections between different functions after prompting. They attempted to commit actions like distributing without any reason why they should do so. Their use of vocabulary was fair to poor. These students were not able to interpret a situation involving linear regression.

Cluster E

Students in this group have a good attitude toward mathematics, try hard to succeed in the course, but still perform poorly. These students are generally not well prepared for the course, with an average Composite ACT score of 20.92 and Math ACT score of 19.27. These students attend class regularly and turn in all of their homework assignments. Despite this, their first exam scores are among the lowest of the five groups (C/D), and they maintain this low average throughout the semester. They are particularly weak with applied problems, although their mastery of procedures and algorithms are good. These students are less likely to drop the class than their test scores predict, with a rate of 12%. They continue to struggle heavily and 62% of them end up earning a C or better in the course. The pre and post exams that measure conceptual growth showed that these students did demonstrate moderate conceptual gains.

When interviewed these students revealed that they like math in general. They think it can be used in a lot of ways, especially to explain how things work, in creating art, and to solve problems. They think they will be able to use the skills they learned in studio college algebra in their careers, but their confidence in their own abilities are low, and they expect to struggle to understand new ideas and solve problems. Although the class is review for most of them, they have to work hard to understand the concepts, fulfill deadlines, and turn in their homework to the

appropriate place. They enjoy most aspects of the course, especially recitation. They also think the online homework is very helpful practice, because they can redo the problems as often as they like. Because the problems change with every other attempt, the students get even more attempts to practice the underlying procedures. The students tend to have trouble understanding the website, and feel that posting the lecture notes online discourages them from coming to class. By far, their least favorite part of the course is lecture, partly because of the intimidating class size. Although they enjoy working with a partner in Studio, they don't see how that part of the class fits in with the rest.

Students spend an average of 3 to 4 hours a week on homework and studying. They usually get help from their friends when they have problems understanding the material, and are not likely to ask instructors. These students spend a lot of time and effort completing their homework, shooting for scores of 100% and using several sources of information to help. During the interviews, students in this group demonstrated fairly solid conceptual understanding of the material, much more than their exam performances would indicate. They were especially adept at interpreting the applied linear regression model. They also seemed to pull out more information from graphs and pictures than from the formulas and charts.