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Improving Student Learning in Undergraduate Mathematics

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IMPROVING STUDENT LEARNING IN UNDERGRADUATE MATHEMATICS

by

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ABSTRACT

The goal of this study was to investigate ways of improving student learning, particularly conceptual understanding, in undergraduate mathematics courses. This study focused on two areas: course design and animation. The methods of study were the following:

- Assessing the improvement of student conceptual understanding as a result of team project-based learning, individual inquiry-based learning and the modified emporium model; and
- Assessing the impact of animated videos on student learning with the emphasis on concepts.

For the first part of our study (impact of course design on student conceptual understanding) we began by comparing the following three groups in Fall 2010 and Fall 2011:

1 Fall 2010: MAC 1140 Traditional Lecture & Fall 2011: MAC 1140 Modified Emporium

2 Fall 2010: MAC 1140H with Project & Fall 2011: MAC 1140H no Project

3 Fall 2010: MAC 2147 with Projects & Fall 2011: MAC 2147 no Projects

Analysis of pre and post tests show that all three groups showed statistically significant increases, according to their respective sample sizes, during Fall 2010. However, in Fall 2011 only MAC 2147 continued to show a statistically significant increase. Therefore in Fall 2010, project-based learning - both in-class individual projects and out-of-class team projects - conclusively impacted the students' conceptual understanding. Whereas, in Fall 2011, the data for the modified emporium model had no statistical significance and is therefore inconclusive as to its effectiveness. In addition the difference in percent of increase for MAC 1140 between Fall 2010 - traditional lecture model - and Fall 2011 - modified emporium model - is not statistically significant and we cannot say that either model is a better delivery mode for conceptual learning.

For the second part of our study, the students enrolled in MAC 1140H Fall 2011 and MAC 2147 Fall 2011 were given a pre-test on sequences and series before showing them an animated video related to the topic. After watching the video, students were then given the same 7 question post test to determine any improvement in the students' understanding of the topic. After two weeks of teacher-led instruction, the students took the same post-test again.

The results of this preliminary study indicate that animated videos do impact the conceptual understanding of students when used as an introduction into a new concept. Both courses that were shown the video had statistically significant increases in the conceptual understanding of the students between the pre-test and the post-animation test.

This work is dedicated to my husband and son

Tomasz and Alexander Rejniak

my parents

David and Kathy Gibson

and my sister

Loni Gibson.

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LIST OF ABBREVIATIONS

DOE	Department of Education
GTA	Graduate Teaching Assistant
MALL	Mathematics Assistance and Learning Lab
NCAT	National Center for Academic Transformation
STEM	Science, Technology, Engineering and Mathematics
UCF	University of Central Florida

CHAPTER 1

LITERATURE REVIEW

Many studies on how to improve student learning in undergraduate education have recently begun to arise with a new emphasis being placed on student learning and retention on a collegiate level. Students, specifically in STEM (Science, Technology, Engineering, and Mathematics) majors find it difficult to maintain the academic level of excellence that they were able to achieve while in high school. The transition from high school math classes to collegiate level math classes consistently provides the greatest difficulty for students to overcome. As a result, many studies on what course designs are best able to assist with this transition have been conducted. The goal of the first part of this study is to consider three different course designs in order to determine which had the greatest impact on students' conceptual learning: traditional lecturing, modified emporium model and learning communities (with and without projects).

Furthermore, research into the use of technology in education is abundant; however, our intent is to identify the differences between traditional videos and animated videos.

1.1 Traditional Lecture

In a traditional lecture course design, students meet in a classroom setting and listen while an instructor presents the new material and gives examples. They are then responsible for practicing the material outside of the classroom on their own time. this may include online course management systems for homework - especially for large classes (300+ students) at Universities.

1.2 Active Learning

Active Learning has received considerable attention in the past few years, yet it still has a very wide range of accepted definitions. [Mad07] Active learning, and its related term, active practice, are not clearly defined. Many instructors do not fully understand what Active Learning is or how it differs from traditional lecturing, specifically in STEM courses, where there is a necessary active component through homework, projects, and laboratories. "Active learning is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing." [BE91] It is easy to see why there is confusion on how this differs from traditional "active learning" activities, such as homework or laboratories. However, it is commonly understood that the practice of active learning refers to activities that are introduced directly in the classroom or in place of classroom time. Most notably, active learning is about engaging the learner and encouraging student participation.

It may be easiest to contrast active learning with passive learning. According to Madsen, Passive learning is where the students sit and listen, but do not take an active role in the learning process. [Mad07] In passive learning, the teacher takes the active role of explaining the material and working the examples. In contrast, active learning makes student become involved in the learning process. Learning "emphasizes the person in whom the change occurs or is expected to occur. Learning is the act or process by which behavioral change, knowledge, skills, and attitudes are acquired." [BE91] "Active learning promotes student learning through problem solving, teamwork, simulations, case work, feedback and other activities that actively engage students in applying, analyzing and synthesizing course content." [Tho02] It is important to note that both active learning and active practice are student focused instead of instructor focused. Active practice is an important part of active learning, where active practice is the means and active learning is the result.

1.3 Emporium Model

In Fall 2010, the University of Central Florida began to incorporate the methodology of active learning into the traditional Pre-Calculus Algebra course, MAC 1140, through the Modified Emporium Model.

NCAT, The National Center for Academic Transformation, and their partner institutions have found that the implementation of the Emporium Model into introductory math courses has consistently produced high-level gains in student learning, while also reducing the cost of instruction. [NCA05]

According to Twigg, "The primary reason many students do not succeed in the [traditional math] course is that they do not actually do the problems. As a population, they generally do not spend enough time with the material, and this is why they fail at a very high rate." [Twi11] UCF adopted a course design where students were encouraged to "do the work" without adding to the number of required hours. Students who are enrolled in the Modified Emporium model course, MAC1140, are required to meet with their instructor one time a week for 50 minutes and spend an additional 3 hours in the MALL, Mathematics Assistance and Learning Lab, thereby maintaining the same total course hours as a traditional math course. This model is called a Flexible Attendance Course design since the students may choose the three hours that they want to spend in the MALL. [NCA05]

This course design puts 75% of the students' learning in the lab, placing the instructor into the role of guide rather than teacher. Instructors use their one hour per week to explain confusing or difficult problems and point out common errors. The Methodology of active learning is at the center of the Modified Emporium Model in that the chosen model inherently lends itself to active practice. At Virginia Tech, the implementation of the Emporium model was guided by 3 main principles: the use and adaptation of technology, active learning, and instilling a sense of responsibility and organization in their students. [RM]

While assessment of the emporium model have clearly and consistently indicated student learning gains, the goal of this study is to not assess improvement of skills but rather focus on conceptual understanding.

1.4 Learning Community

Recently we have seen a shift in focus from learning as an individual to learning as part of a community. The learning community, though it has received much attention and been the focus of many studies, is also not universally defined. The main idea is to recognize and learn from the knowledge and contributions of others to enhance and encourage the learning of the individual.

"The broadest and most inclusive use of learning communities is to describe situations where an array of groups and institutions have united forces to promote systematic societal change and share (or jointly own) the 'risks, responsibilities, resources and rewards'." [Him] Learning Communities have been described as focusing "on the human element of communities, and the profits that accrue from building on the synergies of individuals in common locations or with common interests as they work towards sharing understandings, skills and knowledge for shared purposes" by Kilpatrick, Barrett, and Jones. [KJ03] Another definition is given by Kearns, McDonald, Candy, Knights and Papadopoulos: "any group of people, whether linked by geography or some other shared interest, which addresses the learning needs of its members through proactive partnerships" constitutes a learning community. "It explicitly uses learning as a way of promoting social cohesion, regeneration and economic development." [KP99]

STEM majors are often viewed unfavorably by students and the attrition rate is much greater than many non-STEM majors. While many instructors at a pre-secondary level, about 79% of elementary teachers and 62% of middle school teachers, have adopted small-group or community learning, the push for incorporating cooperation and community into courses has failed to penetrate post-secondary education. [SD97] In fact, the majority of post-secondary education still focuses on teaching instead of learning.

Creating an environment of learning, cooperation, and community have been shown to improve students' motivation and desire to learn, thus achieving a greater success rate for students.

In the following tables, 1.1 and 1.2, the effects of collaborative learning is demonstrated through several independent studies. These independent studies show that the incorporation of collaborative learning, through learning communities, affects not only student success rates but also their attitude toward the class, themselves and their peers.

1.5 Conceptual Learning vs. Procedural Learning

Rittle-Johnson defines conceptual learning as "explicit or implicit understanding of the principles that govern a domain and of the interrelations between pieces of knowledge in a domain." Procedural knowledge was also defined by Rittle-Johnson as "action sequences for solving problems." [RA99] In *Adding It Up: Helping Children Learn Mathematics*, conceptual understanding is defined as "comprehension of mathematical concepts, operations, and relations." [Jer01]

In *Conceptual and Procedural Knowledge of Mathematics: Does One Lead to the Other?*, Rittle-Johnson investigated how teaching mathematical concepts influenced the children's problem-solving abilities vs. how instructing students on problem-solving influenced their conceptual understanding of the math problems. Within her study she found

Table 1.1: Collaborative vs. Individualistic Learning: Reported Effect Size of the improvement in different learning outcomes

Reference	Learning Outcome	Effect Size
Johnson et al [Edi98]	Improved Academic Achievement	0.64
	Improved Quality of Interpersonal Interactions	0.60
	Improved Self-Esteem	0.44
	Improved Perceptions of Greater Social Support	0.70
Johnson et al [JS98]	Improved Academic Achievement	0.53
	Improved Liking Among Students	0.55
	Improved Self-Esteem	0.29
	Improved Perceptions of Greater Social Support	0.51
Springer et al [SD99]	Improved Academic Achievement	0.51
	Improved Student Attitudes	0.55
	Improved Retention in Academic Programs	0.46

Table 1.2: Collaborative vs. Competitive Learning: Reported Effect Size of the improvement in different learning outcomes

Reference	Learning Outcome	Effect Size
Johnson et al [Edi98]	Improved Academic Achievement	0.67
	Improved Quality of Interpersonal Interactions	0.82
	Improved Self-Esteem	0.83
	Improved Perceptions of Greater Social Support	0.67
Johnson et al [JS98]	Improved Academic Achievement	0.49
	Improved Liking Among Students	0.68
	Improed Self-Esteem	0.60
	Improved Perceptions of Greater Social Support	0.47

that students who received conceptual instruction were just as likely to learn the correct procedure; in contrast, the students who received procedural instruction struggled to adapt the problems they were shown to new problems that differed in small ways. [RA99] These findings were consistent with other research, such as Hiebert and Wearne's findings that students who developed conceptual understanding consistently developed procedural skills in the future, whereas many of those who learned the correct procedure did not grasp the related concepts over a three year period. [HW96] "Teaching children the basic concept behind math problems was more useful than teaching children a procedure for solving the problems; these children gave better explanations and learned more," Rittle-Johnson said. [RA99]

Both conceptual learning and procedural learning are a necessary component of student success in STEM courses. In fact, The National Research Council developed five strands of mathematical proficiency listing conceptual understanding and procedural fluency as the first two strands. [Jer01]

So, how do we ensure that students gain conceptual understanding in their STEM courses? What instructional methodology and course design are best for instructing on a conceptual level? These are the questions that will be addressed in this study.

1.6 Project-Based Learning

Project-Based learning is an instructional methodology that centers around the use of projects to enhance student learning and conceptual understanding. The use of projects as a learning tool gives students the opportunity to look at the material they are studying at higher cognitive levels. Often the problems assigned in math courses do not stretch students' learning above the level of Application on Bloom's Taxonomy. However, projects are designed to have students working at much higher cognitive levels, such as analyze, evaluate and create. Requiring students to work through the process of developing and evaluating project results elevates the level of their thinking skills. Thus, in theory, students will gain a greater conceptual understanding and be better able to more easily adapt their procedural understanding to new scenarios.

The use of projects as a method of active learning allows student focus to be directed more towards "the application of knowledge". In contrast, traditional problem-based learning directs student learning towards "the acquisition of knowledge". [Mil03]

1.7 Use of Pre-Tests and Post-Tests

One of the most widely used methods for evaluating student learning is pre and post-testing. This evaluation method is designed to measure changes in participant knowledge. Hartley and Davies define Pre-testing as "any set of related questions, given before instruction, that is directly relevant to the knowledge, attitude, or skill domain to be acquired". The prevalence of pre and post-testing may be attributed in part to the ease with which they can be constructed and administered. They are often developed as a written exercise and may contain matching, true/false, multiple-choice, short-answer or long-answer questions. [HD76]

In an article published and funded through the Department of Education, pre and post-testing refers to "academic achievement tests (in reading, math, and other subjects) that are given to students to assess their academic progress from the beginning to the end of a program of instruction." [Giv] Pre-testing should ideally give a baseline for student understanding at the time of entry to the course and their current achievement level. The difference from pre-testing to post-testing should reflect the level of learning that has occurred throughout the course. This method of measuring student learning is beneficial because it gives a real-time assessment of progress.

1.8 Kahn Academy

"A free world-class education for anyone everywhere." http://www.khanacademy.org/

This is the goal of the Kahn Academy. But how do they propose to accomplish this lofty ambition? Their answer is to provide the following resources:

- An on-line library of videos covering K-12 math, science, and even finance and history. The videos, designed for viewing on a computer or iPad (whose app was launched in March 2012), are short chunks - about 10 minutes in length - of material that are easy for the watcher to digest.
- On-line adaptive assessment exercises. Each problem is randomly generated and provides the user with both step-by-step directions and related videos of how to work the problem.

Here is an example of their video, "**Sequences and Series (part 1)**: Introduction to the arithmetic and geometric series" http://www.khanacademy.org/video/sequences-and-series–part-1?topic=calculus

The video shows an instructor giving a "lecture style" overview of the topic, and resembles a traditional lecture course design presented in short clips in an online mode instead of face-to-face. The video "**Sequences and Series (part 1)**: Introduction to the arithmetic and geometric series", ≈10 minutes in length, gave one basic example of what a sequence is - 1, 2, 3, 4,.... - and then spent the remainder of the video (and into part 2) explaining the finite arithmetic and geometric series, $\sum_{k=1}^{n} k$ and $\sum_{k=1}^{n} a^k$, respectively.

1.9 Technology and Videos in Education

"For over two decades, educational technology has been used to varying degrees in our nation's schools. Numerous studies exist demonstrating that

- (a) educational technology appropriately applied can enhance learning and achievement compared to traditional teaching methods and
- (b) the benefits of educational technology cannot be adequately separated from other variables that impact learning in the larger instructional context." [McC00]

"Making the connection between technology and teacher is one of the most important steps the nation can take to make the most of past and continuing investments in educational technology." [US95] The U.S. Congress Office of Technology Assessment also states that the incorporation of technology in the classroom is central to helping students "become more accomplished learners overall". [US95]

Teachers who have taken steps towards the integration of technology often find that it can help motivate student learning, address different learning styles and expose students to more information and experts. [US95] According to Christensen, instructors who are successfully integrating technology into the classroom teach differently than those who are not. [Chr02] Bransford, Brown and Cocking determined five ways in which technology is better able to support student learning:

- "Bringing exciting curricula based on real-world problems into the classroom;
- Providing scaffolds and tools to enhance learning;

- giving students and teachers more opportunities for feedback, reflection, and revision;
- Building local and global communities that include teachers, administrators, students, parents, practicing scientists, and other interested people; and
- Expanding opportunities for teacher learning." [LE00]

According to McCombs, the keys issues that must be addressed when incorporating technology into education are

- Meeting the students needs for interpersonal connections;
- Acknowledging students different learning abilities, needs, styles and interests;
- Assessing the efficacy of technology to meet the diversity of those abilities, needs, styles and interests. [McC00]

As this research suggests, it is imperative that teachers consider their audience and how they can best engage them in the learning process. The use of technology has been shown to increase student motivation and develop a sense of personal investment in the learning process. [US95] Proper use of technology can overcome many of the roadblocks to learning that students encounter.

There are multiple types of technology that teachers can choose to incorporate into their classrooms. According to the Miriam-Webster dictionary, technology is "a manner of accomplishing a task especially using technical processes, methods, or knowledge". In education we see this application of technology in the use of:

1 On-line Course Management Systems: on-line access to homework, reference videos and text books.

2 Social Media: Facebook, Twitter, YouTube, TeacherTube, etc.

3 Animation

The specific use of video in the classroom has become more and more common with the onset of youtube, `http://www.youtube.com/`, and teachertube, http://www.teachertube.com/. Today's students are growing up in a world in which they are being constantly besieged by visual stimuli through tv, video games, on-line apps, and computers. Hence, visual perception has begun to play a bigger role in the process of learning about their world and understanding it. According to Felder and Solomon, most students are primarily visual learners. [FS] Not surprisingly, many educational institutions have begun to rely heavily on visual media to improve student learning. [Jur99]

"Video technology also helps bridge the gap between the school's artificial environment and the outside world, bringing 'reality' into the classroom." [Jur99] Videos, that turn information into a presentation method that can be replayed, give students more power over when, how and how often the information may be accessed and referenced. The goal for educators is to find a delivery mode that is flexible, appeals to multiple learning styles, empowers student engagement and promotes student learning.

While extensive research has been conducted on the use of technology and videos in the classroom, it is not conclusive. [Jur99] "The capability of using technology does not ensure that its use will be appropriate and that learning will occur. Indeed, its use presents extra challenges for the instructor, who needs to be aware of the potentialities and limitations of the equipment." [Jur99] The breadth of this concern, while important to consider, is outside the scope of this study, which will only consider the use of animated videos as an instructional tool to facilitate the introduction of a new concept in the classroom.

1.10 Animation

In this study, the use of technology is focused on incorporating animated videos into a classroom setting as a means of giving students an introductory conceptual overview of a topic.

Educational animations are designed to foster student learning in an educational setting. With new graphic-oriented software it has become easy and cost effective for instructors to create their own dynamic animations to incorporate into their lessons. But do they have an intrinsic effectiveness that educators are expecting? It would seem that animation, as a delivery mode for presenting content, is dynamic and impactful. However, research has been mixed. While the assumption that animated graphics can and do facilitate student learning, many initial studies have found that animation is no more effective than static graphics. [Tve02] Perhaps animation is not intrinsically effective, instead, the characteristics of individual animations are the key factors. "The ability to communicate information through animation is increasing. However, to use this technology effectively in communication, education, and training, we need to understand how and under what circumstances people learn [through] animations." [HK07]

Howard Gardner presented the idea of multiple intelligences in 1983 in his book *Frames of Mind*. The nine learning styles or intelligences are Verbal/Linguistic, Logical/Mathematical, Visual/Spatial, Bodily/Kinesthetic, Musical, Interpersonal, Intrapersonal, Naturalistic, and Existential. The correct use of animation may allow more learning styles to be addressed during the course of a class period, thus increasing student learning.

In 1995, Williamson and Abraham conducted a study on the use of animation in teaching chemistry. It was found that students who were shown short animations, about 1 to 2 minutes, did significantly better on exams than the students who did not receive the supplemental animated video instruction. They also found that students enjoyed the classes more and had a more positive attitude toward learning the material. [WA95]

In another study, Stith asked approximately half of his class to leave the classroom for approximately 4 minutes while he showed the other half of the students a 65 sec animated video on apoptosis three times. This was done after he had given an 18 minute lecture on the material. After the students re-entered the classroom, Stith gave a quiz over the material covered in the lecture and video. His results showed that both sets of students did statistically the same on questions that were only covered in lecture; whereas, on questions that were covered in both lecture and video, the students who watched the video had an average increase of 20

CHAPTER 2

PRE-CALCULUS EXPERIMENT

The purpose of this study is to determine which course design: Learning Community Model, Traditional Lecture Model, or Modified Emporium Model, provides for the greatest student learning and conceptual understanding of the course material. In addition, we will be studying the impact on conceptual learning when including projects as an instructional enhancement.

Among the course designs that were studied, the Learning Community or the Modified Emporium Model should provide the better environments to enhance student learning. [NCA05] [Edi98] [SD99] The inclusion of projects in the course curriculum should enhance instruction and also improve the conceptual learning experience students will engage in through the application of the mathematical concept in a real world scenario.

Table 2.1 summarizes the three groups studied for this experiment and presents the initial hypotheses.

Table 2.1: Pre-Calculus Experiment: Summary of Pre-Calculus Hypotheses

course	Fall 2010	Fall 2011	Hypothesis
MAC 1140H	Instructor A - Small Lecture with Team Project	Instructor A - Small Lecture with No Project	$\Delta \div$ mean pre-test should be $\geq .2$ in Fall 2010 and $\geq .1$ in Fall 2011
MAC 2147	Instructor A - Large Lecture with 4 In-Class Projects	Instructor B - Large Lecture with No Projects	$\Delta \div$ mean pre-test should be $\geq .2$ in Fall 2010 and $\geq .1$ in Fall 2011
MAC 1140	Instructor B & C - Traditional Lecture Model	Instructor D & E - Modified Emporium Model	$\Delta \div$ mean pre-test should be $\geq .1$ in Fall 2010 and $\geq .2$ in Fall 2011

The sample included 854 undergraduate students from Fall 2010 and 439 undergraduate students from Fall 2011 who were enrolled in the course entitled "Pre-Calculus Algebra". Table 2.2 lists the number of students that completed both the pre-test and the post-tests given in each course that is being considered and the semester in which they took the course.

Table 2.2: Sample Sizes

Semester	MAC 1140H: Honors	MAC 2147: Excel	MAC 1140: Traditional Lecture Model (2010)/ Modified Emporium Model (2011)
Fall 2010	Instructor A - 13	Instructor A - 88	Instructors B & C - 753
Fall 2011	Instructor A - 19	Instructor B - 81	Instructors D & E - 339

The dis-proportionality of sample size for MAC 1140 between Fall 2010 and Fall 2011 can be attributed to a high withdrawal rate in Fall 2011. Another contributing factor is that students were not required to complete the pre-test or post-test.

Pre-Calculus Algebra is a freshman level course covering topics like functions, polynomial functions, exponentials and logarithmic functions, systems of equations, and conics. It has been designed to provide a solid foundation for students who will be taking Calculus.

2.1 MAC 1140: Traditional Lecture Model and Modified Emporium Model

In the Traditional Lecture course design for the 3 credit course MAC 1140 used by UCF in Fall 2010, the class met two times a week for one hour and 15 minutes in a large lecture hall. There were multiple sections offered, with each section having more than 100 students. Practice was given in the form of on-line homework and quizzes that the students were required to complete on their own time. Tests were also given on-line in a computer lab. All sections used the same syllabus, homework and tests.

In the modified emporium model used at UCF in Fall 2011, students enrolled in MAC 1140 course - 3 credits - met with their instructor once a week for 50 minutes and were then required to spend an additional 3 hours each week in a computer lab, MALL, completing on-line homework and quizzes. These students were given free access to GTAs (graduate teaching assistants), instructors and tutors for assistance with the on-line homework while in the MALL. The active practice of working problems and completing examples on their own, with the facilitation of available instructors and tutors, was designed to increase the students' active learning time and reduce the amount of passive learning time in the classroom. The emporium model has been shown to improve student learning. [NCA05] The purpose of this study is only to assess conceptual learning, not procedural learning.

Let us begin our analysis by looking at the Traditional Lecture Model used in Fall 2010 and the Modified Emporium Model adopted in Fall 2011. The assessments in Fall 2010 and Fall 2011 - homework, quizzes and tests - were given in an on-line format with testing done in the Mathematics Assistance and Learning Lab (MALL). In the table below, 2.3, we will examine the data collected from the Pre-Tests and Post-Tests given during both Fall 2010 and Fall 2011.

Table 2.3: Traditional Lecture Model: Fall 2010 and Modified Emporium Model: Fall 2011

MAC1140	Mean Pre-Test	Mean Post-Test	*$\Delta \div$ Mean Pre-Test
Fall 2010 - Instructors B & C	2.48	2.89	0.167
Fall 2011 - Instructors D & E	2.54	2.54	-0.00116

Δ *represents the average change in pre-test and post-test scores*

To determine if the mean percent of increase from Fall 2010 and Fall 2011 were statistically significant, the p-values were calculated and compared with our *null hypothesis*, H_0. If the p-value $< H_0$ then the null hypothesis is rejected. This implies a 95% confidence that our increase did not happen by chance and it is statistically significant. A left-tailed p-value, Z <1, was chosen as an increase from pre-test scores to post-test scores was expected.

As shown in Table 2.4, there was a statistically significant increase for Fall 2010; however, the decrease in Fall 2011 is not conclusive and has no statistical significance.

Table 2.4: Statistical Significance of Average Increases in MAC 1140

MAC 1140	Null Hypothesis: H_0	Alternate Hypothesis: H_a	Expected Population Mean: $\bar{x}$	Sample Mean: μ	Sample Size	P-value	Statistically Significant
Fall 2010	.05	>.05	.1	.167	752	.015	True
Fall 2011	.05	>.05	.1	.00116	339	.993	False

Δ *represents the average change in pre-test and post-test scores*

The mean pre-test scores from Fall 2010 and Fall 2011 are very close. In Fall 2010 while implementing the Traditional Lecture Model the students showed a small increase, approximately 16.7%, on their average post-test score; whereas in Fall 2011, with the implementation of the Modified Emporium Model, there was almost no change, $\approx$-.1%, from the average pre-test score to the average post-test score. The average pre-test scores in Fall 2011 was almost identical to the average Post-Test score. This indicates that the students conceptual understanding remained approximately the same from the beginning of the semester to the end. In addition, the difference in the average increase between Fall 2010 and Fall 2011 had a p-value of .420 which indicates that there is no statistical significance to the difference and is inconclusive in its results. Statistically, it may simply be chance and not be related to the change in course design model.

While extensive research on the implementation of the Emporium Model has shown an improvement in student success rate, it would seem that this is due to an increased focus on procedural learning as opposed to conceptual learning. This supports the conclusion from Rittle that improving students' knowledge of procedures does not inherently improve their understanding of the concepts behind the procedures. [RA99] According to our data, the students who were enrolled in the modified emporium model, MAC 1140 Fall 2011, did not show any improvement in their conceptual understanding over the course of the semester. Although, because of the inconclusiveness of the statistical analysis further study needs to be conducted.

2.2 MAC 1140H: Honors

In the Honors Pre-Calculus Algebra course, students met with their instructor 3 times a week for 50 minutes. This course is considered a living-learning community model, as the honors students are given access to computer labs specifically designated for honors students, tutors, and study areas encouraging interaction among peers. In addition they are given a separate housing block to live, interact and study together.

During the Fall 2010 semester the students were given 4 tests and a final exam. They were also required to complete 10 cumulative assignments throughout the semester, a team project, and daily quizzes. The team project was Global Climate Change Modeling which focused on the Pre-Calculus topic of polynomial functions. The students were assigned groups and given a cumulative project to complete. The topic was "Global Climate Change Modeling" and can be referred to on page 78.

In Fall 2011, the Honors Pre-Calculus Algebra students were required to complete all of the same coursework with the exception of the team project. Otherwise the course structure, instructor, and topics covered remained exactly the same.

Since the only variable between semesters was the implementation of a project in Fall 2010, we will be considering the impact of that project on the students' conceptual understanding of the topic covered by the project compared to the students who were not required to complete the project.

Between Fall 2010 and Fall 2011 MAC 1140H was only given one treatment: the implementation of a multi-topic group project in Fall 2010 and no project in Fall 2011. Otherwise, both courses had the same instructor and course design. In this section we will examine the impact of projects on conceptual learning. The following table, 2.7, displays the data collected from both Fall 2010 and Fall 2011 pre-tests and post-tests for MAC 1140H.

Table 2.5: MAC 1140H: Small Lecture with Team Project vs. Small Lecture with no Project

MAC1140H	Mean Pre-Test	Mean Post-Test	*$\Delta \div$ Mean Pre-Test
Fall 2010 - Instructor A	2.85	4.39	0.540
Fall 2011 - Instructor A	3.11	3.94	0.268

Δ *represents the average change in pre-test and post-test scores*

The students from the Fall 2010 term had an average increase that was more than double the increase seen from the Fall 2011 students. Next we will considered the individual Pre-Test and Post-Test questions to assess if the project had a direct impact on the increase of scores, and thus accounts for the difference from Fall 2010 and Fall 2011. The data will show that the initial hypothesis, the implementation of project-based learning will increase the students' conceptual understanding through the application of the topic in a real world scenario, holds true.

Due to the small sample size for MAC 1140H in both Fall 2010 (13 students) and Fall 2011 (17 students, it was necessary to use a t-score to determine whether the gains were statistically significant. Therefore, the p-values in table 2.6 correspond to the resulting t-score. The same null hypothesis, for determining statistical significance, was considered as when z-scores were found for MAC 1140 and MAC 2147.

As shown in Table 2.6, there was a statistically significant increase for Fall 2010; however, the increase in Fall 2011 is not conclusive and has no statistical significance.

Since Fall 2010 has an statistically significant increase and Fall 2011 did not, it can be concluded that the incorporation of an out-of-class team project did have a positive impact on the students' conceptual understanding.

Table 2.6: Statistical Significance of Average Increases in MAC 1140H

MAC 1140H	Null Hypothesis: H_0	Alternate Hypothesis: H_a	Expected Population Mean: $\bar{x}$	Sample Mean: μ	Sample Size	P-value	Statistically Significant
Fall 2010	.05	$>.05$	.2	.540	13	.027	True
Fall 2011	.05	$>.05$	.1	.268	17	.433	False

Δ *represents the average change in pre-test and post-test scores*

In addition, the difference in increase between Fall 2010 and Fall 2011 had a p-value of .0127. Thus, the difference is considered statistically significant and not the result of chance. This verifies the previous conclusion that the out-of-class team project did impact conceptual learning in MAC 1140H.

The following table shows the percent of increase by question. We will compare the data from Fall 2010 and Fall 2011 to determine if the implementation of the project improved the Fall 2010 students' conceptual understanding, specifically on polynomial functions, over that of the Fall 2011 students.

Table 2.7: MAC 1140H: Average Student Improvement by Question

MAC1140H	Conic Section	Polynomial Function	Exponential Function	Rational Function	System of Linear Equations
Fall 2010	62.6%	117%	25.2%	799%	9.10%
Fall 2011	-7.20%	27.5%	14.3%	450%	15.4%

This table indicates that the average percent of students who accurately answered the question on polynomial functions increased by ≈116% in Fall 2010 after completing a group project addressing this topic. In comparison, the Fall 2011 students only increased by ≈27% when no project was assigned. This would seem to indicate that the project did improve student conceptual learning. In addition, the difference in the gains between Fall 2010 and Fall 2011 on Conic Sections and Rational Functions were also statistically significant.

Did the implementation of the project affect conceptual understanding over the entire course instead of just the individual topic that was specifically investigated? To address this question, we looked at what percent of the total increase per semester each question accounted for. The average increase is more evenly distributed over all five questions for the Fall 2010 students who were asked to complete the group project.

1 Conic Section: 22%

2 Polynomial Function: 30%

3 Exponential Function: 9%

4 Rational Function: 35%

5 System of Linear Inequalities: 4%

In contrast, during Fall 2011, over half of the total average increase, ≈60% was attributed to the question on rational functions. Polynomial functions, exponential functions and system of linear inequalities were even with ≈13.3% and conic sections had a negative gain of ≈6.7%

While both sections had the largest gains seen on rational functions, only the Fall 2010 students also showed more evenly distributed increases over all of the topics.

Thus, the data affirms that the inclusion of a large group project not only helped to improve the students' conceptual understanding of the project topic but also shows promise that it may have facilitated significant gains on other related topics as well.

2.3 MAC 2147: Excel

The University's Excel Program is designed to give freshman STEM students the greatest chance of success within the first two years of college, thereby increasing the retention rate of students in STEM majors. The Excel students are given free access to GTAs - Graduate Teaching Assistants - a tutoring lab to help them succeed in their STEM courses and a GTA mentor. In addition Excel students are able to live in a housing block designated for them, in which they can live, study and socialize together. This model is a living-learning community.

In the Excel Pre-calculus Algebra course, MAC 2147 - same content as MAC 1140 and MAC 1114 combined, students met with their instructor for 1 hour and 50 minutes three days a week in both Fall 2010 and Fall 2011. A one hour recitation session was incorporated into the class time each week giving students the chance to work in groups to complete longer application-type questions. In addition to the set class time, all students were required to complete 4 hours of lab time, prior to the first test, where they work on homework and practice the material that was covered in the class. These lab hours can increase to 8 hours a week or decrease to 0 hours depending on the students performance on each subsequent test, creating a flexible lab time model.

The Excel lab is an independent learning lab that is only open to students who have been admitted into the Excel program. GTAs for math, physics, chemistry, engineering, and computer science are available to help students with their STEM coursework.

In Fall 2010, the Excel students were required to complete 4 in-class individual projects that covered Polynomial Functions (page 87), Rational Functions (page 86), Conic Sections (page 81), and Systems of Linear Equations (page 84).

While there was a change in professor between Fall 2010 and Fall 2011, as well as the inclusion of projects, all other factors - syllabus, on-line homework, testing standards, lab requirements, and daily quizzes - remained consistent. Thus, we should expect the change in instructor to have very little effect on the overall results.

For this experiment, students in MAC 1140, MAC 1140H and MAC 2147 (all Pre-Calculus Algebra courses), were given a pre-test, page 91, at the beginning of the semester and a post-test, page 94, at the end of the semester.

The pre-test and post-test were designed to test the students' conceptual understanding of the following five topics listed in Table 2.8:

Table 2.8: Pre-Test and Post-Test Topics

Problem	Topic
1	Conic Sections
2	Polynomial Functions
3	Exponential Functions
4	Rational Functions
5	System of Linear Equations

The students were also given a set of graphs, containing no numbers, which they had to match up with the correct topic. No numbers were given in order to test the students understanding of the general concept of each topic as opposed to graphing a specific example, which denotes procedural understanding. There were a total of eight graphs given, but three of them were not examples of any of the five topics. In addition to graphs representing the five topics listed in Table 2.8 there was also a piecewise defined function, a logarithmic function, and a linear function. The students were required to recognize a generalization of the graph and identify it with a topic (concept).

The goal of this study was to assess which course design, Traditional Model, Modified Emporium Model or Learning Community Model, led to the greatest improvement in the students' conceptual understanding. Within this we also considered the use of project-based learning as an instructional method to enhance conceptual learning. We will begin our analysis by looking at each course group independent of the other two, in order to determine their individual effect on the conceptual understanding of the students enrolled. The three course groupings are,

1 MAC1140 taught as a traditional lecture in Fall 2010 and MAC1140 taught as a modified emporium model in Fall 2011.

2 MAC1140H taught as a small lecture with one out-of-class team project in Fall 2010 and MAC1140H taught as a small lecture with no project in Fall 2011.

3 MAC2147 taught as a large lecture learning community with 4 in-class individual projects in Fall 2010 and MAC2147 taught as a large lecture learning community with no projects in Fall 2011.

Students enrolled in MAC 2147 during the Fall 2010 term were given four in-class projects to complete throughout the semester. The project topics covered conic sections, polynomial functions, rational functions and system of linear equations - project descriptions can be found in Appendix 5. In Fall 2011, the students were not given any projects to complete. In the following table, 2.9, we report the average change in pre-test to post-test scores for both Fall 2010 and Fall 2011.

Table 2.9: MAC 2147: Learning Community with Projects vs. Learning Community with no Project

MAC2147	Mean Pre-Test	Mean Post-Test	$*\Delta \div$ Mean Pre-Test
Fall 2010 - Instructor A	2.41	4.15	.719
Fall 2011 - Instructor B	2.28	3.09	.351

Δ represents the average change in pre-test and post-test scores

As shown in Table 2.10, there was a statistically significant increase for Fall 2010 as well as in Fall 2011. Since both Fall 2010 and Fall 2011 had a statistically significant increase, it can be concluded that the incorporation of an in-class individual project did have a positive impact on the students' conceptual understanding, as did the small lecture learning community model.

From a quick overview we can see that there was a 37% greater increase in scores for the Fall 2010 students than the Fall 2011 students. As in MAC 1140H we see that the increase gained in Fall 2010 was more than double the increase gained in Fall 2011.

Table 2.10: Statistical Significance of Average Increases in MAC 2147

MAC 1140H	Null Hypothesis: H_0	Alternate Hypothesis: H_a	Expected Population Mean: $\bar{x}$	Sample Mean: μ	Sample Size	P-value	Statistically Significant
Fall 2010	.05	>.05	.2	.719	87	0	True
Fall 2011	.05	>.05	.1	.351	81	.020	True

Δ represents the average change in pre-test and post-test scores

Additionally, the difference in the average increase between Fall 2010 and Fall 2011 had a p-value of .0090, which indicates that it is not a result of chance and is statistically significant. Thus verifying that the in-class individual projects did impact the students' conceptual learning.

Now we will break down the individual data to determine if the projects account for the difference in the increase. The four projects given are as follows:

- Project 1, 87, adressed the topic of Polynomial Functions.
- Project 2, 86, addressed the topic of Rational Functions.
- Project 3, 81, addressed the topic of Conic Sections.
- Project 4, 84, addressed the topic of System of Linear Equations.

In order to determine the effectiveness of in-class individual projects on conceptual learning, we will consider the average percent of change for each topic individually. Figure 2.1 shows the percent of students who correctly answered the five questions on the Pre-test and the post-test in Fall 2010. These questions covered the 4 topics addressed by the above listed projects and exponential functions.

From Figure 2.1, we can see that there were significant increases, 54.2% on conic sections, 39.4% on Polynomial Functions, 43.7% on Exponential Functions, 31.9% on Rational Functions, and 19.2% on Systems of Linear Equations, which seems to imply that the projects completed by the students in Fall 2010 had a positive impact on conceptual learning.

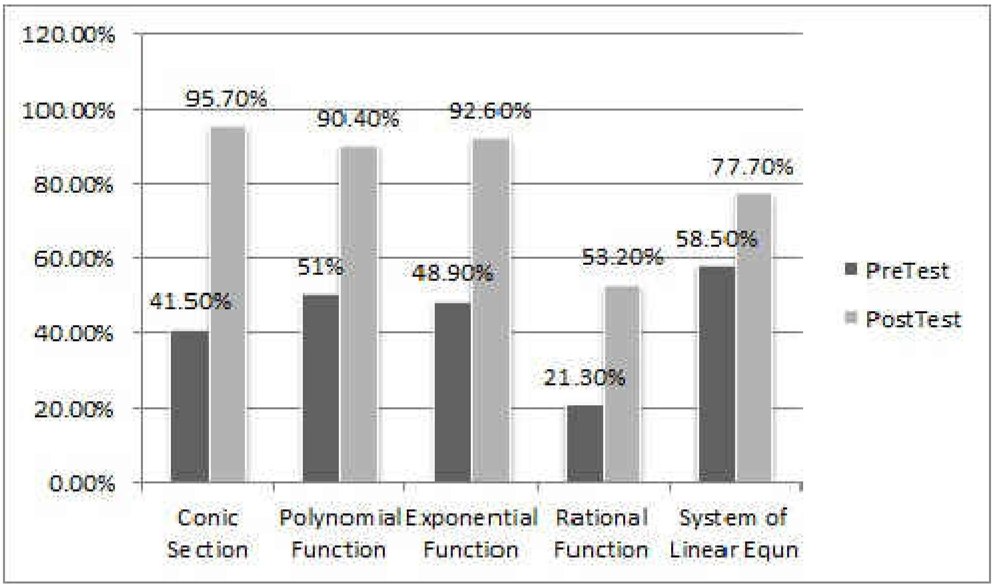


Figure 2.1: MAC 2147: The Average Percent of Students to Correctly Answer the Questions

Comparing the percent of average increase from pre-testing to post-testing of Fall 2010 with Fall 2011, as can be seen in table 2.11, shows that the students who completed projects in Fall 2010 had a greater percent of increase on all questions with the exception of rational functions. However, this could be a result of a lower Fall 2011 pre-test score - 21.3% in Fall 2011 compared with 13.7% in Fall 2011. Also, the increase in the percent of correctly answered rational functions questions in Fall 2010 was ≈32% but only ≈9.5% in Fall 2011.

To get a more complete idea of what the data is telling us, it is important to look at how the total increase between pre-tests and post-tests, for both Fall 2010 and Fall 2011, was distributed over the five questions. There appeared to be a more even distribution for Fall 2010. In Fall 2010, the total percent of increase was divided among the five questions as follows:

1 Conic Section: 29%,

2 Polynomial Function: 21%,

3 Exponential Function: 23%,

4 Rational Function: 17%,

5 System of Linear Inequalities: 10%.

In Fall 2011, conic sections and exponential functions accounted for ≈69.1% of the total increase, whereas system of linear equations had almost no improvement with ≈1.35% increase.

The difference in the percent of average increase in scores between Fall 2010 and Fall 2011 implies that projects are a useful tool to aid instructors in facilitating conceptual learning in the classroom. In addition, the use of in-class individual projects seemed to give students a broader overview of the concepts presented throughout the course leading to a more evenly distributed increase in pre to post test scores when evaluated by question.

Table 2.11: MAC 2147: Percent of Average Increase by Question

MAC2147	Conic Section	Polynomial Function	Exponential Function	Rational Function	System of Linear Equations
Fall 2010	131%	41.1%	85.6%	35.3%	39.2%
Fall 2011	55.3%	32.6%	73.5%	69.2%	1.64%

2.4 Comparative Analysis

So far we have considered each group independent of the other in order to determine the effectiveness of each course design and the implementation of projects on the conceptual learning that students were engaged in. In this section we will briefly discuss the conclusions of each section.

The results from this study suggest that the best course design for promoting and stimulating conceptual learning is the learning community model. The implementation of projects - both in-class inquiry-based and out-of-class team - into a learning community model, proved to be a useful instructional enhancement for conceptual learning.

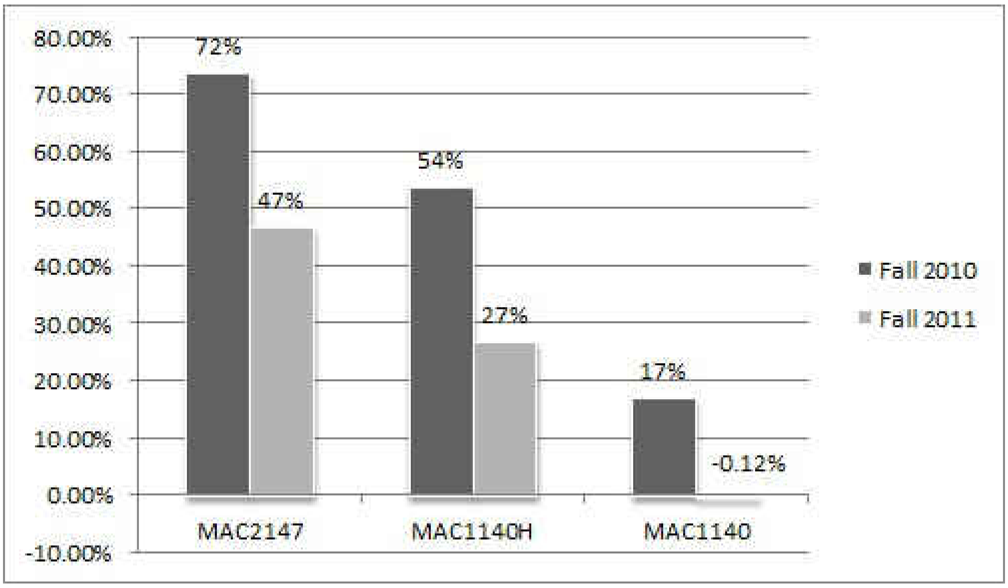


Figure 2.2: The Average Percent of Change from Pre-Testing to Post-Testing

While there are many variables between the three groups, looking at Figure 2.2 shows that both groups employing a learning community model, with and without the implementation of projects, had the most impact over either the traditional model or the modified emporium model in promoting conceptual learning in the classroom. Thus, as the literature review showed, allowing students to engage in active learning and encouraging group/peer learning - the sharing of knowledge, skills and understand - is essential to the successful promotion of conceptual learning. Classroom models that are teacher-focused (traditional model) or problem-focused (modified emporium model) do not promote the interaction among students that impacts conceptual learning.

Furthermore, having students work on and complete projects requires them to not only understand the mathematical procedure but to also apply the concepts of what they have learned to new and different scenarios. This is consistent with what we learned from Mills and Treagust in our literature review of project-based learning. [Mil03] This instructional tool encourages the application of the students' knowledge.

We also saw that active learning and active practice is necessary for both procedural learning and conceptual learning. Twigg concludes her article by stating, "The message is simple: Students learn math by doing math, not by listening to someone talk about doing math." [Twi11] This is true; however, this study has shown that to have students truly gain an understanding of the concepts that they are using while "doing math" there must be other instructional components employed in conjunction. In our study, the additional components were learning communities and project-based learning. This conclusion is consistent with the findings by Johnson et al, and Springer et al that were discussed in Table 1.2 and Table 1.1.

The following table, 2.12, shows the same data that we presented at the beginning of this study in table 2.1; however, the additional column, Conclusions, has been added.

The variability of student ability and learning styles and instructor teaching styles could lead to differing results if this experiment were implemented at other schools or with other undergraduate mathematics courses . However, our findings showed that greater gains occurred when out-of-class team projects and in-class individual projects were included in the course design. Furthermore, the results were consistent with the literary research.

The hypotheses and results of this study are:

- MAC 1140: We expected to see a greater increase in Fall 2011 with the implementation of the modified emporium model. Our initial expectations were a minimum increase of 10% from pre to post test in Fall 2010 and a minimum increase of 20% from pre to post test in Fall 2011. However, our results showed that while Fall 2010 exceeded our hypothesis with an increase of ≈16%, the modified emporium model did not shown the expected improvement. While the results for Fall 2011 were inconclusive, we saw a drop in the average increase from Fall 2010 to Fall 2011 instead of the expected increase. This leads us to believe that further study needs to be done to determine the modified emporium models effect on conceptual learning.

- MAC 1140H: We expected to see a greater increase in Fall 2010 with the inclusion of an out-of-class team project. Our initial expectations were a minimum increase of 20% from pre to post test in Fall 2010 and a minimum increase of 10% from pre to post test in Fall 2011 when no projects were assigned. Encouragingly, our results showed an overall increase of ≈54% in Fall 2010 and ≈27% in Fall 2011. Through further analysis, we saw that while the increase in Fall 2010 was statistically significant, the results from Fall 2011 were inconclusive. However, the difference in increase between semesters was statistically significant. This led us to conclude that out-of-class team projects do promote conceptual learning in students.

- MAC 2147: We expected to see a greater increase in Fall 2010 with the inclusion of four in-class individual projects. Our initial expectations were to see a minimum increase of 20% increase from pre to post test in Fall 2010 and a minimum increase of 10% from pre to post test in Fall 2011 when no projects were assigned. The results showed an overall increase of ≈72% in Fall 2010 and ≈35% in Fall 2011, both of which were much higher than expected. Further analysis showed that that increase seen in both semesters were statistically significant. In addition, we found that the difference in the increase seen between Fall 2010 and Fall 2011 was also statistically significant. This led to the conclusion that in-class projects also promote conceptual learning in students. Furthermore, it seems to indicate that the learning community is the best model, of those studied, for promoting conceptual learning in the classroom.

Table 2.12: Pre-Calculus Experiment: Summary of Pre-Calculus Hypotheses and Results

course	Fall 2010	Fall 2011	Hypotheses	Results
MAC 1140H	Instructor A - Small Lecture with Team Project	Instructor A - Small Lecture with No Project	Δ ÷mean pre-test should be $\geq$.2 in Fall 2010 and $\geq$.1 in Fall 2011	Δ ÷mean pre-test=.540 in Fall 2010 and .268 in Fall 2011
MAC 2147	Instructor A - Large Lecture with 4 In-Class Projects	Instructor B - Large Lecture with No Projects	Δ ÷mean pre-test should be $\geq$.2 in Fall 2010 and $\geq$.1 in Fall 2011	Δ ÷mean pre-test=.719 in Fall 2010 and .351 in Fall 2011
MAC 1140	Instructor B & C - Traditional Lecture Model	Instructor D & E - Modified Emporium Model	Δ ÷mean pre-test should be $\geq$.1 in Fall 2010 and $\geq$.2 in Fall 2011	Δ ÷mean pre-test=.167 in Fall 2010 and -.00116 in Fall 2011

CHAPTER 3

ANIMATION EXPERIMENT

The purpose of this experiment was to assess the impact of animated videos on student learning, with an emphasis on concepts - not skills.

Our hypothesis is that the inclusion of the animated video as an instructional tool will improve student conceptual understanding. Table 3.1 summarizes the hypotheses for this experiment.

For this study, a sample of 99 Pre-Calculus Algebra students enrolled in MAC 2147 and 13 Pre-Calculus Algebra students enrolled in MAC 1140H were given a pre-test and two post-tests. All three tests included the same seven questions testing students understanding of some basic sequences and series concepts. These pre and post tests can be referenced in Appendix 5. Only students who completed all three of the assessments were included in the sample for both MAC 1140H and MAC 2147.

Both courses, MAC 2147 and MAC 1140H were shown the same animated video on sequences and series, `http://whyu.org/Why_u_player3.php`.

Table 3.1: Pre-Calculus Experiment: Summary of Animation Hypotheses

course	Fall 2011	Hypothesis
MAC 1140H	Instructor A - Small Lecture	$\Delta \div$mean pre-test should be $\geq .2$ Post-Animation and $\geq .2$ Post-Instructor
MAC 2147	Instructor B - Large Lecture with No Projects	$\Delta \div$mean pre-test should be $\geq .2$ Post-Animation and $\geq .2$ Post-Instructor

The pre-test, page 97, was given at the beginning of class before starting the chapter on sequences and series. Immediately after taking the pre-test, the 15 minute animated video was shown to the entire class. Students were then asked to take the first of two post-tests - Post-Test After Animation, page 100. For the remainder of the class period and approximately two weeks following the video, the students received either large lecture instruction, MAC 2147, or small lecture instruction, MAC 1140H. After all sections related to the topic were covered by the instructor the students were again asked to take a post-test, Post-Test After Instructor Covered - page 103.

After all pre-tests and post-tests were administered and collected, the results were analyzed. Students who completed only one or two of the given assessments were not included in the sample.

Table 3.2 shows that both MAC 1140H and MAC 2147 had large gains, 44.1% and 61.2% respectively, on the pre-test to post-animation scores. As expected there were also gains on the post-animation to post-instructor scores as well. However, these gains, 29.2% in MAC 1140H and 7.7% in MAC2147, were significantly less than the gains shown from the pre-test to post-animation.

For MAC 1140H, while the students had a higher average pre-test score than MAC 2147, the increase from pre-test to post-animation was consistent with what we see from MAC 2147. In contrast, MAC 1140H had a much higher gain - almost 4 times as great - than MAC 2147 when comparing post-animation to post-instructor. MAC 2147 had scores that seem to suggest the majority of their conceptual learning came from the animation, since the resultant increase from post-animation to post-instructor was very small at $\approx$8%.

Table 3.2: Pre to Post Animation gains and Post Animation to Post Instructor gains

course	Mean Pre-Test Score	Mean Post-Animation Score	Mean Post-Instructor Score	*$\Delta \div$ Mean Pre-Test	*$\delta \div$ Mean Post-Animation
MAC 1140H - Instructo A	3.15	4.54	5.46	.441	.292
MAC 2147 - Instructor B	2.58	4.16	4.48	.612	.077

Δ *represents the average change in pre-test and post-animation scores*

δ *represents the average change in post-animation and post-instructor scores*

While each class seemed to gain a differing amount from post-animation to post-instructor, their respective gains from pre-test to post-animation consistently show a greater increase in conceptual understanding than the expected hypothesis. This preliminary result suggests further study of using animation as an instructional tool to introduce a conceptual overview of a new topic needs to be conducted to verify and expand on these results. While animation is not new, the research into its effectiveness is still in the exploratory stage. [Jur99]

Instructors often try to to employ this technique, without the aid of technology, by asking students to read ahead and/or work examples from sections prior to encountering them in the classroom. However, most students do not have the intrinsic motivation necessary to actually do this. By presenting the material to students, through the use of animated videos, instructors are able to give their students a sneak peek at the new material prior to presenting it in class. Thus, animated videos give students additional exposure as well as presenting it in a new, engaging method that encourages students to become more open to the transfer of knowledge from instructor/video to student. Table 3.3 shows the initial data and hypotheses, given in Table 3.1, while included a new column displaying the results.

While these results show that animation is a promising tool for conceptual instruction, it was also clear that different classes, MAC 1140H and MAC 2147, may gain different amounts of understanding from the video and the instructor. Some classes, as well as different course models - on-line, hybrid, emporium, etc., may have differing levels of gains. As noted by Hegarty and Kriz, learning styles of the students, complexity of the topic being presented, and student knowledge prior to the presentation can all affect how easily students learn from an animated video. [HK07] To find conclusive and general results on the effectiveness of animated videos, further research would be necessary.

The hypotheses and results for this study are:

- Pre to post-animation: We expected to see a minimum of 14% increase - approximately one question - in both MAC 1140H and MAC 2147. The results showed that both courses exceeded our expectations with MAC 1140H showing an increase of ≈44% and MAC 2147 showing an increase of ≈61%. These results, which we found to be statistically significant for MAC 2147 only, seem to indicate that student learning can be improved by using animated videos as an introduction into a new concept. Thus affirming the need to conduct further studies.

- Post-animation to Post-Instructor: Here we expected to see an increase similar to the pre to post-animation increase; however, the first gains were so high that this was not attainable in reality. Our initial hypothesis was to see an additional 14% increase on average, again this is approximately equal to one question. The results show that MAC 1140H and MAC 2147 had increases of ≈29% and ≈8% respectively. The results of this are inconclusive due to statistically insignificant increases.

Table 3.3: Pre-Calculus Experiment: Summary of Animation Hypotheses and Results

course	Fall 2010	Fall 2011	Hypothesis	Results
MAC 1140H	Instructor A - Small Lecture with Team Project	Instructor A - Small Lecture with No Project	Δ ÷mean pre-test should be ≥.14 and Δ ÷mean post-animation should be ≥.14	Δ ÷mean pre-test=.441 and Δ ÷mean post-animation=.292
MAC 2147	Instructor A - Large Lecture with 4 In-Class Projects	Instructor B - Large Lecture with No Projects	Δ ÷mean pre-test should be ≥.14 and Δ ÷mean post-animation should be ≥.14	Δ ÷mean pre-test=.612 andΔ ÷mean post-animation=.077

CHAPTER 4

SUMMARY AND FINAL CONCLUSIONS

In the pre-calculus experiment, we set out to assess the improvement of student conceptual understanding resulting from the inclusion of team project-based learning, individual inquiry-based learning in a learning community model and the adoption of the modified emporium model. Table 2.12 summarizes the three groups that were studied in the pre-calculus experiment, the hypotheses for each and the final conclusions that were made.

Three trends showed up during the analysis of our data:

1 Fall 2010 students who completed the out-of-class team project showed greater improvement in conceptual understanding, specifically as related to the project topic, polynomial functions than Fall 2011 students who were not assigned a project.

2 Fall 2010 students who completed the four in-class inquiry-based projects showed greater, more evenly distributed improvement in conceptual understanding than Fall 2011 students who were not assigned a project.

3 The modified emporium model seemed to have no impact on the conceptual understanding of the students enrolled in Fall 2011. Likewise, the traditional lecture model also had little effect on the conceptual understanding of the Fall 2010 students.

Thus leading to the conclusion that the learning community model, specifically combined with project-based learning, provides the most effective method of improving student conceptual understanding. It was shown that students who completed either the out-of-class team projects or in-class individual projects showed to have greater conceptual understanding than students who did not complete any type of projects. However, the study did not determine if one type of project-based learning is better able to facilitate conceptual learning in the classroom. This would require further study.

In the animation experiment, the goal was to assess the impact of animated videos on student learning with an emphasis on concepts. The conclusions of the study indicate that animated videos, used as an introductory overview to new concepts, have the potential to promote conceptual learning for students.

Table 4.1: Summary of Hypotheses and Results

course	Fall 2010	Fall 2011	Hypothesis	Results
MAC 1140H	Instructor A - Small Lecture with Team Project	Instructor A - Small Lecture with No Project	Δ $\div$mean pre-test should be $\geq$.2 in Fall 2010 and $\geq$.1 in Fall 2011	Δ $\div$mean pre-test=.540 in Fall 2010 and .268 in Fall 2011
MAC 2147	Instructor A - Large Lecture with 4 In-Class Projects	Instructor B - Large Lecture with No Projects	Δ $\div$mean pre-test should be $\geq$.2 in Fall 2010 and $\geq$.1 in Fall 2011	Δ $\div$mean pre-test=.719 in Fall 2010 and .351 in Fall 2011
MAC 1140	Instructor B & C - Traditional Lecture Model	Instructor D & E - Modified Emporium Model	Δ $\div$mean pre-test should be $\geq$.1 in Fall 2010 and $\geq$.1 in Fall 2011	Δ $\div$mean pre-test=.167 in Fall 2010 and -.00116 in Fall 2011
MAC 1140H	Instructor A - Small Lecture with Team Project	Instructor A - Small Lecture with No Project	Δ $\div$mean pre-test should be $\geq$.2 and Δ $\div$mean post-animation should be $\geq$.2	Δ $\div$mean pre-test=.441 and Δ $\div$mean post-animation=.292
MAC 2147	Instructor A - Large Lecture with 4 In-Class Projects	Instructor B - Large Lecture with No Projects	Δ $\div$mean pre-test should be $\geq$.2 and Δ $\div$mean post-animation should be $\geq$.2	Δ $\div$mean pre-test=.612 andΔ $\div$mean post-animation=.077

CHAPTER 5

SUGGESTIONS FOR FUTURE WORK

Both studies, pre-calculus experiment and animation experiment, are rudimentary in their research and have given only preliminary findings. This initial study was conducted to determine whether or not further research was warranted. According to the analysis of the data collected, both experiments indicate a rationale for further investigation.

For the pre-calculus experiment, one further study would be to conduct a similar experiment in other undergraduate mathematics courses to see if the results are similar for courses other than Pre-Calculus Algebra. In addition, conducting this experiment on courses that have students at different class standings (i.e., freshman, sophomore, junior and senior) as well as transfers vs. FTIC may give different results.

It would be beneficial to further study the effectiveness of projects on conceptual learning by ascertaining their impact on a different course design, such as the traditional lecture model or the modified emporium model. This would help to answer the question, are they as impactful in all course models or just learning communities? Another future research opportunity, could be to study both team projects and individual projects, as well as in-class and out-of-class projects, to determine which would be the best implementation of this instructional tool. Another study would be to determine whether the smaller in-class projects need to be given multiple times throughout the semester to impact conceptual learning in a broader course scope and how many would maximize its effectiveness.

For the animation experiment, one further study would be to create a class which would present animated videos at the introduction of every new topic and then compare it to a control group that does not include animated videos. It would also be interesting to study animated videos impact in different math courses and different course designs.

APPENDIX A: SYLLABI

MAC 1140H: *Honors Precalculus Algebra*

MWF 11:30-12:20 in COMM Room 112

Professor	Dr. Cynthia Y. Young
Office	MAP 231G
Phone	(407) 823-5987
Email	cyyoung@mail.ucf.edu
Office Hours	MWF 9:30am-11:00am M 3:30pm – 4:30pm

Text: *Precalculus with Limits,* Cynthia Y. Young, 2nd Edition 2010 packaged with WileyPlus. **Envelope contains Wiley Plus Registration Codes (Do NOT Discard).** *See email about three price options for books.

Grades:

Tests	50%
Final Exam	25%
Wiley Plus	10%
Team Project: Climate Change	10%
Quizzes	5%

A: 90%-100% **B**: 80%-89% **C**: 70%-79% **F**: 0%-59% or **NC**

ASSESSMENT DESCRIPTIONS

Tests: There will be four tests given. Your test average is worth 50% of your grade.

Final Exam: The final exam (10am on 12/8) is cumulative and is worth 25% of your grade.

Quizzes: The Exercises in each section have 6 categories (Skills, Applications, Catch the Mistake, Conceptual, Challenge, and Technology). It is your responsibility to work through all but the technology exercises. There will be a quiz at 11:30 every non test day- one problem selected from the class before Exercises.

Project: There will be a team project on the environment worth 10% of your grade.

Calculators: Scientific (not graphing) calculator.

Blue Books: 8.5"X11" blue books for each test and the final exam. In order to gain admission to the classroom on test days, you will need to submit a 8.5" x 11" bluebook totally void of writing.

Wiley Plus is an online course management system with many valuable features. The entire book is there electronically as well as the entire student solutions manual (with full solutions). In addition, anywhere you see a video icon next to an example in the book; you can click in Wiley plus and watch a video of me working that problem. There are 5 Prerequisite assignments due **Sat Aug 28th** and **10 cumulative** assignments for this course which are due on **Saturdays at 11pm**.

Course Logins: http://edugen.wiley.com/edugen/class/cls183768/
First Day (Registering) http://wiley.breezecentral.com/firstday
Tech Support: http://hesupport.wiley.com/wileyplus

Date	Class Material
Monday, August 23	Syllabus/Pretest
Wednesday, August 25	Chapter 0
Friday, August 27	1.1 Functions
Monday, August 30	1.2 Graphs of Functions
Wednesday, September 1	1.3 Graphing Techniques: Transformations
Friday, September 3	1.4 Combining Functions
Monday, September 6	*LABOR DAY*
Wednesday, September 8	1.5 One-to-One Inverse Functions and Inverse Functions
Friday, September 10	2.1 Quadratic Functions
Monday, September 13	**TEST 1 (CHAPTERS 0 and 1)**
Wednesday, September 15	2.2 Polynomial Functions of Higher Degree
Friday, September 17	2.3 Dividing Polynomials
Monday, September 20	2.4 The Real Zeros of a Polynomial Function
Wednesday, September 22	2.5 Complex Zeros: The Fundamental Theorem of Algebra
Friday, September 24	2.6 Rational Functions
Monday, September 27	3.1 Exponential Functions and their Graphs
Wednesday, September 29	3.2 Logarithmic Functions and Their Graphs
Friday, October 1	3.3 Properties of Logarithms
Monday, October 4	3.4 Exponential and Logarithmic Equations
Wednesday, October 6	UCF FOOTBALL GAME (short class): Projects Handed Out (Teams Assigned)
Friday, October 8	**TEST 2 (Chapters 2 and 3)**
Monday, October 11	7.1 Vectors
Wednesday, October 13	7.2 The Dot Product
Friday, October 15	7.5 Polar Coordinates
Monday, October 18	8.1 Systems of Linear Equations in Two Variables/8.2 Three Variables
Wednesday, October 20	8.3 Systems of Linear Equations and Matrices
Friday, October 22	8.6 Partial Fractions
Monday, October 25	8.7 Systems of Linear Inequalities
Wednesday, October 27	9.1 Conic Basics/ 9.2 The Parabola
Friday, October 29	9.3 The Ellipse
Monday, November 1	9.4 The Hyperbola
Wednesday, November 3	9.5 Systems of Nonlinear Equations
Friday, November 5	10.1 Sequences and Series
Monday, November 8	**TEST 3 (Chapters 7, 8, and 9)**
Wednesday, November 10	10.2 Arithmetic Sequences and Series/10.3 Geometric Sequences and Series
Friday, November 12	10.4 Mathematical Induction
Monday, November 15	10.5 Binomial Theorem
Wednesday, November 17	11.1 Introduction to Limits, 11.2 Techniques for Finding Limits
Friday, November 19	11.2 Techniques for Finding Limits
Monday, November 22	11.3 Tangent Lines and Derivatives, 11.4 Limits at Infinity
Wednesday, November 24	*THANKSGIVING*
Friday, November 26	*THANKSGIVING*
Monday, November 29	11.5 Finding the Area Under the Curve
Wednesday, December 1	**PROJECT PRESENTATIONS**
Friday, December 3	**TEST 4**
Monday, December 6	REVIEW/POSTTEST
Wednesday, December 8	**FINAL EXAM 10AM**

MAC 2147: *Precalculus (EXCEL)*

MWF 1:30-3:20 in HPA 119

GTA's: Daniel Bueller and Ashley Evans

Professor	Dr. Cynthia Y. Young
Office	MAP 231G
Phone	(407) 823-5987
Email	cyyoung@mail.ucf.edu
Office Hours	MWF9:30am-11:00am M 3:30pm – 4:30pm

Text: *Precalculus with Limits,* Cynthia Y. Young, 2010 packaged with WileyPlus. **Envelope contains Wiley Plus Registration Codes (Do NOT Discard).**

Grades:

Tests	50%
Final Exam	20%
APPS Projects (there are 5)	10%
Wiley Plus	10%
EXCEL Participation Grade	5%
Quizzes	5%

A: 90%-100% **B**: 80%-89% **C**: 70%-79% **F**: 0%-59% or **NC**

ASSESSMENT DESCRIPTIONS

Tests: There will be five tests given (see schedule).

Final Exam: The final exam (1pm on 12/8) is cumulative and worth 20% of your grade.

Quizzes: The homework Exercises in each section have 6 categories (Skills, Applications, Catch the Mistake, Conceptual, Challenge, and Technology). It is your responsibility to work through the Skills, Applications, Conceptual, and Challenge Exercises. There will be a quiz at 11:30 every non test day- one problem selected from the class before Exercises.

Calculators: Scientific (not graphing) calculator.

Blue Books: 8.5"X11" blue books for each test and the final exam. In order to gain admission to the classroom on test days, you will need to submit a 8.5" x 11" bluebook totally void of writing.

APPS: There will be one guest lecture by Dr. Bill Self and 5 Applications Projects that will constitute 10% of your grade.

EXCEL: The EXCEL Participation grade will be determined by your GA mentor according to your EXCEL Lab Log and Action Plans developed with mentor.

Wiley Plus: Wiley Plus is an online course management system with many valuable features. The entire book is there electronically as well as the entire student solutions manual (with full solutions. Anywhere you see a video icon next to an example in the book, you can click in Wiley plus and watch a video of me working that problem. There are 5 Prerequisite assignments due **Sat Aug 28th** and **10 cumulative** assignments for this course which are due on **Saturdays at 11pm**.

Course Logins: http://edugen.wiley.com/edugen/class/cls183767/
First Day (Registering) http://wiley.breezecentral.com/firstday
Tech Support: http://hesupport.wiley.com/wileyplus

The Withdraw Deadline is Friday October 15, 2009

Date	**Class Material**
Monday, August 23	Syllabus/Pretest/Chapter 0
Wednesday, August 25	1.1 Functions 1.2 Graphs of Functions
Friday, August 27	1.2 Graphs of Functions 1.3 Graphing Techniques: Transformations
Monday, August 30	1.4 Combining Functions 1.5 One-One Functions and Inverse Functions
Wednesday, September 1	2.1 Quadratic Functions 2.2 Polynomial Functions of Higher Degree
Friday, September 3	**TEST 1 (Chapters 0 and 1)**
Monday, September 6	*LABOR DAY*
Wednesday, September 8	2.3 Dividing Polynomials, 2.4 Real Zeros of a Polynomial Function
Friday, September 10	2.5 Complex Zeros: Fundamental Theorem of Algebra *APPS I* (Polynomial Functions)
Monday, September 13	2.6 Rational Functions 3.1 Exponential Functions and their Graphs
Wednesday, September 15	3.2 Logarithmic Functions and Their Graphs 3.3 Properties of Logarithms
Friday, September 17	3.4 Exponential and Logarithmic Equations 3.5 Exponential and Logarithmic Models
Monday, September 20	Review
Wednesday, September 22	Dr. Bill Self/*APPS II* (EXPONENTIAL Functions)
Friday, September 24	**TEST 2 (Chapters 2 and 3)**

Date	**Class Material**
Monday, September 27	4.1 Angle Measure
Wednesday, September 29	4.2 Right Triangle Trigonometry 4.3 Trigonometric Functions of Angles
Friday, October 1	4.4 The Law of Sines 4.5 The Law of Cosines
Monday, October 4	5.1 Trigonometric Functions: The Unit Circle Approach 5.2 Graph of Sine and Cosine Functions
Wednesday, October 6	UCF FOOTBALL GAME
Friday, October 8	5.2 Graph of Sine and Cosine Functions 5.3 Graphs of Other Trigonometric Functions
Monday, October 11	6.1 Verifying Trigonometric Identities 6.2 Sum and Difference Identities
Wednesday, October 13	6.3 Double-Angle and Half Angle Identities 6.4 Product-to-Sum and Sum-to-Product Identities 6.5 Inverse Trigonometric functions
Friday, October 15	6.6 Trigonometric Equations *APPS III* (Trigonometric, Rational Functions, Poly, etc.)
Monday, October 18	7.1 Vectors 7.2 The Dot Product
Wednesday, October 20	**TEST 3(Chapters 4, 5, and 6)**
Friday, October 22	7.5 Polar Coordinates
Monday, October 25	8.1 Systems of Linear Equations in Two Variables 8.2 Systems of Linear Equations in Three Variables
Wednesday, October 27	8.3 Systems of Linear Equations and Matrices 8.6 Partial Fractions
Friday, October 29	8.6 Partial Fractions *APPS IV* (Systems of Linear Equations)
Monday, November 1	9.1 Conic Basics 9.2 The Parabola
Wednesday, November 3	9.3 The Ellipse 9.4 The Hyperbola
Friday, November 5	9.5 Systems of Nonlinear Equations 9.9 Parametric Equations and Graphs
Monday, November 8	10.1 Sequences and Series 10.2 Arithmetic Sequences and Series
Wednesday, November 10	**TEST 4 (Chapters 7, 8, and 9)**
Friday, November 12	10.3 Geometric Sequences and Series *APPS V*(Conics)
Monday, November 15	10.4 Mathematical Induction 10.5 Binomial Theorem
Wednesday, November 17	11.1 Introduction to Limits 11.2 Techniques for Finding Limits
Friday, November 19	11.2 Techniques for Finding Limits
Monday, November 22	11.3 Tangent Lines and Derivative 11.4 Limits at Infinity; Limits of Sequences
Wednesday, November 24	THANKSGIVING
Friday, November 26	THANKSGIVING
Monday, November 29	11.5 Finding the Area Under a Curve
Wednesday, December 1	Problem Solving/Focus Groups
Friday, December 3	**TEST 5 (Chapters 10 and 11)**
Monday, December 6	REVIEW/POST TEST
Wednesday, December 8	**FINAL EXAM**

PRECALCULUS – MAC 1140

Fall 2010

CLASS INFORMATION, POLICIES AND SCHEDULE

Lecturer: Ms. Lori Dunlop Pyle

Email: Ldunlop@mail.ucf.edu (Please see information on page 6 about e-mails before e-mailing me)

Office: MAP 101

Office Hours: M-F 10:30-11:20

Class times:

	Section 0004	Section 0005:
Class times:	T Th 9:00AM – 10:15AM, BA119	T Th 12:00PM - 1:15PM, HPA 119

Textbook: *Precalculus*, by M. Sullivan, custom edition for UCF (with MyMathLab access code)

Chapters covered: 4, 5, 6, 7, 8, 9 (for details, see the **Class Schedule**)

Number of credits: 3

Course Structure: lectures, online homeworks and quizzes; exams given in the testing lab

Online Homework: There will be weekly graded online homeworks and quizzes, which utilize the MyMathLab software packaged with your textbook (you will access the software using the MyLabsPlus portal and environment at www.ucf.mylabsplus.com). As these assignments must be completed online, students will be expected to have access to a computer. There are computers with MyMathLab installed in several of the computer labs on the main campus. Homework assignments will be assigned in advance and due **no later than 11:59PM on Wednesday nights**. Information on how to register and access the software will be given in class. **It is your responsibility to keep track of when the homework assignments are due and allot enough time to complete them.** The due dates will not be extended, so please plan accordingly. Personal computer issues, including login errors, will NOT be a reason to offer any type of extension. If you are experiencing computer issues, you are encouraged to contact the 24 hour a day technical support.

The online homework questions are algorithmic iterations of the textbook exercises. Homework assignments can be repeated an infinite number of times within the time period specified; the latest submission is the one that counts towards your grade. Homework constitutes 7% of your course grade. Your lowest homework grade will be dropped when computing your final course grade.

Online Quizzes: For each of the online homework assignments, there is an associated online quiz that needs to be completed. **In order to begin the online quiz, you must score at least 70% on the associated online homework assignment**. If you do not score a 70% or higher on the homework by the due date, you will not be able to take the associated quiz which will result in you earning a 0% on that quiz. Quizzes will be due **no later than 11:59PM on**

Thursday nights. They can be taken up to seven times and the highest score of all the attempts will be the recorded grade for that particular quiz. It is highly recommended that you take a quiz more than once. Quizzes constitute 8% of your course grade. Your lowest quiz grade will be dropped when computing your final course grade.

There will be a comprehensive online homework assignment and quiz due at 11:59 pm on Monday, December 6, 2010. It counts as a regular homework assignment, unless you are working towards a grade of NC (see below).

Note: there is always going to be a homework assignment and a quiz due during an exam week. Since homework and quizzes cover material from the week before the one they're due, the homework and quiz due on an exam week will always contain material you will be tested on in the exam.

Technology issues: should you ever experience a technical issue when accessing the MyLabsPlus website, such as a login error, or an error message when accessing a homework or quiz, you must contact the **MyLabsPlus** tech support (available 24 hours a day) at

Phone: (888) 883-1299
Email: helpdesk@ucf.mylabsplus.com

Some additional information on common technical issues can be found at http://math.ucf.edu/gepcourses.

Please do not email me about a technical issue before contacting tech support and getting a ticket number from them. They are usually able to solve your issue right away and get you back to work very soon. In case your issue is more serious or takes longer to be resolved, the ticket number ensures that I can follow up on your case if needed. In the (rare) event of a generalized technical issue, I will send out a class email. **If you do not receive a class email, always assume the issue you are experiencing is yours alone and contact tech support as soon as possible.** Login issues are usually an issue with your web browser and/or your computer and thus they are not general issues. Failure to contact tech support and get a ticket number might mean that you will receive a grade of zero on an assignment.

Tests and Final Exam: There will be three tests and a comprehensive final exam. For the dates, please see below. They will be administered in a dedicated testing lab and it will be your responsibility to register for them through a dedicated website accessible via MyMathLab. (See test scheduling and testing lab policy and procedures section of this document.) There will be an announced time period for when the test will open and close for scheduling. Typically, test scheduling will open the Monday before testing week at 5-7 pm and close at 10 pm the Sunday night before testing week begins. **All tests must be scheduled during the allotted time period for that particular test.** Once the scheduling time period has ended, there will not be any changes or additions to the test schedules.

It is your responsibility to schedule the exam during the scheduling period and to make sure your registration was successful. Often students spend so much time choosing their preferred exam time that the website times out. **You are not registered for an exam unless, when you log in into the scheduling website, you see your reservation listed under "Check reservation". It is an indispensable part of the scheduling process that you do log out of the scheduling software and log in again to check that your reservation is indeed there. Failure to do so does not qualify you for a make-up exam. You should also receive a confirmation message on the computer screen upon successfully completing your exam registration, and/or a confirmation email within a few hours; however, the only actual indication that you are indeed scheduled for the exam is the reservation listed under "Check reservation".**

Please make sure that you have scheduled your test prior to the schedule closing date as you will receive a grade of 0% if you do not schedule your test. This policy applies to all tests and the Final Exam.

If you do not show up for your scheduled appointment, a grade of 0% will be given for the test. This includes showing up at a time other than the one your test is scheduled for. This policy applies to the Final Exam as well. No exceptions will be made.

Students registered with the Student Disability Services who want to take their test with accommodations must schedule their tests with SDS within the allotted scheduling time period for each test, and take their test in one of the testing days scheduled for their course section. The above rules and restrictions hold for all students.

Students should attend each test with the following items:

- Valid UCF Identification Card
- Knowledge of your MyMathLab login and password
- Bluebook
- Pen or pencil
- TI30-XA Calculator

Should a student come to the Testing Lab without his/her UCF ID or without his/her Bluebook, he/she will not be allowed into the room.

A grade of zero on a test will be assigned in one of the following situations:

- the student fails to schedule his/her exam during the allotted scheduling period (including the case in which the student does not complete the exam scheduling process);
- the student misses his/her scheduled appointment to take the exam;
- the student violates the UCF academic integrity policies during the exam or in any circumstance relative to the exam (from scheduling it to taking it);
- the student's cell phone rings, vibrates, or they access it for any reason while in the Testing Lab.

Exam dates: **Exam 1:** September 22 - 24
Exam 2: October 11 - 12
Exam 3: November 8 - 9
Final Exam: December 7 - 13

Note: Practice Exams are for practice purpose only and do not count towards the course grade. However, they are the best way to prepare for an exam, as they contain the types of problems that might appear on the exam.

Make-up policy: Test, homework, and quiz make-ups will not be given. Health or family related excuses will not grant an extension. Personal travel plans, medical reasons, and personal or family emergencies will not be a valid reason for taking any test at a different time than scheduled. **The first missed homework/quiz will automatically become the dropped homework/quiz grade**; any additional missed homework/quiz will be recorded as a grade of 0%. Option B will be used if a student misses a test (see "Grading" below). University related absences that require special scheduling must be arranged one week **prior** to the assessment date and valid documentation is to be provided. Again, **it is your responsibility to keep track of due dates and scheduled exam dates.**

<u>THE FOLLOWING POLICY APPLIES TO THE FINAL EXAM ONLY.</u> In the event you are not able to arrive during your appointment time for the final exam for any reason at all or you fail to schedule a final exam test appointment, you will be permitted to take your final exam at 7:00pm on Monday, December 13, 2010 with a 20 percentage point penalty. Example: A student who uses this option and scores a 94% on the final exam would have a 74% recorded in the professor's gradebook.
This policy is applicable for the FINAL EXAM ONLY. The 20 percentage point penalty is not negotiable!

Grading: Your grade will be calculated based on the following options:

Option A:	**Option B:**
• Exam 1 – 20% of total grade • Exam 2 – 20% of total grade • Exam 3 – 20% of total grade • My Math Lab Online homework average – 7% of total grade • My Math Lab Online quiz average – 8% of total grade • Final exam score– 25% of total grade	• The two highest test scores – 40% of total grade • My Math Lab Online homework average – 7% of total grade • My Math Lab Online quiz average – 8% of total grade • Final exam score– 45% of total grade

Option B will be used if a student misses a test. If all three tests are taken, the option resulting in the highest grade will be used to compute the student's final course grade percentage.

Please Note: The penalty for an academic integrity violation will range from a grade of zero on an exam to a grade of F for the course. If a grade of 0% is given on any test due to an academic integrity violation, Option A will be used to calculate the course grade.

The +/- system will not be used in this class. **There will be no curves or extra credit.** Letter grades will be awarded according to the following grading scale:

A: 90-100% B: 80-89% C: 70-79%

F: 0-69% NC: below 70% and NC criteria met

NC Grade Policy: The intent of the "No-Credit" (NC) grade is to encourage struggling students to remain in class and work hard, rather than withdrawing midway through the semester. By completing the course, the student's exposure to all the class material should allow them to perform better when repeating the class. No course credit is given for an "NC" grade, nor will it satisfy any requirements or subsequent courses' prerequisites. However the student's UCF grade point average will not be penalized for the "NC".

The "NC" grade will be awarded in place of an F when all the following criteria are met:

* Student earns 0% on no more than two online quizzes
* Student earns 0% on no more than two online homework assignments
* Student earns 0% on no more than one test or exam (This includes Test 1, 2, 3 and the Final Exam)

* Student completes the comprehensive online homework and quiz by December 6, 2010 at 11:59 pm

Note: a **grade of zero on a quiz/homework** will be assigned whenever a student misses the deadline given to complete them, or if the student does not obtain a score different from zero on a quiz/homework.

Please note that an "NC" grade cannot be requested. If a student has met the "NC" criteria, he/she will automatically receive a grade of "NC". Conversely, if a student does not meet the "NC" criteria, a grade of "NC" will not be given.

Since the "NC" criteria are non-negotiable, I will absolutely not reply to any email asking for an "NC" grade if you did not exactly satisfy each of the criteria listed above, no matter how close to satisfying them you were. However, do email me if you believe that a mistake was made when assigning your final grade.

Please notice that the course policy about dropping the lowest homework and quiz score is INDEPENDENT of the NC policy. Example: Bob has missed three quizzes during the semester. For the computation of his course grade, one of the zeros is dropped, while the other two stay in place and count towards Bob's quiz average. On the other hand, he has missed more than two quizzes, therefore he does not qualify for an NC grade anymore. If at this point Bob's final course grade percentage is 70% or better, Bob will receive a grade of C or better; if his course grade percentage is less than 70%, Bob will receive an F.

Calculator: You may use a **Texas Instruments TI-30XA** calculator on the tests. You may not use any other type or model calculator in this course. Cell phone calculators will not be permitted, nor will be sharing calculators. Use of an unauthorized calculator during a test will result in a grade of zero and possible disciplinary action.

Course resources:

- SARC (Student Academic Resource Center) will be offering Supplemental Instruction (SI) sessions for Precalculus. These are voluntary, free study sessions led by peers that have successfully taken the course before. Information at http://www.sarc.sdes.ucf.edu/?id=si.
- The Math Lab in MAP 113 offers tutoring free of charge. Spring hours will be posted at http://www.math.ucf.edu/~mathlab/.
- The MML software provides various resources, such as a personalized Study Plan.
- Of course, my office hours.

Your responsibilities: You are expected to keep track of the due dates of homework and quizzes; to register for an exam in time, to make sure your exam registration was successful and show up to take it on the scheduled day/time; to bring with you the required material/know your MyMathLab login info on exam day; to understand, remember and follow the class policies hereby listed.

Good practices/etiquette: Good practices that will improve your chances at succeeding in this course are:

- attending all classes;

- keeping up with the material;
- taking notes in class and reviewing them;
- looking up in the textbook the pages relative to the material covered in class, especially the examples;
- completing extra homework problems for practice;
- coming for help whenever something is not clear;
- preparing for an exam a few days earlier rather than the night before;
- completing the Practice Tests that will be posted one week before each exam;
- keeping track of deadlines.

To ensure a comfortable learning environment for you and your classmates, come to class in time, do not leave early, turn off or silence your cell phone or pager, and refrain from disruptive behavior.

Email communication: You will receive several important messages from me during the semester, all of which will be sent to your Knights email account. It is therefore your responsibility to check your Knights account on a regular basis. You will also receive from precalc@mail.ucf.edu the confirmation emails once you register for an exam. It is convenient to add both this email and my own to your contact list to ensure delivery.

I try to answer students' emails within 48 hours. In a few cases, it might take me longer to reply. If you have a question regarding the class or its policies, please refer to this syllabus, the text book, e-mails I have sent your class, or announcements on MyLabsPlus BEFORE e-mailing me the question. Most questions that you may have can be answered through one of these sources and you will have your answer faster than if you e-mail me. If you email me asking a question that is answered by this document, I will simply reply "SEE COURSE POLICIES".

Writing to Faculty: Although e-mail is typically used as an informal method of communication, this is not the case when writing to a faculty member. In order therefore to ensure a response to your message, you should follow the template below:

- Include a subject to indicate the course you are taking and the time that the lectures meet, your first and last name, and a meaningful topic.

  Example: "MAC1140 12:30 – Jane Doe – Issue with problem 4 in HW 1"

- Address your instructor respectfully.
- Write a short formal message that outlines your concern.
- Include your name at the conclusion of the message.

Academic Honesty / Cheating: The work submitted in this class is expected to be your own. Forms of cheating/academic dishonesty include (but are not limited to): communicating with another student during a test (this includes giving information to another student as well as receiving that information), using an unauthorized calculator, bringing in and using unauthorized material of any sort during a test, and communicating contents of a test to another student. Penalties will range from a grade of zero on an exam to a grade of F for the course. In addition, further disciplinary action through the university may be taken. Please be aware that disciplinary action through the university could result in suspension or expulsion. For more information on academic honesty, please see the Golden Rule contents available at http://www.goldenrule.sdes.ucf.edu.

Disability related accommodations: The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. This syllabus is available in alternate formats upon request. Students who need accommodations must be registered with Student Disability Services, Student Resource Center Room 132, phone (407) 823-2371, TTY/TDD only phone (407) 823-2116, before requesting accommodations from the professor. No accommodations will be provided until the Student Disability Services office has notified the professor concerning appropriate accommodations. **Students registered with the Student Disability Services who want to take their test with accommodations must schedule their tests with SDS within the allotted scheduling time period for each test.**

Mathematical Assistance and Learning Lab (MALL)
Policies and Procedures

The following describes the policies and operating procedures for the Mathematical Assistance and Learning Lab located in MAP 241 and 242. It is intended to provide important information and instructions for all users of the lab. Students should review the following information and procedures.

1. Scheduling a Test. There will be an announced time period for which the test will open and close for scheduling. Typically, test scheduling will open the Monday before testing week at 5-7 pm and close at 10 pm the Sunday night before testing week begins. Students will schedule their tests by clicking on the "Schedule a Test" menu button in MyMathLab. Once the scheduling time period has ended, there will not be any changes or additions to the test schedules. Please make sure that you have scheduled your test prior to the schedule closing date as you will receive a grade of 0% if you do not schedule your test. Please note: upon completion of a test scheduling process, a confirmation message containing the test date and time will appear on the screen. You have not scheduled a test until you see this confirmation message! You should confirm that the reservation is complete by clicking on the check reservation link in the system.
Additionally, a confirmation email should be sent to your Knight email account. The confirmation emails will come from precalc@mail.ucf.edu.

It is an indispensable part of the scheduling process that you do check that your reservation is listed under "Check reservation" on the scheduling webpage. Failure to do so does not qualify you for a make-up exam.

2. Check-in and out for an exam. Please arrive at the MALL 15 minutes before your scheduled testing appointment. **A valid UCF Student ID Card and a full sized (8.5"x11") bluebook is required to gain entrance to the Lab.** Your UCF ID will be electronically scanned to authenticate your access to the exam by the Lab Manager, other Lab staff, or one of the proctors. You will be assigned to sit at a particular computer workstation.

3. Reporting problems. If you encounter difficulty with any equipment or software in the Mathematical Assistance and Learning Lab, you must report the problem to a proctor or staff member for assistance before proceeding/attempting to fix the problem on your own. Report as much information about the problem and your location as you can. Because many exams are timed, reporting a technical problem as quickly as possible will minimize the time required to get back online and complete the exam. If you have a concern relative to an exam question, you may complete a Test Question Form to report the concern to your instructor.

4. Electronic Monitoring. The Mathematical Assistance and Learning Lab environment and its computers are electronically monitored/recorded to include real-time video. Any and all perceived incidents of student misconduct will be reported to the instructor who may report it to the Student Conduct Board for appropriate action.

5. Acceptable use. Students in the Mathematical Assistance and Learning Lab are expected to use the resources responsibly and in accordance with the Campus Use of Information Technology and Resources Policy, which may be found at http://ucf.edu/rule.html. Computer workstations must not be turned off, moved, or unplugged. When departing the testing area, each student should return his or her keyboard, mouse, and chair to their normal positions, and remove all paper trash from the area.

6. No unauthorized materials. It is preferred that no cell phones, PDAs, backpacks, books, or notebooks be brought to the Mathematical Assistance and Learning Lab. However, if a student must bring one or more of the aforementioned items, they will be stored at the student's feet under the desk. Cell phones are to be turned off, not set on vibrate or to an audible ringer, and at no time is a student to access a cell phone while in the Mathematical Assistance and Learning Lab. Failure to follow this rule may result in a grade of 0% on the test and possible disciplinary actions. If skateboards are brought to the Lab, they must be left in a designated area, and the Mathematical Assistance and Learning Lab is not responsible for lost or stolen items.

7. Unauthorized Individuals. No unauthorized individuals are permitted in the Mathematical Assistance and Learning Lab.

8. Food and Drinks. No food or drinks may be brought into the Lab.

9. Leaving the testing area. Once a student is seated for an exam, he or she is not permitted to move from that location for the duration of the exam. The exam must be submitted prior to leaving the MALL.

10. Policy for General Power Failures. In extreme situations in the Lab, such as a general power failure, a server failure, or forced evacuation of the building, alternate testing formats and/or date(s) will be announced.

Class Schedule - MAC 1140 – Pre-Calculus Algebra – Fall 2010

Week 1 Aug 23 - 27	Class policies and Intro to MyMathLab 4.1 (Polynomial Functions) Review of long division 4.5 (Real Zeros of Polynomials)	Class Policies and Class Schedule available in MyMathLab R Aug 26: Drop Deadline F Aug 27: Add Deadline
Week 2 Aug 30 – Sept 3	4.6 (Complex Zeroes of Polynomials) 4.2 (Rational Functions) 4.3 (Sketches of Rational Functions)	W Sept 1: HW 1 due R Sept 2: Quiz 1 due
Week 3 Sept 6 - 10	4.3 (Sketches of Rational Functions) continued 4.4 (Polynomial/Rational Inequalities) 5.1 (Composite Functions)	M Sept 6: Labor Day (no class) W Sept 8: HW 2 due R Sept 9: Quiz 2 due
Week 4 Sept 13 - 17	5.2 (Inverse Functions) 5.3 (Exponential Functions) 5.4 (Logarithmic Functions)	W Sept 15: HW 3 due R Sept 16: Quiz 3 due
Week 5 Sept 20 - 24	5.5 (Properties of Logarithms) 5.6 (Logarithmic/Exponential Equations) 5.7 Compound Interest	**W – F Sept 22 – 24:** **EXAM 1 (4.1 – 4.6, 5.1 – 5.4)** W Sept 22: HW 4 due R Sept 23: Quiz 4 due
Week 6 Sept 27 – Oct 1	5.8 (Applications to science) 6.2 (Parabola)	W Sept 29: HW 5 due R Sept 30: Quiz 5 due
Week 7 Oct 4 - 8	6.3 (Ellipse) 6.4 (Hyperbola)	No class on Wed due to UCF game W Oct 6: HW 6 due R Oct 7: Quiz 6 due
Week 8 Oct 11 - 15	7.1 (Systems of linear eqns) 7.2 (Matrices/row operations)	**M – T October 11 – 12:** **EXAM 2 (5.5 – 5.6, 5.8, 6.2 - 6.4)** W Oct 13: HW 7 due R Oct 14: Quiz 7 due F Oct 15: Withdrawal Deadline

Week 9 Oct 18 - 22	7.3 (Determinants) 7.4 (Matrix algebra/Inverse matrices)	W Oct 20: HW 8 due R Oct 21: Quiz 8 due
Week 10 Oct 25 - 29	7.5 (Partial fractions) 7.6 (Systems of nonlinear eqns)	W Oct 27: HW 9 due R Oct 28: Quiz 9 due
Week 11 Nov 1 - 5	8.1 (Sequences, Recursive sequences) 8.2 (Arithmetic sequences) 8.3 (Geometric sequences)	W Nov 3: HW 10 due R Nov 4: Quiz 10 due
Week 12 Nov 8 - 12	8.3 (Geometric series) Continued 8.5 (Binomial Theorem)	**M – T Nov 8 – 9:** **EXAM 3** **(7.1 – 7.6, 8.1 - 8.3 not including geometric series)** W Nov 10: HW 11 due R Nov 11: Quiz 11 due
Week 13 Nov 15 - 19	8.4 (Mathematical Induction) 9.1 (Limits by tables and graphs)	W Nov 17: HW 12 due R Nov 18: Quiz 12 due
Week 14 Nov 22 - 26	9.2 (Limits algebraically) 9.3 (One sided limits)	R Nov 25 – F Nov 26: Thanksgiving Break (no classes held) F Nov 26: HW 13 and quiz 13 due
Week 15 Nov 29 – Dec 3	Review Comprehensive final HW and quiz open on Monday	W Dec 1: HW 14 due R Dec 2: Quiz 14 due
Week 16 Dec 6	**COMPREHENSIVE FINAL EXAM** **(Chapters 4 – 9)** **Dec 7 - 13**	M Dec 6: last day of classes and comprehensive final HW and quiz due

Note: I reserve the right to modify this schedule if appropriate.

Mathematics for Calculus
MAC 2147
5 Credit Hours
Fall 2011

Instructor:	Ms. Lori Dunlop Pyle
Office:	MAP 101
Phone:	823-3185
e-mail:	Lori.Dunlop-Pyle@ucf.edu
Office Hours:	M W F 1:00-2:00 pm T Th 10:00-11:00 am
Meeting Time/Place	MWF 2:30-4:20 pm in HPA 119

E-Mail:

All communication between student and instructor and between students should be respectful and professional. As of 2009, Knightsmail is the only official student email at UCF. Class rosters list Knightsmail addresses rather than external email addresses, and all official class communications will be sent only to the Knightsmail addresses. Students are responsible for acquiring and checking their Knightsmail accounts regularly. Please be sure to sign your name to your e-mails.

Tests:

There will be 4 in-class tests and a comprehensive final exam. If your final exam score is higher than your lowest test score, your final exam grade will replace your lowest test score. Please note that if your test grade is a zero as a penalty for an academic integrity violation, that test grade will not be replaced with your final exam score.

Homework and Quizzes:

The homework Exercises in each section have 6 categories (Skills, Applications, Catch the Mistake, Conceptual, Challenge, and Technology). It is your responsibility to work through the problems I assign from the Skills, Applications, Conceptual, and Challenge Exercises. There will be a quiz every non test day- one problem selected from the previous class exercises. You will need 3" X 5" note cards for the quizzes. You will also have graded homework assignments on Wiley Plus, an online homework system which utilizes the **Wiley Plus access code packaged in an envelope with your textbook (Do NOT discard).** As these assignments must be completed online, students will be expected to have access to a computer. Students may use a computer in one of the computer labs on the main campus.

All assignments will have posted due dates and these **due dates will not be extended** so please plan accordingly. Personal computer issues, including login errors, will NOT be a reason to offer any type of extension. If you are experiencing computer issues, you are encouraged to contact Technical Support by clicking on “Help” in the upper right-hand screen when you are in the course. You can also use the lifesaver icon on the main landing page. You will then be directed to select your level of support: FAQs, Ask a Question, or Live Chat. Live chat tech support is available 24 hours M-F and Sat-Sun. from 4:00 PM-11:59 PM EST. Live chat for customer care is available M-F from 8AM-8PM EST.

Class work: I may assign problems in class that will be turned in at the end of class for a grade.

Participation: Your participation grade will be based upon whether you are complying with EXCEL requirements such as lab hours and turning in test corrections when required. Participation with our service project will also be part of your participation grade. Each week you will receive 1 point if you have met all of your requirements or 0 points if you have not met all of your requirements.

Service Project: Community is an integral part of our UCF creed and the EXCEL program. As such we will be working with a local elementary school class to better serve our community. We can have a great influence in introducing these students to UCF and helping them learn. Helping others can be one of life’s most rewarding experiences. I hope you enjoy our project!

Required Text: *Precalculus with Limits,* Cynthia Y. Young, Wiley Publishers, 2010 packaged with Wiley Plus.

Test Dates:

Test 1: Friday, September 16
Test 2: Friday, October 7
Test 3: Friday, October 21
Test 4: Friday, November 18

Final Exam: Wed., Dec. 7 from 1:00-3:50 PM in our regular classroom. Travel plans will not be an acceptable reason to take the test at a different time.

Attendance: Attendance will be taken daily.

Grading:

Test average: 50%
Final Exam: 25%
Quiz average and class work average: 10%
Wiley Plus: 10%
Participation 5%

Make-up policy:	There will be **no make-up exams, quizzes, or class work** except in extreme circumstances (ex: death in immediate family, military obligation, school activity, documented illness, etc.) according to university policy. You will be asked to provide proper documentation.
NC Grade:	To earn the grade of NC you must meet the following criteria 1) Regular attendance (6 or fewer unexcused absences) 2) Student must have taken all tests 3) Student earns 0% on no more than two online homework assignments

Grading Scale:

90-100	A
80-89	B
70-79	C
0-69	F (unless you meet the NC criteria)

Calculators: You will be required to use <u>only</u> the TI-30XA (Texas Instruments) scientific calculator for tests, quizzes, and class work. Using an inappropriate calculator will result in a grade of zero on the assignment and possible disciplinary action.

Cell Phones: Cell phones must be turned off (not on vibrate) before coming to class. Use (defined as having one physically in your hand) of a cell phone during a test or quiz will be considered contact with another person and will be viewed as a form of academic dishonesty because I cannot be assured in such a circumstance that you have not taken a picture of the test/quiz or sent a text message to someone. **<u>Thus, do not touch your cell phone during a test or quiz. Wait until after you have left the room and are finished with the test/quiz to use it.</u>**

Music Players: iPods and other music players are not to be used during class (including while taking tests and quizzes). Having one out during a test or quiz will result in a grade of zero and possible disciplinary action.

<u>Important Fall 2011 Academic Dates and Deadlines</u>:

Classes Begin	Mon., Aug. 22
Late Registration	Mon., Aug. 22 – Fri., Aug. 26
Drop Deadline (Last day for full refund)	Thurs., Aug. 25
Add Deadline	Fri., Aug. 26
Withdrawal Deadline	**Thurs., Oct. 27**
Classes End; Last Day to Remove Incomplete	Sat., Dec. 3
Final Exam Period	Mon., Dec. 5-Sat., Dec. 10

<u>Holidays</u>:

Labor. Day	Mon., Sep. 5
Veterans Day	Fri., Nov. 11
Thanksgiving	Thurs., Nov. 24-Sat., Nov 26

Prerequisites: Solid background in algebra or trigonometry

Course Description: This is a course for students with a good background in mathematics who do not want to go directly into calculus. We will cover chapters 1-11 in the text book.

Course Goals: Students will learn algebra and trigonometry to prepare them for calculus.

Disability Related Accommodations: The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. Students who need accommodations must be registered with Student Disability Services, Student Resource Center Room 132, phone (407) 823-2371, TTY/TDD only phone (407) 823-2116, before requesting accommodations from the professor. No accommodations will be provided until the Student Disability Services office has notified the professor concerning appropriate accommodations.

Academic Honesty: The work you submit in this class is expected to be your own. Forms of cheating/academic dishonesty include (but are not limited to): communicating with another student during a test or quiz (this includes giving information to another student as well as receiving that information), using an unauthorized calculator, using unauthorized material during a test or quiz, and communicating contents of a test or quiz to another student either during or after the test/quiz. Since lab hours count toward your participation grade, logging into the EXCEL database on behalf of someone not in the lab or having someone log in for you when you are not in the lab will be considered a form of academic dishonesty as well (only you should log yourself into the EXCEL database). I reserve the right to penalize a student for academic dishonesty by assigning the student an F for the course. A grade with a "Z" designation may also be assigned (for more information on the "Z" designation grade, please go to http://www.z.ucf.edu/). In addition, further disciplinary action through the university will be taken. Please be aware that disciplinary action through the university could result in suspension or expulsion. For more information on academic honesty, please see the Golden Rule contents available at http://www.goldenrule.sdes.ucf.edu/ .

Note: Information in this syllabus is subject to change. Any changes will be clearly announced in class.

APPENDIX B: PROJECTS

Global Climate Change Project

This is a *team* project worth 10% of your total course grade. The project has two parts (1) a written report and (2) a 15 minute in-class presentation on December 1st. The full reports (in pdf format) should be emailed to Dr. Young as well as printed out in color and turned in as a hard copy at the time of presentation. Additionally power point presentations and an electronic copy should also be emailed to Dr. Young.

Used in fields of study that range from engineering to economics to sociology, a mathematical model is a tool that uses mathematical language to describe a system. There are many types of models, which help us to not only better understand the world as it is; but, by projecting different scenarios based on available data, allow us glimpses into possible futures.

Current changes in the environment, which will affect all of our futures, have brought about a fierce debate. Some scientists believe that human activities have played a large part in bringing about global warming, which impacts not only day-to-day temperatures but also species extinction, loss of glacial ice, and the quality of the air we breathe. Others feel that current changes in the climate are simply part of a natural cycle and are not a cause for concern. The purpose of this project is for ***you*** to explore the topic of global climate change and become an informed participant in this debate.

1. Find temperature data (that spans at least 30 years up to at least the year 2000) and plot the temperature as a function of time (year). We have studied many types of functions in this course to date- what type of function do you think best models this data? Develop at least three types of models (i.e. linear, polynomial, and exponential) that govern temperature as a function of time. Extend your results 10 years. Do your models suggest there is or is not global warming? Justify your argument.
2. Find data (that spans 20 years or more) for some greenhouse gas and plot the emissions as a function of time (year). Develop three different types of functions we have studied in this course that model these data. Which model do you think is the best? Justify your answer. Use this model to predict emission levels in the year 2050.
3. Dr. Young drives a Ford Expedition (and loves it). Research different makes of Hybrid SUV's and Traditional Gas SUV's and calculate the cost associated with each type (use specific models and manufacturers' data**). All of the SUV's you select must come in either AWD or 4WD**. Don't forget the cost of gasoline, electricity, and maintenance, etc. Graph the cost of each of these models as a function of miles driven. How many miles would you have to drive for the hybrid SUV to be the most economical ? Don't forget to include initial costs, any government incentives for that model, the mileage, in town or highway driving, cost of gasoline, cost of electricity, etc..

The Kidney Stone Problem - Ellipses

A.) One effective way to treat kidney stones is a medical process called lithotripsy, which uses the unique properties of an ellipse to focus shockwaves onto a kidney stone. These shockwaves break the stone down into tiny pieces that can pass through the body. The early methods of lithotripsy used an elliptical metal tub filled with water, where the patient was placed at one focus of the ellipse, and the shockwave generator was located at the other focus. The generator would then transmit a signal, which would bounce off of the side of the tub, and onto the patient placed in a specific position at the other focus of the tub. This causes pressure, but no pain, on the area of the body where the stone is located, causing the stone to break down.

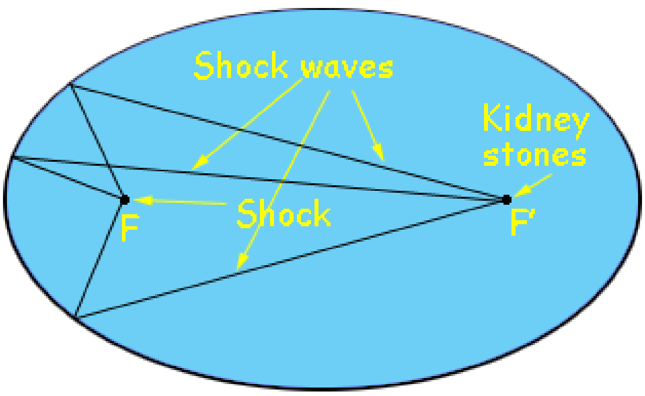
Your local hospital has contracted you to help design an aluminum lithotripsy tub. The hospital wants a tub that is 67.2" long and 46.8" wide. Additionally, the manufacturer of the shockwave generator warns that the generator must be at least 40" away from the patient undergoing lithotripsy for safety reasons. Will the generator's requirements allow the hospital to have the tub dimensions they want?

B.) The hospital also requires larger tubs for overweight or obese patients, and you have been contracted to design the larger tub as well.

From the list of facts below, choose exactly two (2) facts that you can use to create the equation of the ellipse of the new tub. There is more than one correct combination of facts, but not every fact is necessarily relevant or useful.

a.) Due to the larger size of the tub, the patient and the generator will now be 59.0" apart.
b.) The eccentricity of the ellipse describing the new tub is 0.0014
c.) The vertices of the ellipse describing the new tub are 80.2" apart.
d.) The length of the new tub is 13" longer than the regular tub
e.) The width of the new tub is 7.5" longer than the regular tub
f.) The length of the major axis of the ellipse is 2a, the length of the minor axis is 2b.

C.) ***Thought Question:*** No matter what direction the shockwave generator is pointing (as long as the generator is located at one focus), the signal will ALWAYS bounce off of the side of the tub and pass through the second focus of the ellipse. Why do you think this is? Think of another application where this unique property of an ellipse could be useful.



<u>The McDonald's Problem (Parabolas)</u>

A.) Notice how the famous golden arches of McDonald's are really parabolas. You are helping to design a new McDonald's restaurant in your neighborhood. Another engineer has concerns that the large golden arch sign you ordered won't fit into the metal frame that has just been delivered. The manufacturer of the golden arch sign tells you that one arch can be described by $y = -1(x - 4.5)^2 + 15$(the output is in feet), will the arch fit into a 14' x 16' frame?

16'

14'

?'

?'

B.) Which of the following equations could represent a parabolic **function** that could be used to design an arch used for McDonald's? (Hint: arrange the following equations into standard form)

$$Y = \frac{-X^2}{4p}$$

$$\sqrt{X} = \frac{Y}{2p^{1/2}}$$

$$Y = (4pX)^{1/2}$$

$$X = -2\sqrt{pY}$$

The LORAN Problem (Hyperbolas)

LORAN (LOng-RAnge-Navigation) is a navigational tool used by ships. A ship at sea can pick up the simultaneous radio wave transmissions of two radio stations on a nearby coast. If the boat is at sea, it will be slightly closer to one radio station than another, which results in a small time difference between the signals received from the two stations. The time difference, along with the rate the signal travels (the speed of light), can be used to calculate the distance from shore. If the boat follows the path associated with the constant time difference, that path will form a hyperbola, and the radio stations are the foci of that hyperbola.

A.) Two loran radio stations are located 500 miles apart along a coast. If a ship records a time difference of 0.67 milliseconds and continues on the hyperbolic path corresponding to that difference, where does it reach shore?

B.) Draw a graph of the hyperbola represented in the situation above. Where are the asymptotes located? Describe what the asymptotes mean in "real-world" terms.

Name: October 29, 2010

PID:

<u>MAC 2147 Pre-Calc Apps III: Systems of Linear Equations – Group Assignment</u>

Read the data sheet provided and answer the following questions. Assume that you drive 15,000 miles per year (all in city) and the price of gasoline is $3.00 per gallon.

1.) Write a linear equation that models the total cost of owning and operating each vehicle *y* as a function of the number of years of ownership *x*.
    a. Camry
    b. Camry Hybrid
    c. Highlander
    d. Highlander Hybrid

2.) Write a linear equation that models the total number of pounds of carbon dioxide each vehicle emits *y* as a function of the number of years of ownership *x*.
    a. Camry
    b. Camry Hybrid
    c. Highlander
    d. Highlander Hybrid

3.) How many years would you have to own and drive the vehicle for the hybrid to be the better deal? <u>Show this both graphically and algebraically</u>.
    a. Camry Hybrid versus Camry
    b. Highlander Hybrid versus Highlander

4.) How many years would you have to own and drive the vehicle for the hybrid to emit 50% less carbon dioxide than its conventional counterpart?
    a. Camry Hybrid versus Camry
    b. Highlander Hybrid versus Highlander

In 2005 hybrid vehicles were introduced in the U.S. market. The demand for hybrids, which are typically powered by a combination of gasoline and electric batteries, was based on popular recognition of petroleum as an increasingly scarce nonrenewable resource, as well as consumers' need to combat rising prices at the gas pumps. In addition to achieving greater fuel economy than conventional internal combustion engine vehicles (ICEVs), their use also results in reduced emissions.

An online "Gas Mileage Impact Calculator," created by the American Council for an Energy-Efficient Economy (www.aceee.org), was used to generate the following tables comparing a conventional sedan (four-door) and an SUV versus their respective hybrid counterparts.

Gas Mileage Impact Calculator

	TOYOTA CAMRY 2.4L 4, AUTO $3.00/GALLON 15,000 MI/YEAR	TOYOTA CAMRY HYBRID 2.4L 4, AUTO $3.00/GALLON 15,000 MI/YEAR
Gas consumption	611 gallons	449 gallons
Gas cost	$1,833.00	$1,347.00
Fuel economy	25 mpg	33 mpg
EMISSIONS		
Carbon dioxide (greenhouse gas)	11,601 pounds	8,522 pounds
Carbon monoxide (poisonous gas)	235 pounds	169 pounds
Nitrogen oxides (lung irritant and smog)	10 pounds	7 pounds
Particulate matter (soot)	255 grams	255 grams
Hydrocarbons (smog)	6 pounds	8 pounds

	TOYOTA HIGHLANDER 3.5L 6, AUTO STK $3.00/GALLON 15,000 MI/YEAR	TOYOTA HIGHLANDER HYBRID 3.3L 6, AUTO AWD $3.00/GALLON 15,000 MI/YEAR
Gas consumption	740 gallons	576 gallons
Gas cost	$2,220	$1728
Fuel economy	20 mpg	26 mpg
EMISSIONS		
Carbon dioxide (greenhouse gas)	14,052 pounds	10,936 pounds
Carbon monoxide (poisonous gas)	229 pounds	187 pounds
Nitrogen oxides (lung irritant and smog)	11 pounds	8 pounds
Particulate matter (soot)	320 grams	399 grams
Hydrocarbons (smog)	7 pounds	16 pounds

The MSRP and mileage comparisons for the 2008 models are given below:

	CAMRY	CAMRY HYBRID	HIGHLANDER	HIGHLANDER HYBRID
MSRP	$19,435	$26,065	$28,035	$34,435
Miles per gallon in city	21	33	18	27
Miles per gallon on highway	31	34	24	25

Name: October 29, 2010

PID:

MAC 2147 Pre-Calc Apps III: Systems of Linear Equations – Individual Assignment

Read the data sheet provided and answer the following questions. Assume that you drive 15,000 miles per year (all in city) and the price of gasoline is $3.00 per gallon.

1.) Compare the yearly cost of owning and operating a Camry Hybrid to the cost of owning and operating a Highlander Hybrid. When does the cost of the Camry Hybrid equal the cost of the Highlander Hybrid? Why does the cost of the Camry Hybrid never equal the cost of the Highlander Hybrid?

   a. The equations of the Camry Hybrid and Highlander Hybrid have the same slope
   b. The equations of the Camry Hybrid and Highlander Hybrid intersect at a negative value of time
   c. The equation of the Camry Hybrid has a negative slope, and the equation of the Highlander Hybrid has a positive slope
   d. The equations of the Camry Hybrid and the Highlander Hybrid intersect at a positive value of time

2.) The Camry hybrid and the Highlander Hybrid are both being taken for a test drive. They both are driven through the city, as well as on the highway. Both cars used the same amount of gas when driving through the city, and both cars used the same amount of gas when driving on the highway. At the end of the test drive, the Camry Hybrid drove a total of 159.1 miles. The Highlander Hybrid drove a total of 118.9 miles. What is the amount of gallons of gas that both cars used in the city, and what is the amount of gallons of gas that both cars used on the highway (remember that both cars used the same amount of gas)?

   a. 1.5 gallons used in the city, 15 gallons used on the highway
   b. 0.7 gallons used in the city, 4 gallons used on the highway
   c. 0.35 gallons used in the city, 8 gallons used on the highway
   d. 0.01 gallons used in the city, 3 gallons used on the highway

The Part-Time Job Problem

A.) To combat your growing student loans for school, you decide to sign up for a part-time job to make some extra money. You were lucky enough to find two opportunities – you can work for UCF Parking services, or you can work as a janitor at the recreation center. Both jobs are going to pay you based on the number of hours you work. UCF Parking services is going to pay you according to the following function: $f(x) = \frac{x^2 - 3x - 4}{x+2}$ where x is the number of hours worked per week, and f(x) is the amount of money you will be paid per hour. The recreation center will pay you according to the following function: $f(x) = \frac{x^2 - x - 2}{x^2 + x - 6}$ Where x is the number of hours worked per week and f(x) is the amount of money you will be paid per hour.

*If f(x) < 0, assume the pay rate is $0/hour.

Which job would you choose, and why?

B.) You've started your new part-time job, and now your manager has given you the opportunity for a bonus. He offers you two bonus packages, based on the number of overtime hours you work per week (you must work more than 3 overtime hours to get the bonus). You can choose to be paid by one of two functions, where x is the number of overtime hours worked, and f(x) is the amount of additional money you get per hour (on top of your normal hourly pay):

$$f(x) = \frac{x^2 - 9}{x+3} \qquad OR \qquad f(x) = x - 3$$

You tell your friends about your bonus to see what they think. "Those functions are the same!" says one of your friends. The rest of the group says that they are not, and that you should choose the first option. Who's right? Explain your reasoning.

C.) As a part-time employee, you don't have any benefits. Every time you are sick and have to miss work without giving your manager a 48-hour notice, your manager, unfortunately, docks your pay for the month. Look at the following equation, where x is the number of sick days you (potentially) have, and f(x) is the amount of money taken out of your paycheck, should you actually miss x amount of days. Try to predict any holes or asymptotes, and what the graph might look like. Then, graph the function.

$$f(x) = \frac{2x^2 + 10x + 12}{3x + 2}$$

a.) Were your predictions correct?
b.) What is the difference between a hole/discontinuity, and an asymptote?
c.) In your own words, try to describe what any holes and/or asymptotes mean in "real world" terms.
d.) Do you think the system for docking pay is fair?

The Rollercoaster Problem

1. Cedar Point is a world-renowned theme park in Sandusky, Ohio. The roller coasters there are some of the biggest and fastest in the entire world. Top Thrill Dragster, once the world's tallest ride (Japan has recently built an even taller ride), is known for it's speed and height. It's only seconds long, and features only one loop curves from the ground at a 90 degree angle into the air, and curves at almost 90 degrees again as it comes back down to the ground. Each passenger car reaches a speed of nearly 120 miles per hour before it climbs the loop.

The maximum height of this rollercoaster can be found using the following function, which describes the height of the rollercoaster as a function of time.

$$f(x) = -\frac{5}{3}x^2 + \frac{155}{3}x + 30$$

Answer the following with respect to the function's output in the first quadrant only.

A. What is the maximum height of the rollercoaster?
B. How long (in seconds) is the ride?
C. Graph the equation.

2, Cedar Point is going to build a new ride this summer. The new roller coaster can be described by the following function: $f(x) = -\frac{1}{6}(x^4 - 45x^3 + 575x^2 - 1875x)$
(assume that this function describes the shape of the rollercoaster, where x is horizontal distance and f(x) is vertical distance)

A. Do you think that this equation represents a good design for the new ride? Support your answer by performing the following calculations, and using at least two reasons.
- How many zeros does this function have? What do these zeros mean in real-world terms?
- Find the zeros and graph the function given one of the roots is (x-5)
- Analyze your graph and determine if this function is a good representation of a real rollercoaster.

B. Finally, try to manipulate the equation to provide a polynomial function that is representative of a more realistic rollercoaster.
- Use the Intermediate Value Theorem to prove that your new rollercoaster has at least one zero. Why do you want the function representing your function to have at least one zero?
- Graph the function of the new rollercoaster you designed.

APPENDIX C: PRE-TEST AND POST-TEST

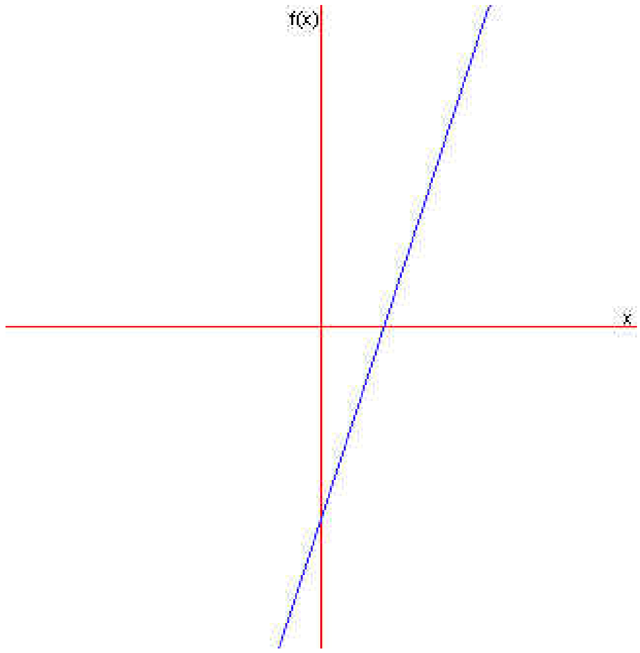
NAME:______________________   PID______________________

PRETEST: PRECALCULUS

For the following 5 Topics Select the Letter that Corresponds to the Appropriate Graph:

Problem	Topic	Corresponding Graph
1	Conic Section	
2	Polynomial Function	
3	Exponential Function	
4	Rational Function	
5	System of Linear Inequalities	

A



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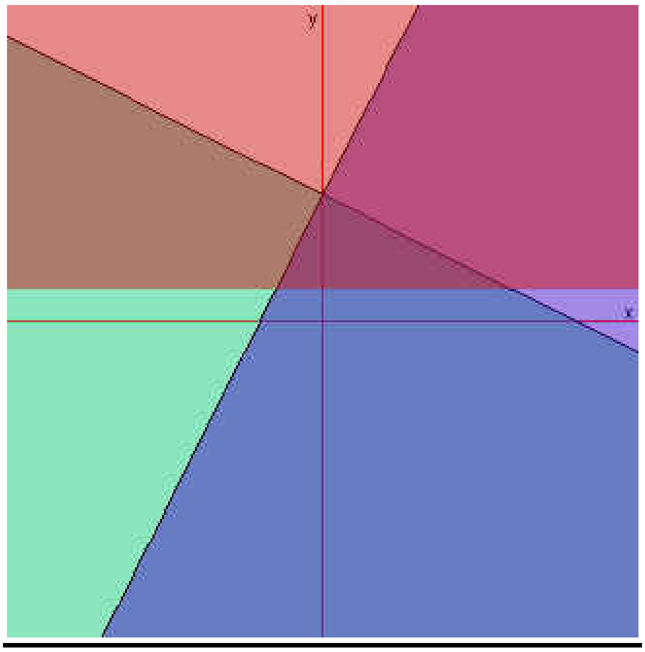

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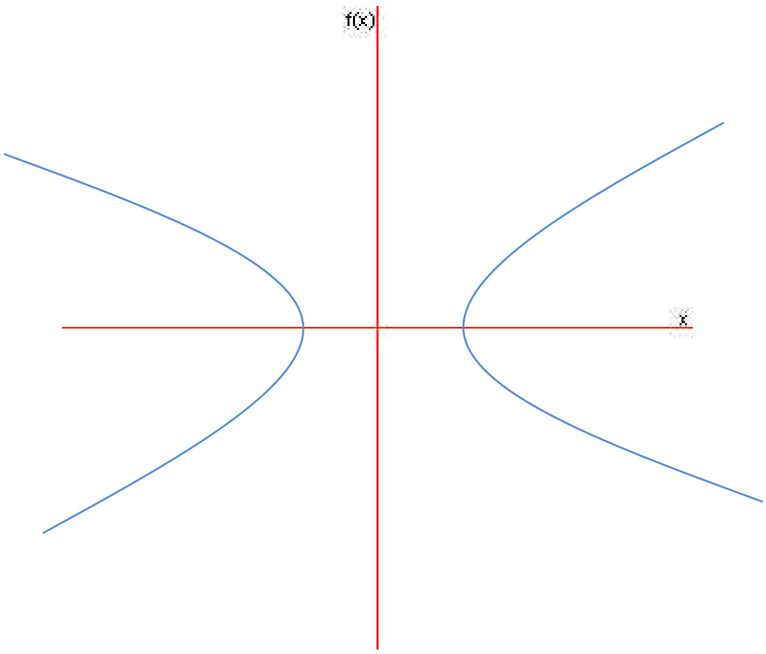

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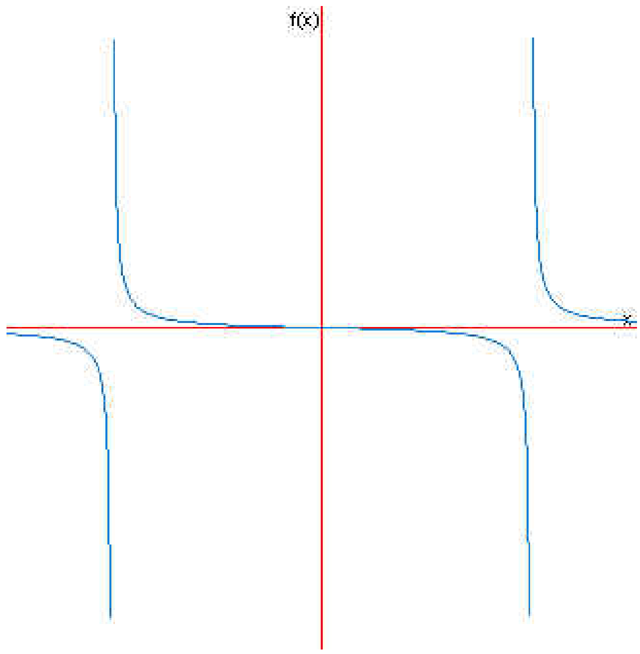

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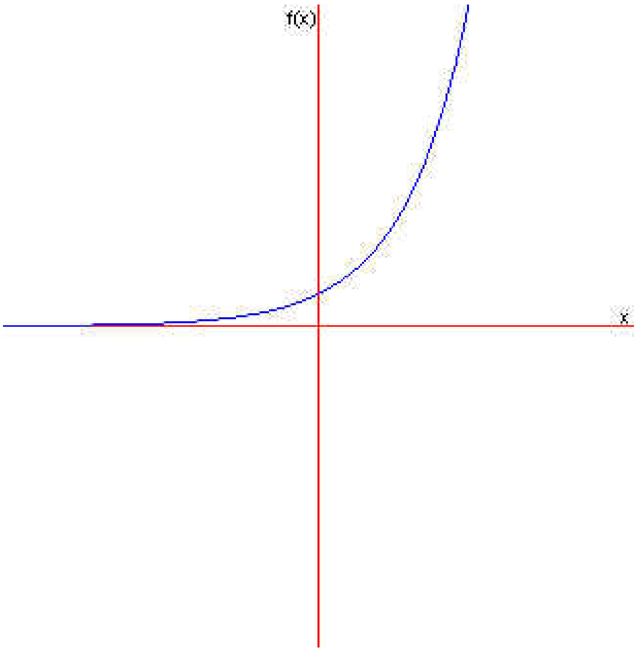

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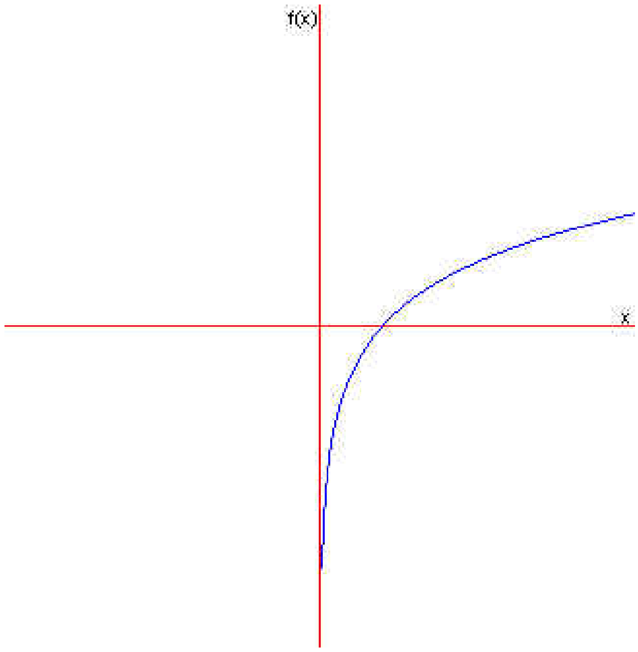

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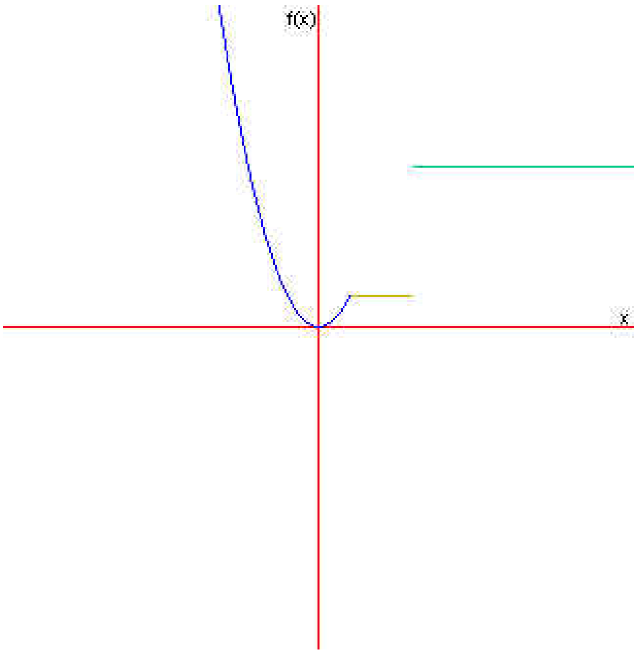

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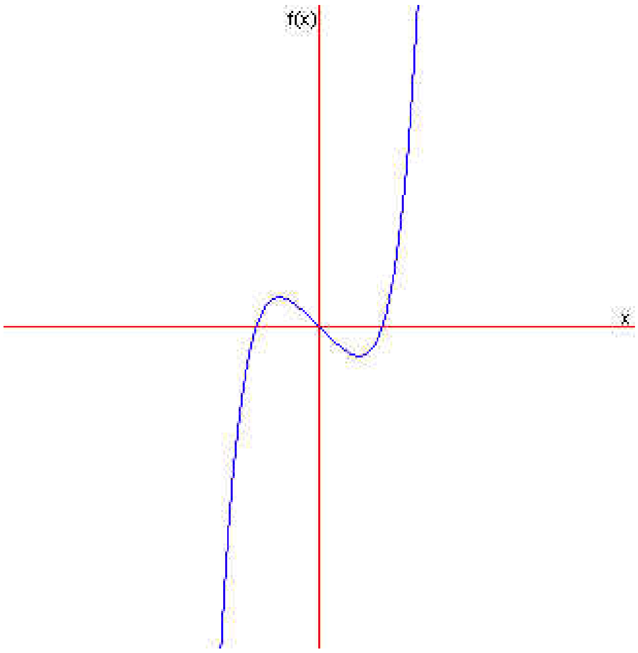


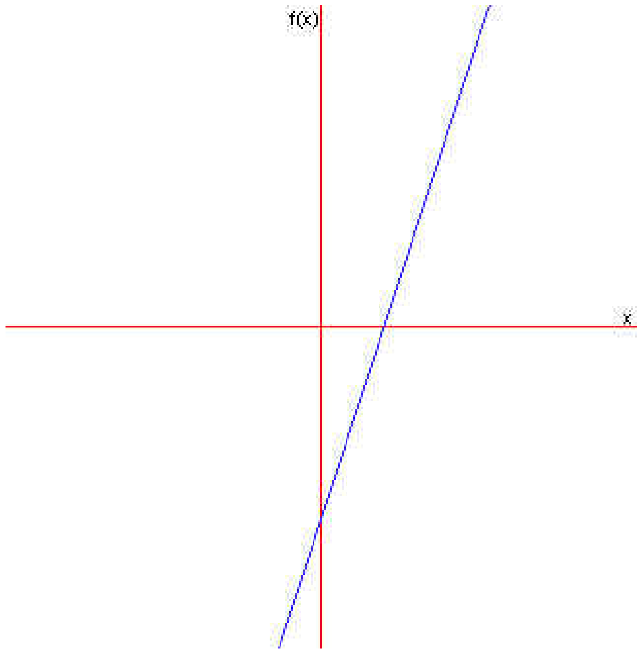
NAME:______________________ PID______________________

POST-TEST: PRECALCULUS

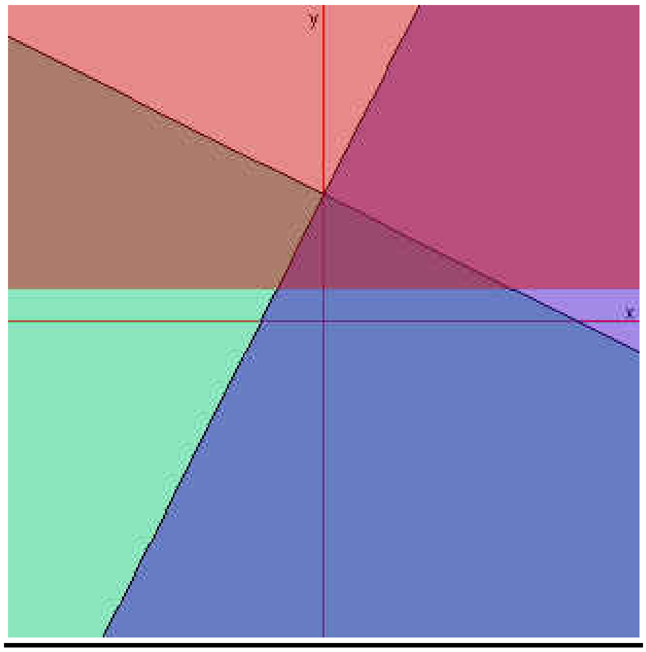
For the following 5 Topics Select the Letter that Corresponds to the Appropriate Graph:

Problem	Topic	Corresponding Graph
1	Conic Section	
2	Polynomial Function	
3	Exponential Function	
4	Rational Function	
5	System of Linear Inequalities	

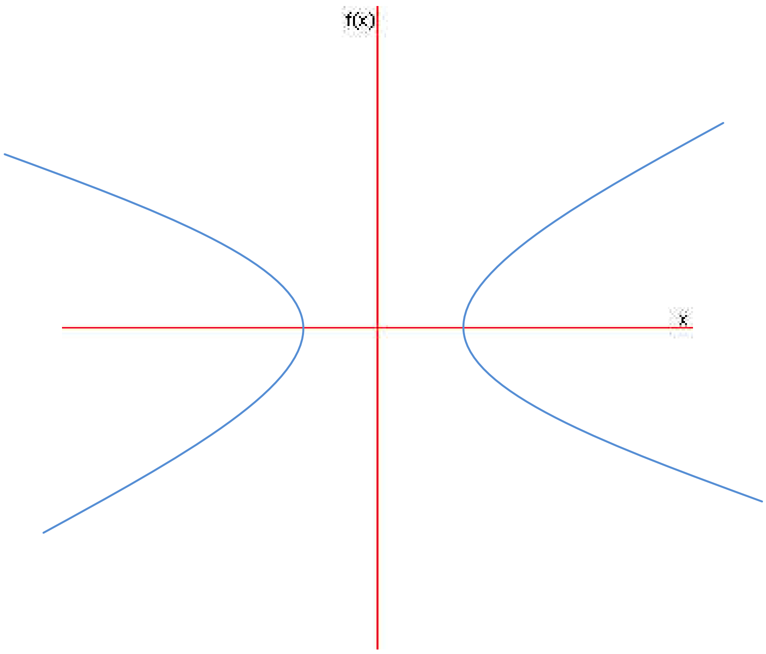
A



B



C



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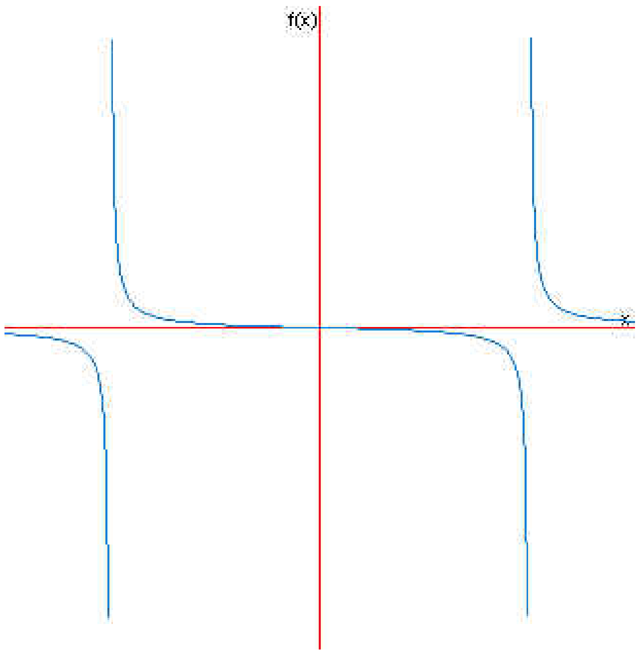
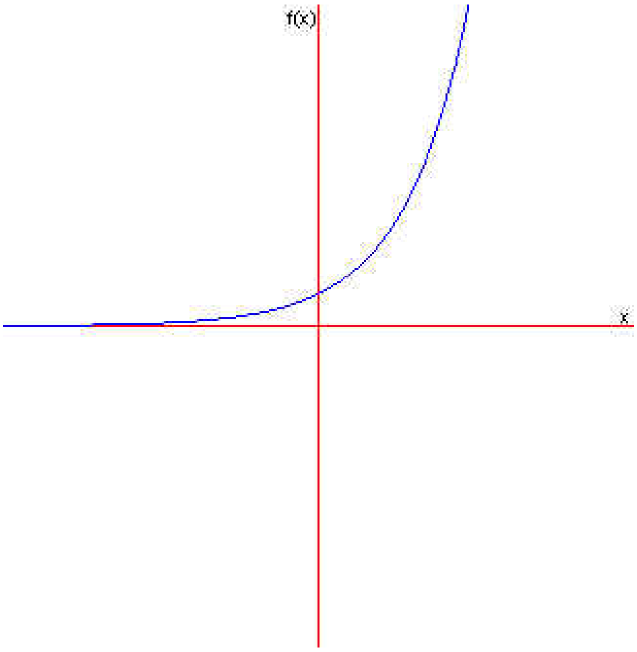


E



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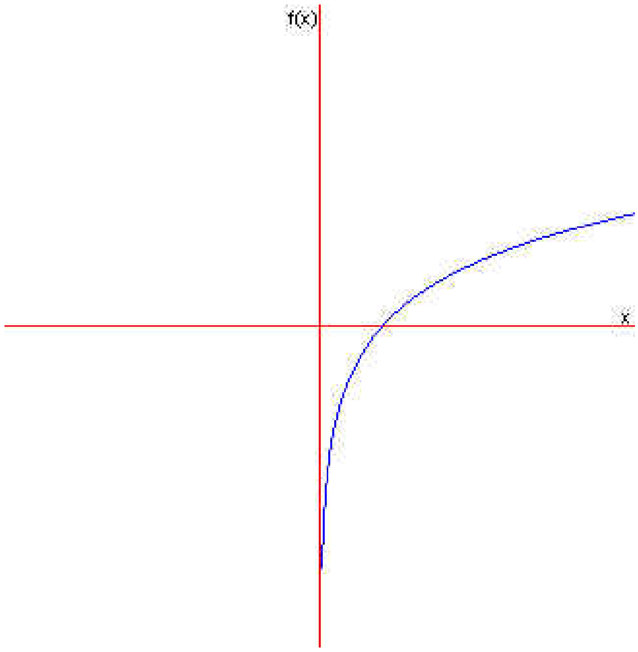
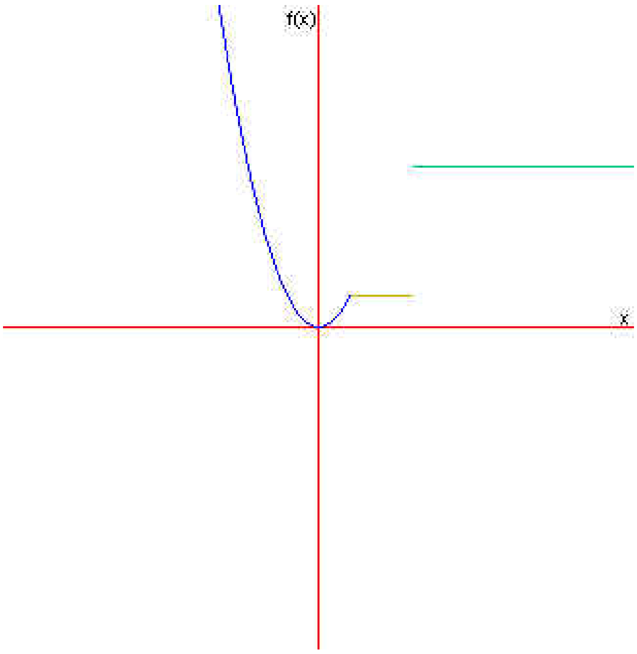
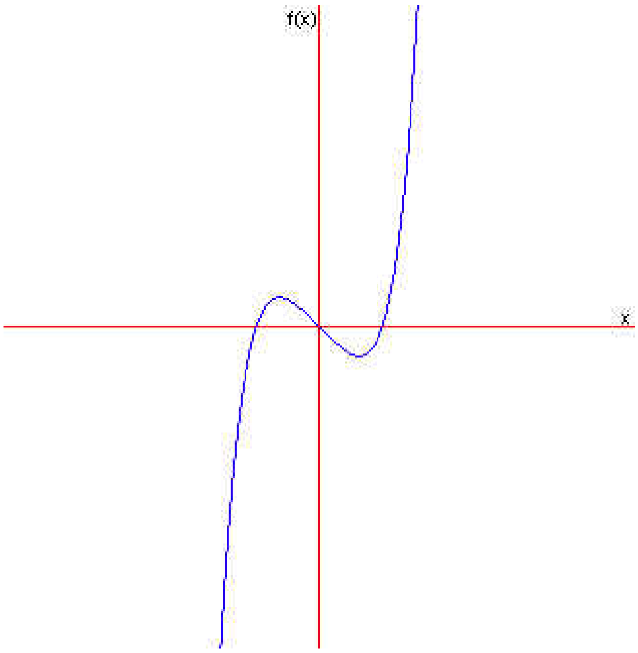


G



H



Name:_______________________PID:____________________

COURSE:___________________________

Sequences and Series

Pre Test

	ALWAYS TRUE	ALWAYS FALSE	SOMETIMES TRUE
A sequence is a list of terms.			
A series is a sum of terms.			
A finite series converges.			
An infinite series diverges.			
If a sum does not converge then it diverges.			
An infinite series can converge if the terms get smaller and smaller.			
A sequence can be represented with sigma notation.			

Name:________________________PID:______________________

COURSE:______________________________

Sequences and Series

Post Test (after animation)

	ALWAYS TRUE	ALWAYS FALSE	SOMETIMES TRUE
A sequence is a list of terms.			
A series is a sum of terms.			
A finite series converges.			
An infinite series diverges.			
If a sum does not converge then it diverges.			
An infinite series can converge if the terms get smaller and smaller.			
A sequence can be represented with sigma notation.			

Free Response:

1. Did the animation keep you interested/engaged in infinite sequences and series?

2. Did the animation contribute to your learning infinite sequences and series? If so explain.

3. Would you like to take a course where all topics had a similar type animation?

4. Any suggestions for improving the animation?

Name:____________________PID:_________________

COURSE:_______________________

Sequences and Series

Post Test (Instructor Covered)

	ALWAYS TRUE	ALWAYS FALSE	SOMETIMES TRUE
A sequence is a list of terms.			
A series is a sum of terms.			
A finite series converges.			
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If a sum does not converge then it diverges.			
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4. Any suggestions for improving the animation?

Name:____________________PID:__________________

COURSE:________________________

Sequences and Series

Post Test After Animation

	ALWAYS TRUE	ALWAYS FALSE	SOMETIMES TRUE
A sequence is a list of terms.			
A series is a sum of terms.			
A finite series converges.			
An infinite series diverges.			
If a sum does not converge then it diverges.			
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Name:____________________PID:__________________

COURSE:________________________

Sequences and Series

Post Test (after animation)

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Name:______________________PID:____________________

COURSE:___________________________

Sequences and Series

Post Test (Instructor Covered)

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Name:________________________PID:______________________

COURSE:______________________________

Sequences and Series

Post Test After Instructor Covered

	ALWAYS TRUE	ALWAYS FALSE	SOMETIMES TRUE
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COURSE:_______________________

Sequences and Series

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Name:_______________________PID:_____________________

COURSE:____________________________

Sequences and Series

Post Test (Instructor Covered)

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APPENDIX D: IRB

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Gabrielle K. Rejniak**

Date: **March 27, 2012**

Dear Researcher:

On 3/27/2012, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Improving Student Learning in Pre-Calculus
Investigator:	Gabrielle K. Rejniak
IRB Number:	SBE-12-08243
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Patria Davis on 03/27/2012 04:17:18 PM EST

IRB Coordinator

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