2015

Engaging College Students in Online Remedial Mathematics Courses With Video Instruction

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Walden University
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Abstract

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MEd, Southern New Hampshire University, 2005

BA, Southern New Hampshire University, 2003

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Educational Technology

Walden University

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Abstract

Many students entering college in the United States need assistance in at least one academic area, causing remedial courses to be commonplace in higher education. This study evaluated the impact of video instruction in learning the content found in an online remedial math course. The instructional videos were created using the guidelines of Universal Design and cognitive load theory. A quantitative, quasi-experimental method was used to evaluate a dataset made available by a regionally accredited private New England college's online division. The online division offers undergraduate and graduate degree programs and certifications, and the students are located all over the world. The dataset started with 203 participants, with 78 completing the first module, 36 completing the second module, and 17 completing the third module. Paired *t* tests revealed that while both text and video instruction improved the scores between the pre- and posttests, there was no statistically significant difference between those two groups. However, the end sample size was small, with many students not completing all three modules. This limited the interpretation to the results of the pre- and posttest scores of the first module only. These findings inform faculty teaching remedial online math courses, as well as course designers, seeking to improve these courses and increase the success rate for students passing the course. This has implications for social change because student success in these remedial math courses may in turn increase persistence, retention and graduation.

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Dedication

This work is dedicated to my friends and family that have always been there to support me through this endeavor. If not for their love and patience, I would not have completed this journey. There were countless long nights, and they were there to help me every step of the way, always lending a sympathetic ear just when I needed it. I especially dedicate this to my husband, Bladimir, who has been there for me to lend ongoing support through this process. This process was certainly a long and difficult one, but he has been there to help in any way he could. Thank you, everyone, for helping me to accomplish this dream of mine.

Acknowledgments

This has certainly been a long journey for me. It has been a goal of mine for a while to complete my PhD. I certainly could not have taken those initial steps toward that goal without my mom. She supported me and pushed me to get this process going, and I am eternally grateful for the fact she did that. I would not be here today if it was not for the love and support that I needed to get started.

I also want to thank all of my colleagues at Southern New Hampshire University who provided me with continuous support throughout this whole process. As many of them had been through this same journey, they were able to help keep me focused and be a resource when I needed to talk to someone who understood what I was going through. Their support was irreplaceable during the times I needed it the most.

My husband has also been there for me throughout the later portion of this process. He was not in my life when I started my journey, but he certainly helped get me to the finish line. He is the calm to my storm and that helped me tremendously throughout the dissertation process. He was always there to remind me that everything would work out and that I was accomplishing my dream.

Last, but not least, I must thank my dissertation committee. Dr. Jennifer Smolka has been there to help me throughout this process, both as my dissertation chair and my advisor. I would not have been able to make it through this without the phone calls and texts that helped me get this done. The knowledge and experience you were able to bestow upon me has certainly helped me accomplish this dream of mine.

I am reaching the finish line and I have you all to thank for that.

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Chapter 1: Introduction to the Study

Background

Many students enter college without the academic skills needed to be successful in all subject areas and require remedial coursework (Attewell, Lavin, Domina, & Levey, 2006; Bettinger & Long, 2009). Of these students who need to take remedial courses, more take remedial mathematics courses than any other remedial courses (Attewell et al., 2006; Bahr, 2007; National Center for Education Statistics (NCES), 2003). The large number of students taking remedial mathematics courses makes it valuable to develop strategies to help students complete these courses successfully and gain the skills needed to continue on with their degree programs. One newer instructional method of helping students learn the content in mathematics courses is video instruction, with the focus varying depending on if the course is taught in person or online.

For online students, video instruction engages students and helps them make connections with the content better than traditional text resources (Choi & Johnson, 2005; Hughes, 2009). A commonly found version of video instruction is the recording of traditional courses and archiving the video files for students view at a later time (Cascaval, Fogler, Abrams, & Durham, 2008). Having multiple representations of information such as this is beneficial to students, with audio and text complementing each other (Hughes, 2009; Moreno & Durán, 2004).

The literature search for this study identified a research gap concerning the overall effect of video instruction on online remedial mathematics courses. In addition to that, this search also did not identify any studies testing for different impacts of video instruction for different types of topics covered in a remedial mathematics course.

Problem Statement

For remedial mathematics students, trying to learn math from their textbook and text-based lecture notes can be difficult. This difficulty is increased in some settings, such as online courses that simply republish traditional materials in a digital format. As core classes, such as English and mathematics, are typically the first for a student to take, being able to pass their remedial math course would not only impact how successful they are in their future math courses, but also how they view the effectiveness of online courses in general. One study showed that students who were the most successful in their mathematics classes were also most likely to persist and graduate in four years (Parker, 2005). New methods of presenting information need to be considered in order to increase the number of students who are successful in their remedial math courses and therefore increase graduation rates. This project examined the effectiveness of an alternate instructional option, video instruction, which combines auditory and visual presentation to increase learning in online remedial math courses at a private university. Doing so addressed the gap in the literature reviewed for this study regarding the effectiveness of video instruction for online remedial mathematics courses.

Purpose of the Study

This study investigated whether video instruction is more beneficial to online students in remedial math courses than traditional text-based materials. Three different topic areas were examined to determine the effectiveness of video instruction based on different levels of difficulty for content found in a remedial math course. These topic areas were solving linear equations, linear equations, and applications of linear equations.

Nature of the Study

A quantitative experimental pre- and posttest study was done, which included participants that were randomly assigned to control and treatment groups. Students in the online program who had not taken a mathematics course in any college program and felt that the remedial mathematics course would be an appropriate first mathematics course were be invited to be part of the study. Both the control and treatment groups included three modules that were representative of content covered in the remedial mathematics course, with pre- and posttests for each module. The control group had text-based instruction and the treatment group had video instruction. This study used those results and compared the gains of the participants in each module in order to address the research questions.

Research Questions and Hypotheses

Research Questions

1. Does video instruction help online students in a remedial math course learn more overall than traditional text notes?

2. Is there a difference in the gains in student learning with video instruction between different topics (solving linear equations, linear equations, and applications of linear equations) included in a remedial math course?

Hypotheses

1. There is a difference in the overall gains in learning remedial math between students using video instruction versus students using only text-based instruction, as measured by the pre- and posttest scores in three content modules (solving linear equations, linear equations, and applications of linear equations).

2. There is a difference in each of the content areas (solving linear equations, linear equations, and applications of linear equations) between students using video instruction and students using only text-based instruction, as measured on the pre- and posttest scores in three content modules.

Theoretical Base

Universal Design

Universal Design's goal is to make things such as architecture, programs, and curriculum accessible to many different groups of people, including those with disabilities and with different learning styles (Burgstahler, 2008). For example, while captioning on videos is clearly necessary for students with hearing impairments, they can also help students for whom English is not their first language. It can also help any student who needs to view the video without sound.

As part of Universal Design, course content should be accessible to students with disabilities. If these accessibility items are kept in mind during the design phase, they would be easier to implement. In addition, accessible materials may be needed by a person at different stages of their life (Burgstahler, 2008). One example is that a person who is older may benefit from larger font sizes as their eye sight decreases, even though originally they may not have needed that.

Universal Design for Learning, or UDL, takes the ideas of Universal Design and looks at curriculum, pedagogy, and policies (Rose, Meyer, & Hitchcock, 2005). UDL has three principles, the first being to "provide multiple, flexible methods of presentation" (Rose & Meyers, 2006, p. ix). For this study, this supports the idea of providing video instruction in addition to traditional text instruction in online courses. When this takes place in a standard online course, it would give the students the opportunity to utilize the course materials that they feel best supports their learning.

Cognitive Load Theory

The rationale of improved learning through multimedia is not simply that the student is getting the information twice, in words and pictures. Mayer (2009) said that "people learn better from words and pictures than from words alone" (p. 4). The combination of two or more types of media, referred to as multimedia can be used in education to capitalize on this concept. Multimedia instruction can be used in a variety of ways, from computer-based instruction, to PowerPoint presentations, to recordings of live classes or lectures. Most of Mayer's work explores the combination of words and pictures, which is what this study had with the video instruction. The content in multimedia is not always the same between both sources; words and pictures are used to complement each other, enabling students to integrate both representations of the content and create meaningful connections (Mayer, 2009).

With cognitive load theory and multimedia learning, there are twelve features that have been tested for effectiveness. These are coherence, signaling, redundancy, spatial contiguity, temporal contiguity, segmenting, pre-training, modality, multimedia, personalization, voice, and image. Of those, ten features were found to lead to effective multimedia presentations, with multimedia and image being the two that did not have a strong effect (Mayer, 2009). For this study, this means that the videos created should minimize extraneous words and images, highlight key pieces of information, have text captioning of the lecture part as closed captioning so that it can be turned off, have words and images presented at the same time and near each other on the screen, have the videos broken up into smaller pieces, summarize what will be covered in the video, have the text presented in a conversational style, and have the audio done in a human voice.

There are some critiques of cognitive load theory. One is that there are no direct measurements of cognitive load in many of the studies done on this topic; instead, posttests are given and the results of those tests are analyzed to determine the results of cognitive load (De Jong, 2010). This makes it difficult to determine what the exact impact of cognitive load is, especially among the different types of cognitive load. Another issue is that some research has found contrary to the main idea of cognitive load theory, that the cognitive load should be minimized in all situations, is not always accurate for students with higher levels of expertise in that particular subject area (Schnotz & Kürschner, 2007). Finally, while extraneous load can and should be minimized through the instructional design process, intrinsic load should be adapted to the level of the student (Schnotz & Kürschner, 2007).

For this particular study, the intrinsic load was set by the curriculum of the math department. The content of the videos was set to mirror the content of the traditional course notes. Therefore, the extraneous load was the only piece that could be adjusted in this study. In addition, the students who would select into this study are students who do not feel strong about mathematics; therefore, they would not have a high level of expertise with this subject area.

Definition of Terms

Video instruction: the video instruction created in this study was computer created instruction with visual and auditory components, similar to a virtual whiteboard or narrated PowerPoint presentation. The videos were created with guidelines from cognitive load theory and Universal Design (See Appendix B). Participants in the video instruction group only had access to the videos.

Text-based instruction: the text-based instruction created in this study consisted of Word document files that included all of the lecture notes for that module and were similar to the instructional materials found in traditional online classes. Participants in the text-based instruction group only had access to the text notes.

Assumptions

Several key assumptions were made in the study design. I assumed that the students who opt into the study believed that the remedial math course was an appropriate starting math class for them and did not enroll in the course for other reasons. Each student’s individual gains between the pre- and posttests were used for analysis so that someone who knew the material well did not artificially raise the whole groups' test scores.

I also assumed that the students who participate in the study would take the time to go through all of the instructional materials and try their best on the assessments, as if this was a course for credit. Blackboard was configured to allow access to each course element as soon as the previous element was accessed; therefore, students were required to look at each piece before they could continue on. In addition, students were asked to keep track of the amount of time spent viewing their instructional materials and were asked about that amount of time in their final survey. Any participant who spent less time than the length of the video, which was also a comparable amount of time to read the text-based notes, would be considered to not have done all of the work. While this then assumed that the participant was honest about the amount of time spent working on each module's instructional materials, any system of logging time spent in instructional materials in online courses has potential flaws.

Another assumption was that the students would complete the assessments on their own, without trying to look up answers, look back through the instructional materials during the assessments, or get help from an external person. This study was outside of an actual course; therefore, how well they did on the pre- and posttests did not impact their grades in any courses. This removed the motivation to use any resources while completing the pre- and posttests.

Finally, there were assumptions about the demographics and skill set for the participants. The first was that students who opted into the study would be representative of the online student population. Another was that students would have the reading skills necessary to complete to modules, as they would have met all of the admissions requirements to enroll in the college.

Limitations

This study had several limitations. The first was that not all students might take the time to go through all of the instructional materials for their group, as they would in a course that is graded, because there was no impact to their overall grade. There was no way to track in the course management system how long the students spent viewing each instructional material, just how many times it was opened, so the amount of time spent between the treatment and control groups might not have been equal. In addition, students decided mid-study that they did not want to put in the amount of time needed to go through the whole study. This did lead to a high attrition rate for this study.

Another limitation was that even though this study did not impact their grade, the students might have still decided to get help from an outside person during the study, instead of completing it based on the given instructional materials. There was no proctoring tools used for the pre- and posttests in the study. Students were asked in the study to not use any additional resources; however, there was no method to monitor this.

Finally, there was a limitation that students self-selected into this study; therefore, not all students who would benefit from a remedial mathematics course may realize that they need it and so did not volunteer to be part of the study. Along with that, another limitation with students having volunteered for the student was they might not have completely represented the typical online student population who would need remedial math courses. The demographics of the study were compared against the online population as a whole; however, there was not a dataset given for this study of the demographics of only students who would require a remedial math course.

Delimitations

Only online students who had been registered for a course within the past year and have not taken a math course either at the school used in this study, hereafter referred to as Private New England College, or transferred in credits for a math course were given the opportunity to participate in this study. Students were given the course description of a remedial math course and asked to participate if they believed that the course would be an appropriate math course for them to start with, and asked not to participate if they believed otherwise.

Online students, in the context of this study, were students who have the online location as their center of record. These students may also take courses in person, but they primarily take their courses online, instead of having a satellite location or the main campus location as their center of record and primarily taking in person courses with an occasional online course. Students were considered for this study if they had an active degree program and had taken a course within the past year. The remedial mathematics course referenced in this study was a Fundamentals of Algebra course that included basic arithmetic and elementary algebra. The specific modules used from this course for this study included solving linear equations, linear equations, and applications of linear equations.

Significance of the Study

This study addressed a gap in the literature around the effectiveness of video instruction in online remedial mathematics courses. It was specifically designed to test for differences in the impact of video instruction in different topic areas. For example, one sample problem asked students how to solve for an unknown variable, while another asked students to write the equation of a line based on a word problem. This information will be useful to faculty of remedial mathematics courses, as well as content designers for online courses. In addition, by helping students gain the mathematics skills necessary in order to graduate, it will bring about positive social change, as education is important for people to improve themselves and their communities, as well as being necessary for many careers or advancement in the workplace.

Summary and Transition

Students who are not prepared for college level courses are entering higher education (Attewell et al., 2006; Bettinger & Long, 2009). These students often need to take remedial coursework, including remedial mathematics. In an online program that uses traditional textbooks and other text-based instructional materials, this can be an especially difficult task, as students who are struggling with the content area have to teach themselves the concepts through text-based instruction. While adjustments to how the content is presented should be made to increase learning for students in these courses, few studies have examined the effectiveness of other instructional methods such as video instruction in online environments. This experimental quantitative study addressed this gap in the literature on the effectiveness of video instruction for students in online remedial mathematics courses by comparing the pre- and posttests of three different modules for participants in the control group with text-based instruction and the treatment group with video based instruction.

Chapter 2: Literature Review

Most colleges and universities offer some type of remedial coursework, with over a quarter of incoming freshman taking at least one remedial course (Attewell et al., 2006; Bahr, 2007). As there is such a high need for remedial coursework, the benefits of it need to be looked at, as well as what can be done to make it more effective. One such strategy for remedial mathematics courses, especially for online courses, is video instruction.

Search Strategy

I began my literature search with core readings on Universal Design by Burgstahler (2008), Meyer, Rose, and Hitchcock (2005, 2006) and the use of multimedia in instruction by Mayer (2003, 2009). This was followed by a search for articles on remedial mathematics education in higher education, cognitive load theory, and multimedia instruction. The databases used were Academic Search Complete, Education Full Text, and ERIC. The general search strategy was to access the most appropriate articles by using keywords with the limitators AND and only peer-reviewed articles were selected in order to remove trade publications and limit the results to scholarly sources. The original search focused on materials published after 2005. However, some sources cited in articles were also accessed to read the original study.

Keywords. The search terms used for the articles that were analyzed were remedial education, remedial mathematics, distance education, online education, higher education, video instruction, multimedia instruction, cognitive load theory, and universal design. Other search terms included remedial college education, college remedial mathematics, and math computer instruction, before narrowing down the search terms to find relevant articles.

Theoretical Framework

There were two theories that framed the study. These theories were Universal Design and cognitive load. Both of these theories were utilized when designing the video instructional materials.

Universal Design

In Universal Design, it is important to provide accessibility to a variety of groups of people in regards to architecture, programs, and curriculum (Burgstahler, 2008). Universal Design for Learning (UDL) takes the ideas of Universal Design and looks at curriculum, pedagogy, and policies (Rose, Meyer, & Hitchcock, 2005). UDL has three principles, the first being to "provide multiple, flexible methods of presentation," the second being to "provide multiple means of action and expression," and the third being to "provide multiple means of engagement" (Rose & Meyers, 2006, p. ix). An example of the first principle would be that while captioning videos is necessary for students with hearing disorders, it also helps out students whose first language is not English and students that need to watch the video without audio for one reason or another, such as trying to review course materials while at work or while waiting for a doctor's appointment.

It is easier to implement Universal Design when accessibility is considered from the start of the design phase. Adding accessibility to previously created materials creates significantly more problems. There also needs to be flexibility in how the materials were created, as accessible materials can change form over time according to a student's changing needs change as time passes (Burgstahler, 2008). For example, if a person's eyesight worsens with age, they might require a larger font size in order to effectively use their old text-based materials. The capacity to adjust the font size is an example of accessible design flexibility and facilitates implementing Universal Design.

Cognitive Load Theory

Mayer (2009) argued that combining words and pictures together allowed people to learn better that using words alone (p. 4). The use of two or more types of media is considered multimedia. Multimedia in the classroom can come in various forms such as live classes or lectures where speaking can be combined with visuals, PowerPoint presentations, and computer-based instruction. Students using multimedia acquire information in at least two different ways, such as through pictures and words. However, the content in multimedia is not always the same between the two individual media types, and the content instead is designed to work together for a student to be able to integrate both representations to create meaningful connections (Mayer, 2009).

Twelve features of cognitive load theory and multimedia learning have been tested for effectiveness. These are: coherence, signaling, redundancy, spatial contiguity, temporal contiguity, segmenting, pre-training, modality, multimedia, personalization, voice, and image. Of those, ten features were found to lead to effective presentations that used more than one type of media, with multimedia and image being the two that did not have a strong effect (Mayer, 2009).

Several studies have critiqued cognitive load theory. There are no direct measurements to show the benefits of cognitive load, which means the results as to the impact of cognitive load are found by using and analyzing posttests (De Jong, 2010). Another concern raised is that some research contradicts the premise that cognitive load needs to be reduced in every situation, by the researchers stating that students with high expertise in that particular subject area do not need the cognitive load reduced (Schnotz & Kürschner, 2007). While extraneous load can and should be minimized through the instructional design process, intrinsic load should be adapted to the level of the student (Schnotz & Kürschner, 2007). These conflicting findings and the nature of the findings can make it extremely difficult to determine the impact of cognitive load.

Remedial Mathematics Courses

Remedial college courses are created in order to address academic deficiencies that incoming students may have and to prepare students for work at the college level (Bettinger & Long, 2009). Students of any type, nontraditional, traditional, or coursework only students, may need to take one or more remedial courses, although there are some characteristics that are more common for students in remedial courses. For students who do take remedial courses, there is differing opinions in the research as to whether or not the courses benefit students.

Profile of Students in Remedial Courses

Many students entering colleges are not academically prepared for college-level coursework and need to take remedial courses (Attewell, Lavin, Domina, & Levey, 2006; Bettinger & Long, 2009). In the fall of 2000, 28% of freshmen entering postsecondary institutions in the United States had enrolled in at least one remedial course. Students taking remedial courses are more likely to need remediation in math than in any other subject area (Attewell et al., 2006; Bahr, 2007). Twenty-two percent of freshmen in the United States registered for a remedial math course, which was higher than the enrollments for writing (14%) and reading (11%) courses (National Center for Education Statistics (NCES), 2003). As such, most postsecondary institutions offer some type of remedial coursework, and these courses give students another chance at higher education, as well as being a form of quality control (Attewell et al., 2006).

Students taking remedial courses tend to fall into certain groups. College students in remedial courses are mostly over the age of 20 and are often either returning to college later in life or had delayed starting college (Attewell et al., 2006). Students in a two-year college are more likely to take a remedial course than similar students in a four-year college, as are students in public schools versus those in private schools (Attewell et al., 2006). African American students are more likely than non-Hispanic White students of the same skill level to take remedial courses (Attewell et al., 2006). Finally, with mathematics, students may feel anxious about their ability to successfully complete a college mathematics course, based on past failures (Taylor, 2008). Therefore, colleges that have a large number of students who fall into these demographics will likely have more students needing remedial courses and so will need to take that into consideration when designing their curriculum.

Benefits of Remedial Education

The benefits of remedial education are sometimes debated in the research, with mixed results being found. There are some who note that remedial courses provide students with the skills necessary to succeed in college and help them complete their degrees successfully (Attewell et al., 2006; Bettinger & Long, 2009). There are others who note that it may not benefit students, by increasing the degree requirements and decreasing the graduation rate (Bettinger & Long, 2009). This difference in opinion can be influenced by different factors, including the skill set of the students taking remedial courses and the design of the remedial courses.

One point of view is that students in remedial courses have better educational outcomes than students with similar backgrounds and skills levels who did not take remedial courses. Students in remedial courses were less likely to drop out after five years and more likely to complete a degree within four to six years, again, compared to peers with similar backgrounds and skill levels (Bettinger & Long, 2009). In addition, they found that with remedial math courses, students who were planning on majoring in math related fields were more likely to complete their degree and slightly more likely to major in a field than similar students who did not take a remedial math course (Bettinger & Long, 2009).

For students who successfully complete a remedial math course, remediation in math classes can have the ability to completely resolve the issue of a deficiency in math skills. These students are the ones who need the least assistance in bringing their math skills up to the college level (Bahr, 2007). However, they also found that 75.4% of students do not achieve college level math skills with remedial math courses (Bahr, 2007). This lead to their conclusion that for students who remediate successfully, these courses are effective (Bahr, 2007).

Remedial courses can also help with student retention. Students who passed at least one remedial course were more likely to continue in college than students who had similar skills and did not take remedial courses (Attewell et al., 2006). In addition, they also earned more credits (Attewell et al., 2006). This also supports the idea that for students who successfully complete remedial coursework, they can be beneficial (Attewell et al., 2006). As retention is an issue for any college or university, this is an important piece to look at.

For the negative perspective on remedial courses, Attewell et al. (2006) stated that there is a negative effect for taking remedial courses on graduation for students in four-year colleges. Students who took these courses also took around two to three additional months to graduate (Attewell et al., 2006). Therefore, they found that with students attending a four-year college, there is a slightly lower chance that students who take remedial courses graduate, but it does not stop most students from completing their program (Attewell et al., 2006). Finally, they found that the graduation rates were 12% to 15% lower for students who took three or more remedial courses, compared to students with similar skills who did not take remedial courses (Attewell et al., 2006). However, roughly one in three students who were in remedial classes completed their degree program within eight years (Attewell et al., 2006).

For remedial mathematics courses, one point of view is that remedial courses may have no effect on graduation and learning. They also found that only 30% of students passed their remedial mathematics courses and most students may need more that one attempt with the course before successfully completing it (Attewell et al., 2006).

Remedial mathematics courses address content and skills that students will need, as most degree programs require at least one college level mathematics course (Mireles, 2010). Based on the curriculum for college level courses, these remedial courses need to address both fundamental and problem solving skills (Mireles, 2010).

One potential problem with many remedial mathematics courses is that the instructors tend to be part-time adjuncts who are only given a textbook and general outline for guidance (Mireles, 2010). This is different from other mathematics courses where full time faculty may have more time to carefully go through all of the topics to be covered and decide on the materials and methods of teaching these topics based on research.

Another issue with remedial courses is that the students' skill levels are at varying starting points (Attewell et al., 2006). While all students in a remedial class may not be prepared for college level work, their ability levels can be at such different spots that it can be difficult to work on curriculum design.

The profile of students who are taking remedial courses needs to be considered while designing the courses. Nontraditional students, those who are returning to college or who delayed starting college, may have different needs from traditional students (Kenner & Weinerman, 2011). Creating resources and a curriculum that addressed these unique needs can help increase the success rate for these students (Kenner & Weinerman, 2011). Nontraditional students may also be coming to classes with strategies for learning information that may not be beneficial in higher education (Kenner & Weinerman, 2011).

While the research shows mixed results in remedial courses and how they benefit students, it appears that some of the issues could be with how remedial coursework is developed. Poorly designed courses may be partially at fault when students do not perform well. Students are entering higher education who are not prepared for college level work, therefore something needs to be done to help them. One possible solution is to work on the remedial courses to make them better and help students gain the skills needed to be successful in their future courses.

Technology for Instruction in Mathematics

Computer Instruction

One method that some colleges have adopted for remedial mathematics courses is computer-based courses. Some students prefer this model of course as they are able to work on the topics they feel they need the most assistance with and can work at their own pace (Taylor, 2008). Computer instruction can provide immediate feedback and large databases of problems for students to practice on (Juan et al., 2011). They also like the individualized instruction and feedback that is available with computer-based courses (Taylor, 2008). Computer-based instruction also helps increase the ability for the students to interact with the course content, maintaining their attention (Fleeger, Booker, Winters, & Mathew, 1993). In addition, it can provide worked examples; however, the benefit of those is not clear when that is the only instruction offered (Crippen & Earl, 2007).

However, the impact of computer-based or aided classes is unclear. One study showed no difference in gains between a class who used computer-based instruction to supplement their standard lectures and a class who used group work with assigned homework problems from the textbook to supplement their standard lectures (Walker & Senger, 2007). Another study showed that students taking an online finite mathematics course had higher posttest mean scores than students taking a traditional version of the class (Smeal, Walker, Carter, Simmons-Johnson, & Balam, 2013). The design considerations for computer-based learning can also conflict, with the need for encouraging critical thinking skills conflicting with the need for providing guidance (Slabon, 2006). Therefore, poorly designed computer-based instruction could account for some of the mixed results.

Video Instruction

The Internet contains many examples of video instruction for mathematics that is available now (Bowers, Passentino, & Connors, 2012). One method of providing video instruction for mathematics courses is to record face-to-face classes to share with the students in that same course, hybrid courses, and online courses. This process involves recording the traditional course and archiving the videos for students to log in and view. For in person students, these videos could be used to review content, clarify any questions they may have, and to catch up on material covered during absences (Cascaval, Fogler, Abrams, & Durham, 2008). In schools where traditional courses are recorded and archived, there is not always a change to the instructional style. The instructor can teach their course as they usually would and the whole class is recorded (Cascaval et al., 2008).

One study that looked at student perceptions of archived videos for different levels of mathematics courses found that the more difficult the course is, the more useful the students reported the videos to be. The videos also appeared to be accessed more right before a quiz or exam in the class, which indicates they were used for review purposes. Finally, students found these videos useful and thought that they were a benefit to the course, no matter what the course level or the instructor's teaching style (Cascaval et al., 2008). Another study had similar results, with students reporting that they found the video instruction to be useful and easy to follow and that they felt that they experienced gains in their mathematics knowledge from utilizing the videos (Kay & Kletskin, 2012).

Another study hypothesized that students liked having videos to use in order to review mathematics because many students are nervous about that subject area. The students liked being able to watch videos of their instructor going through all of the steps of sample mathematics problems (Hughes, 2009). Students can benefit from having examples worked out to demonstrate problem solving techniques (Moreno & Durán, 2004).

Type of Instruction with Videos

Properly designed video instruction can be beneficial for mathematics instruction. They can also be used as a supplement to other more traditional forms of instruction. This type of instruction allows for students to work at their own pace and interact with the content.

Video instruction can be used to demonstrate abstract concepts, make connections to real world examples, and help students understand the concepts being taught (Kim & Whittier, 2011). Video instructional materials can be used for different types of scaffolding too, such as differentiated scaffolds, redundant scaffolds, and synergistic scaffolds (Ortel-Cass, Khoo, & Cowie, 2012). The videos used as instructional materials can be produced at a low cost and/or low effort, including the use of video equipment such as mobile phones or inexpensive cameras. The important piece is that the videos have a pedagogical purpose and that the content is structured appropriately (Kolas, Munkvold, & Nordset, 2012).

Video instruction allows for repeated viewing of the content, reinforcing and clarifying the content covered, as well as pausing, playing back sections, skipping over content that the viewer already knows, and being mobile so that a student can more easily study the content wherever they are (Heilesen, 2010; Jowitt, 2008; Lin & Michko, 2010; Mu, 2010). Students may have a preferred viewing style for watching instructional videos and others may switch their viewing styles based on the content and what their needs are (de Boer, Kommers, & de Brock, 2011). Beyond the retention of content learned, video instruction can also increase learner satisfaction compared to text in problem-based instruction (Choi & Johnson, 2007). However, poorly designed instructional materials can be overwhelming to students who are learning something new (Moreno & Durán, 2004).

For instruction, providing information in multiple representations helps strengthen the learning process. These multiple representations allow for making connections so that students are able to transfer information easier. For mathematics, these connections can include the symbols used and the process that they represent and visual representations of mathematic procedures (Moreno & Durán, 2004).

An example of having multiple representations of information in video instruction that is done well is having corresponding auditory and visual information being presented at the same time. This allows the information to be held in working memory together and provide a connection for students (Moreno & Durán, 2004).

Students with higher academic skills benefited from teaching methods that introduced a cognitive conflict. However, students with lower academic skills benefited from teaching methods that focused on direct teaching (Zohar & Aharon-Kravetsky, 2005). This means that for remedial courses, direct instruction would be the most appropriate.

Video instruction can then be used to guide students through different processes, helping them make sense of the content without having them become frustrated trying to figure out on their own what needs to be done. The video instruction should also explain what needs to be done and why, instead of just providing corrective feedback to students (Moreno & Durán, 2004).

Videos in Online Learning

Online courses are becoming more common, with a 2011 survey finding that 77% of the college presidents surveyed had online courses offered through their institution, with 89% of public four-year colleges and 60% of private colleges offering online courses (Parker, Lenhart & Moore, 2011). Well designed online courses have instructors who realize that traditional classes should not just be recreated into an online format. Instead, they should look at what an online environment allows for and use those new tools and strategies to create their courses (Hughes, 2009).

For a large number of online courses, students mainly learn through reading. There is the textbook, lecture notes, discussion boards, and other primarily text-based methods of instruction. These may not meet the needs and learning preferences of all students. However, some courses go beyond that and offer interactive sites, audio lectures, and video lectures. These allow a student more control in how they interact with the course content, engage students, and help make connections to commit content to memory better. All of this can increase student motivation and retention (Hughes, 2009).

One study showed that students felt that video instruction was more effective than text instruction for remembering content. They also reported being more motivated to pay attention to the video content and found them more memorable (Choi & Johnson, 2005). Instructional materials with video and audio combined can help students more fully understand complex topics, compared to text and graphics, which may be less clear to students (Hartsell & Yuen, 2006). However, another studies have found that video instruction should be used as supplementary material or a complement to the other traditional resources in a class instead of replacing them (Fernandez, Simo, & Grinfeder, 2009; McGarr, 2009).

Video and audio files in courses also allow students to have a better connection with their instructor, in the case of instructor created files. Online students can get a better sense of their instructor through these types of files than with traditional print notes. Videos in online courses do not need to be perfect, just professional, and students are not expecting instructor created files to be. In fact, minor mistakes and personal examples can be part of what makes students feel more connected to their instructors (Hughes, 2009). In general, students do not learn as well through verbal only instruction, whether that is audio or text, compared to instruction that combines verbal and visual instruction (Mayer, 2003).

There are some guidelines for video instruction in online courses. The first is that all of the content should be thought out and prepared ahead of time to make sure the content runs smoothly. Notes can also be created at this point to provide students and reinforce what is being taught in the video. The content should also be broken up so that each video is smaller than a traditional lecture based course. This makes it easier for students to watch, allows them to brush up on topics individually, and allows for the instructor to make future changes easier (Hughes, 2009). Breaking the content into shorter sections can help students to feel more confident in learning the material (Ibrahim & Callaway, 2012). These shorter videos also address the issue that there is a limitation on the short-term memory of a student, and so instruction should be kept simple in order to allow students to process the content instead of first needing to use other learning strategies to address working with a large amount of content at once (Chou & Tsai, 2005). If working memory is overloaded, then meaningful learning will not occur for that student (Prion & Mitchell, 2008).

With learning and integrating knowledge, there are three assumptions that are connected to cognitive load theory: people have dual channels for most learning, people have limited capacities, and people must engage in active processing (Fitzpatrick, 2009). Therefore, cognitive load theory has more guidelines for video instruction. One guideline is to take advantage of the weeding technique, where the instruction is concise (Mayer & Moreno, 2003). Another is to prevent the split-attention effect, where the student is looking at both an animation and reading text on screen (Mayer & Moreno, 2003). This can be done by having the verbal content narrated while the animation plays, but not including the text and the narration, as redundancy should be eliminated (Mayer & Moreno, 2003). With the principles of Universal Design, however, accessibility should still be included in the instructional design process. This would include having captioning in the videos. In order to still reduce the extraneous load and eliminate redundancy, the captioning should be able to be turned on by students who need it, instead of having it displayed all of the time. Table 1 shows the effect of the independent variables in this study on the dependent variables.

Table 1

Variables

Variable	Description
Achievement gain	Overall gains between the pre- and posttests in the three units studied with text versus video instructional materials
Content areas	Overall gains between the pre- and posttests, by instructional material type, between three content areas (solving linear equations, linear equations, and applications of linear equations)

Summary and Transition

The videos for this study were created with guidelines from cognitive load theory and Universal Design. Universal Design provided the framework of accessibility and cognitive load theory provided the framework of how to present the material and what content to have as the visual components and what content to have as the auditory components. This study compared those videos against text instruction to see which is a better instructional method for online remedial mathematics courses.

Chapter 3: Research Method

Introduction

This experimental, pre- and posttest quantitative study examined online students in the United States who had not yet taken a college-level math course. It specifically examined students at Private New England College (pseudonym) who indicated that a remedial math course offered would be appropriate for them and completed this study. The participants were randomly assigned to a control group with text instruction and a treatment group with video instruction. They completed three modules, respectively covering solving linear equations, linear equations, and applications of linear equations. This study used the differences between the pre- and posttest scores on an individual level, found by subtracting the pretest score from the posttest score for each participant, to determine the successfulness of the treatment.

This study addressed the following primary research questions:

1. Does video instruction as designed help online students in a remedial math course learn more overall than traditional text notes?
2. Is there a difference in the gains in student learning with video instruction between different topics (solving linear equations, linear equations, and applications of linear equations) included in a remedial math course?

This chapter describes the procedures that were used for the purpose of answering these research questions, as well as information on the research design, participants, instruments, treatment, data collection procedures, and data analysis procedures.

Research Design and Approach

A study was done at Private New England College that used a quantitative experimental pre- and posttest design with participants randomly assigned to control and treatment groups. This research design was used to determine the effect of the treatment on participants of two different types of instructional materials in three different topics. The use of a pretest and a posttest in each of the three content areas allowed for determining statistical differences between the treatment and control groups in this study. This was not an actual graded course and no other instruction or communication was provided, other than reminders about completing the study.

Setting and Sample

Participants were recruited via email. An email asking for participants was sent to all students at Private New England College who were internally listed with online as their center of record, specifying that they were online students, and who had also not taken a math course at Private New England College or transferred in a math course. There were 8,251 students who met that criterion. The invitation email included a link to a survey for students to enter their email address and see the consent information. Anyone who agreed to be part of the study was entered into a drawing for two $50 gift cards. Participants were asked to read the course description for the remedial math course and volunteer to be a participant if they felt that the remedial course was a good fit for their first math course.

All participants were randomly assigned to two Blackboard classes, consisting of a control group with text-only instruction and the treatment group with video instruction only. Both groups had a Blackboard class with three math modules that were set to display content only as the student completed the previous step. For example, the pretest had to be done before the instructional materials were displayed, and those had to be marked as reviewed before the posttest was available. When the posttest for the module was complete, the next module was available. Each group was informed that they were participating in a study to determine effective instructional materials for online remedial math courses, but were not informed about or given access to the instructional materials of the other group.

Power and Sample Size

Several earlier studies have addressed the use of audio and images in instructional methods compared to all-text instruction. One study was designed to examine auditory content, versus visual, versus auditory and visual combined with an effect size of 0.74, text versus the integration of text, images, and sound with an effect size of 0.61, and presenting words as narration rather than on screen text, with an average effect size of 1.17, based on six experiments (Mayer & Moreno, 2003; Metiri Group, 2008). This gives an average effect size of 0.84. Doing a *t* test comparing the means of two independent groups, with an alpha of 0.05 and power of 0.95, the total minimum sample size is 64 participants, with 32 in the treatment and control groups needed to finish the study. This would be a .02% response rate needed for this study, based on the potential 4,000 participants. A minimum of 100 participants, with 50 each in the treatment and control groups, was determined for this study's sample size, so as to allow for any participants dropping out of the study before completion. All students who volunteered to participate in the study were randomly assigned to a group in order to get a better representative sample.

Treatment

The control and treatment groups were both assigned to Blackboard classes with three modules covering the three topics (solving linear equations, linear equations, and applications of linear equations) for the study. The topics covered, pre- and posttests and instructional content of both groups was identical. The treatments for this study differed by group, with video instruction provided for each module instead of text-based instructional materials. The text-based lecture notes were used as the source for video content (see Appendix A). The directions of what steps to do to solve each math problem and the sample problems were the same for both sets of instructional materials.

The videos were created using Adobe Captivate. Each video showed examples of the topics being addressed, followed by a problem for participants to solve on their own before continuing with the video to check their answer. These videos also had a navigable table of contents, allowing participants to return to the video and skip ahead to where they previously left off (see Appendix B). As suggested by cognitive load theory, the videos only included the math steps being done, without additional text or images. This makes the instruction concise, prevents split-attention affect, and eliminates redundancy. However, each video has the capability of having captions turned on for participants who require them with closed captioning, utilizing Universal Design.

Instrumentation and Materials

Instruments

The instruments used by this study were pre- and posttests that I wrote for each of the three modules (see Appendix C). These tests were based on the types of test questions that are used in the remedial math course's textbook (Akst & Bragg, 2012) and common final exam questions. The adjustments made to those questions consisted of changes to numbers, while keeping the difficulty the same (e.g., 5-4 changed to 6-3), parts of the questions omitted (e.g., removing the need to graph a line in the linear equations problems), and creating new word problems with similar formats but changes to the numbers and scenarios. This was done to prevent the actual common final exam questions from being seen before a student is taking that class, to create additional questions to have enough items to make an accurate analysis, and to keep the questions in line with the sections of the content of the course that were selected to create the modules.

The pre- and posttests I created were reviewed by three math faculty from a different university. These faculty members determined that the two versions of each test were assessing the same items. Therefore, the tests were similar levels of difficulty and assessed the same things. In order to assess this, the tests were given to students to equate them before the start of the full study. This group of students was similar to those asked to participate in the actual study, with a similar skill set for mathematics, but were not online students. These pilot study participants were recruited by asking faculty teaching to mention the study in their classes and encouraging them to offer extra credit to students who participated. The pilot sample consisted of 25 students who were given all three tests for the different content areas with all of the questions that were eventually on the pre and posttests. The questions were then scored for difficulty within each question type, splitting the questions evenly between the final pre and posttest.

To verify validity, a panel of three math faculty members who were not part of the university reviewed the tests for validity. These faculty members verified that the tests corresponded with the topics in the modules. Module one had 20 questions in both the pre- and posttests and assesses solving linear equations. Module two had 20 questions in both the pre- and posttests and assesses linear equations. Module three had 10 questions in both the pre- and posttests and assesses applications of linear equations. All of the questions required the participant to type in the correct answer, instead of having choices to select from. This reduced the likelihood of having participants score high on the tests due to guessing. In addition to the pre- and posttests, basic demographic information was gathered on each student, including age, gender, and major.

Curriculum Materials

The text-based instructional materials were sections of the online course lecture notes from the co-chair of the math department, who taught this course online and whose content was being used for the standardized model of the online course. These were designed to be similar to lecture notes for a face-to-face course and include all of the explanations and worked out problems that would be done in a classroom. The text-based materials were then used to create the videos; therefore, the videos match the text-based instructional materials in how the content is taught, making the only difference between the two the instructional method. Guidelines for cognitive load and Universal Design were also used in the creation of the videos (see Appendix B). For cognitive load, the instruction is concise and only contains what content is needed for instruction. Issues involving split-attention and redundancy were also addressed by having the verbal content and animation synced up and not having the text of the verbal content also visible. However, because Universal Design includes having accessibility built in to the instructional design process, closed captions were available for a student to turn on or off as needed. The modules cover three different topic areas, solving linear equations, linear equations, and applications of linear equations. These topics were selected to provide a range of topics and to build upon the previous module to give participants the content needed to complete the following module.

Table 2

Structure of Modules

Module #	Topic
1	Solving linear equations
2	Linear equations
3	Applications of linear equations

Data Collection and Analysis

Preparation of the Data

Pre- and posttests within Blackboard were used to gather data on the two instructional methods. All participants in the control and treatment groups had the same tests and directions for how to complete the study, with the only difference being which instructional material was used. Any participant who did not complete a posttest for a particular module had the scores for that module removed from the final calculations. Participants also did not get access to the instructional materials until the pretest was completed, and then the participants did not get access to the posttest until the instructional materials were opened. There was no way of making sure that a participant watched the full video or read everything in the text-based notes; therefore, the only check point was that the files had been opened. Participants were randomly assigned to the control and treatment groups; as such, they were probabilistically equivalent. All test scores were exported from Blackboard into Excel to remove participant names, remove any scores for participants who did not complete the individual modules, inspected for errors, and formatted to import the data for analysis.

Data Collection

The demographic information, including age, gender, and major, was compared between the two groups, as well as compared against the demographics of the general online student population with descriptive statistics. Additionally, the demographics of the groups was looked at by pulling information from the database system for everyone who started and everyone who finished, to see if certain types of students were less likely to persist in this study. Data gathered included age, the date they started at the university, major, and if they were transfer students. This may be indicative of what types of students would be less likely to persist in a remedial mathematics course too. Comparing the demographics by using chi squares at the start and end of the study also showed if the groups remained equivalent and if they were similar to the overall student population.

Each participant's scores was compared by calculating the difference score between the pre- and posttests for each individual module. The first research question was analyzed by doing a paired *t* test of the pre versus the posttest for the two different instructional materials and then a paired *t* test with the gain scores of the participants in the group with text instruction versus video instruction. For the second research questions, an analysis of variance of gain scores was done, first calculating the gain score and then using them in an analysis of variance. The between subjects factor was the treatment. This process was done for each of three modules. The results were then compared across each individual module to see if there was a difference in the gains in student learning with video instruction for different content areas. Each of these tests was run on the scores of all students who completed the posttests, removing the scores of any student who left the posttest blank. Minitab was used to run these calculations. All names were removed from the final analysis and not shared with anyone else.

Table 3

Data Analysis

Research Question	H_o/H_a Pair	Variables Held Constant	Variables Compared	Statistical Test Used
Does video instruction help online students in remedial math courses learn more overall than traditional text notes?	H_o: There is no difference in the gain scores between pretests and posttests between video instruction and text instruction. H_a: There is a difference in the gain scores between pretests and posttests between video instruction and text instruction.	Content in the instructional materials	Pre- and posttest scores Types of instructional materials	Paired *t* test
Is there a difference in the gains in student learning with video instruction between different topics included in a remedial math course?	H_o: There is no difference in the gain scores between pretests and posttests between different topics (solving linear equations, linear equations, and applications of linear equations) included in a remedial math course. H_a: There is a difference in the gain scores between pretests and posttests between different topics included in a remedial math course.	Content in the instructional materials	Pre- and posttest scores Content areas	Analysis of variance of gain scores

Protection of Human Participants

All students who were invited to take part in the study were sent an email that included the consent form (see Appendix D) and link to a survey where they entered their contact information in order to volunteer for the study. If a participant wanted to be assigned to one group or another, it would first be explained that it is still unknown which instructional method is the most effective. If they persisted, they were assigned to the group of their choice, but their scores would be removed from the study as it would no longer be a random assignment. The researcher was the only person with access to the Blackboard courses for the control and treatment groups, which included the names of the participants. The data collected for the pre- and posttest results was exported from there into Excel and stripped of names and any other identifiable information.

Summary and Transition

The videos for this study were created with guidelines from cognitive load theory and Universal Design. This study compared those videos against text instruction to see which was a better instructional method for online remedial mathematics courses. Table 1 shows the effect of the independent variables in this study on the dependent variables.

Chapter 4: Results

Introduction

Remedial education is common at two and four year degree granting institutions in the United States. Many students enter colleges without the necessary academic skills to be successful in all subject areas, and more students take a remedial mathematics course than any other remedial courses (Attewell, Lavin, Domina, & Levey, 2006; Bahr, 2007; Bettinger & Long, 2009; NCES, 2003). The purpose of this quasi-experimental quantitative study was to determine whether or not video instruction helped students in online remedial math courses learn more than traditional text instruction, either overall or by specific topics. The research questions and hypotheses for the study were:

RQ1. Does video instruction help online students in remedial math courses learn more overall than traditional text notes?

H_O1: There is no difference in the gain scores between pretests and posttests between video instruction and text instruction.

H_A1: There is a difference in the gain scores between pretests and posttests between video instruction and text instruction.

RQ2. Is there a difference in the gains in student learning with video instruction and text instruction between different topics included in a remedial math course?

H_O2: There is no difference in the gain scores between pretests and posttests between different topics (solving linear equations, linear equations, and applications of linear equations) included in a remedial math course.

H_A2: There is a difference in the gain scores between pretests and posttests between different topics (solving linear equations, linear equations, and applications of linear equations) included in a remedial math course.

Data Collection

The study protocol was approved by Walden University's Institutional Review Board on June 10, 2014 (IRB, approval #06-10-14-0110851). The dataset consisted of a sample of 203 students who volunteered for a study on the impact of video instruction versus text instruction in remedial math. Of the 203 students who volunteered for the study, 101 were randomly assigned to the video instruction group and 102 were assigned to the text instruction group. Of the 101 students in the video instruction group, 38 completed the first module on solving linear equations, 16 of the 38 completed the second module on linear equations, and 8 of those 16 students completed the third module on applications of linear equations. Of the 102 students who started in the text instruction group, 40 completed Module 1, 20 out of those 40 completed Module 2, and 9 of those 20 completed Module 3 (Table 4).

Modules 2 and 3 were only made available to each participants after they completed the previous module. As a result, participants who completed Module 3 had all also completed Modules 1 and 2. Each module comprised of a pretest for the content of the individual module, the mathematical instruction, and a posttest for the content of that individual module. The pre- and posttests had identical questions, with the only differences being the numbers in the mathematical equations (see Appendix C). The dataset included the following variables: pre- and posttest scores on each of the modules, student age, gender, state, GPA, major, date they stated at the university, and if they were a transfer student. The type of instructional material used (video or text) was the independent variable. The dependent variables were the pre- and posttest scored for each module. Due to the small number of participants who completed the study, not all of the variables in the dataset could be utilized.

Table 4

Sample Size Across Text Instruction and Video Instruction Groups

Module Completed	Text Instruction	Video Instruction	Total
Total Participants	102	101	203
Module 1	40	38	78
Module 2	20	16	36
Module 3	9	8	17

Gender Distribution

The distribution of gender in the sample did not align to the distribution of the population (Table 5). There were more women (78.8%) than men (21.2%) overall in the study. However, in the population of online undergraduate students at the university, there are more women (60.8%) than men (39.2%). Therefore, this difference was to be expected, although not to this extent.

Table 5

Gender Across Text Instruction and Video Instruction Groups

	Text Instruction		Video Instruction		Total	
Module Completed	Count	Percentage	Count	Percentage	Count	Percentage
Total Participants						
Female	79	77.5%	81	80.2%	160	78.8%
Male	23	22.5%	20	19.8%	43	21.2%
Total	102		101		203	
Module 1						
Female	33	82.5%	30	78.9%	63	80.8%
Male	7	17.5%	8	21.1%	15	19.2%
Total	40		38		78	
Module 2						
Female	19	95%	13	81.3%	32	88.9%
Male	1	5%	3	18.8%	4	11.1%
Total	20		16		36	
Module 3						
Female	8	88.9%	6	75%	14	82.4%
Male	1	11.1%	2	25%	3	17.6%
Total	9		8		17	

Age Distribution

The participants in the study were also older than the undergraduate online population of Private New England College, where the mean age is 33.26, with a standard deviation of 9.86. The mean age of the participants in the text instruction group was 37.77, with a standard deviation of 11.07. The mean age of the video instruction group was 35.38, with a standard deviation of 11.69 (see Table 6).

Table 6

Age Across Text Instruction and Video Instruction Groups

Module Completed	Text Instruction	Video Instruction
Total Participants		
M	37.77	35.38
Mdn	36.00	33.00
SD	11.07	11.69
n	102	101
Module 1		
M	38.60	32.11
Mdn	36.00	29.00
SD	12.06	10.28
n	40	38
Module 2		
M	40.45	34.38
Mdn	36.00	32.00
SD	13.34	10.14
n	20	16
Module 3		
M	38.33	32.50
Mdn	35.00	31.00
SD	13.02	9.41
n	9	8

GPA Distribution

The participants in the study had a higher GPA than the undergraduate online population of Private New England College, where the mean GPA is 2.383, with a standard deviation of 1.503. The mean GPA of the participants in the text instruction group was 2.999, with a standard deviation of 1.044. The mean GPA of the video instruction group was 2.749, with a standard deviation of 1.229 (Table 7). While it is not surprising that students who have a higher GPA than the general population would complete the study, it is interesting to note that these participants elected to be in the study based on their thinking that they should be taking a remedial mathematics course as their first mathematics course.

Table 7

GPA Across Text Instruction and Video Instruction Groups

Module Completed	Text Instruction	Video Instruction
Total Participants		
M	2.999	2.749
SD	1.044	1.229
n	102	101
Module 1		
M	3.410	2.958
SD	0.582	1.183
n	40	38
Module 2		
M	3.298	3.481
SD	0.682	0.601
n	20	16
Module 3		
M	3.509	3.643
SD	0.727	0.425
n	9	8

Sample Size and Effect Size

The dataset of each of the three pre- and posttests was checked for any missing test scores or problematic scores where a participant had a zero on their pre- and posttest. Any participant with a zero score for both their pre- and posttests, which could indicate that a student did not attempt to actually complete the tests, had their scores removed from the dataset. A total of 18 scores were removed from the dataset. Two were removed from Module 1, five were removed from Module 2, and 11 were removed from Module 3.

The study was limited by an insufficient number of students completing all three modules for the study's dataset. Based on the effect size of 0.84, alpha of 0.05, and power of 0.95, the total minimum sample size needed was 64 participants, with 32 in the treatment and control groups needed to finish the study. Table 8 shows the calculated effect size and power actually obtained for each of the modules. A large number of participants did not complete the study. Only 17 out of 203, or 8%, completed all three modules. As a result, the minimum sample size was not reached for all modules. The only dataset to meet the minimum sample size was the pre- and posttest scores for Module 1. Although some of the results for the participants who completed Modules 2 and 3 are analyzed, the applicability of these results is limited by the less-than-minimum sample size. Therefore, only the results for Module 1 are interpreted in detail.

Table 8

Effect Size and Power Across Text Instruction and Video Instruction Groups

Module 1	
ES	0.01000501
Power	0.0547016
n	78
Module 2	
ES	0.2246536
Power	0.1614945
n	36
Module 3	
ES	0.4081334
Power	0.1997529
n	17

Treatment Fidelity

Both groups were given a pretest, upon whose completion individual students were immediately given immediate access to the instructional material for the corresponding module. After the instructional material was reviewed, participants were given immediate access to the posttest for that module. The completion of the posttest opened the next module online for the participants, where this process repeated.

An issue was identified concerning participants who received a zero on both their pre- and posttests, which could indicate that the participant just clicked through the tests without actually attempting to complete them. This led to 18 scores being removed throughout the three modules. Another issue was with participants persisting and completing all three modules. Only 8% of the study participants completed all three sets of pre- and posttests.

Results

Research Question 1

The first analysis evaluated whether or not there was a difference between video and text instruction in online remedial math courses. The null hypothesis stated that there would be no difference in the gain scores between pretests and posttests between video and text instruction. Due to the small sample size, only module one had enough participants complete the pre- and posttests in order to use for analysis. Table 9 presents the results of the paired *t* test for the pre and posttest scores of participants who completed Module 1, as well as comparing the gain scores of those who completed

Module 1 between the text and video instruction groups. The results of the paired *t* test showed that there was no statistically significant difference in the individual scores with either instructional material type on its own, and there was no statistically significant difference between the group that received text-based instruction and the group that received video based instruction, with this sample size.

Table 9

Paired t test on Gain Scores for Completion of Module 1 Pre- and Posttests

Text Instruction	
t	1.915
df	39
Sig.	0.063
n	40
Video Instruction	
t	1.905
df	37
Sig.	0.065
n	38
Text Compared to Video	
t	0.00
df	37
Sig.	1.00
n	38

Based on the analysis, the null hypothesis for research question one fails to be rejected. The results of paired *t* test indicated that there is no significant difference between text and video instruction.

Research Question 2

The second analysis evaluated whether or not there was a difference between video and text instruction in specific content areas in remedial math courses. The null hypothesis stated that there would be no difference in the gain scores between pretests and posttests for three modules (solving linear equations, linear equations, and applications of linear equations). Tables 10 through 12 present the results of the analysis of variance of gain scores for each of the three modules pre- and posttest pairings. However, only the results for module one will be used for interpretation, as that was the only module to meet the minimum sample size.

Table 10

Analysis of Variance of Gain Scores for Module 1 Content Area

Measure	Text Instruction	Video Instruction
n	40	38
M	1.20	1.24
SD	3.96	4.00
MS	0.026	
F	0.002	
Sig.	0.968	

Table 11

Analysis of Variance of Gain Scores for Module 2 Content Area

Measure	Text Instruction	Video Instruction
n	20	16
M	5.05	6.56
SD	6.86	6.58
MS	20.335	
F	0.448	
Sig.	0.508	

Table 12

Analysis of Variance of Gain Scores for Module 3 Content Area

Measure	Text Instruction	Video Instruction
n	9	8
M	4.11	2.75
SD	3.89	2.66
MS	10.618	
F	0.951	
Sig.	0.345	

Based on the analysis, the null hypothesis for research question two also fails to be rejected. The results of the analysis of variance of gain scores of each of the individual modules indicates that there is no significant difference between text and video instruction by content area.

Summary and Transition

In the paired *t* test and all of the analysis of variance of gain scores tests, there was no significant difference between text and video instruction, either overall or by content area. However, only module one was able to be used due to the small sample size, which limited the analysis for longer term gains. One problem with this study and the small sample size is that it is hard to note at this point whether there was no statistically significant difference between the two types of instruction because they are both equally useful to students or if it was because the power was so low.

While not a significant difference, it was interesting to note that the mean gains were higher in the video instruction group than the text instruction group, up until the third content module. The third module was with application problems, where the content covered in the first two modules was needed in order to solve word problems. However, the sample size was too small to generalize and state that with word problems, students learn better from text instruction.

Chapter 5: Discussion, Conclusions, and Recommendations

Remedial courses are commonplace in higher education in two and four year degree granting institutions in the United States, with many students needing assistance in at least one academic area upon entering college (Attewell at al., 2006). This quasi-experimental quantitative study was designed to see if there was a difference between text and video instruction in online remedial math courses, as a way of attempting to improve course design and have more students remediate successfully. There were 203 participants who were online students at Private New England College (pseudonym) that started the study, with 17 participants completing all three modules in the study. This chapter provides the context for the research study findings.

Interpretation of Findings

This study examined whether or not video instruction increased scores in remedial math content more than text-based instruction. The overall gains and the gains by content area were analyzed. While the sample size was limited, it did allow for some analysis.

Research Question 1

The first research question was designed to determine whether or not there was a difference between video and text instruction in online remedial math courses. The data analysis found no statistically significant difference in test scores between a group that received text-based instruction and a group that received video based instruction. The significance of this finding is limited by a low study sample size.

Research Question 2

The second research question was designed to determine whether or not there was a difference between video and text instruction in specific content areas in remedial math courses. The data analysis of variance of gain scores for each of the individual modules indicated no significant difference between text and video instruction by content area.

Interpretation

The negative answers for both of the research questions indicate that there was no statistically significant difference between the text and video instruction groups. One of the reasons for this could be due to the small sample size. If this study were to be repeated, I would increase the number of participants in order to account for the number of students who failed to persist in the study. Only 8% of the participants who started this study completed all three modules.

Another component that could have had an impact on the results of the study was with the content selected. When teaching linear equations, graphing is one of the topics that is typically covered. When graphing is assessed in this remedial online math course, it is currently done with multiple-choice questions. The study was designed with opened ended questions, to prevent students guessing at correct answers, which lead to the graphing components being removed. Graphing equations is a more visual process; therefore, video instruction may have been better suited to topics such as graphing.

A significant change was made to the online classes at Private New England College during the study period. More of these classes have been standardized, so that every section of a particular course has the same assignments and course materials. There are also more sections of the remedial math course being offered during the academic year, with the same instructors teaching in multiple sections. Instructors can add additional resources to their course section, however. The original study that the analysis was based on was separate from the remedial math courses to remove any differences based on the instructor's materials and teaching styles. By removing the study from a course that would impact students' grades, it also lowered the incentive for students to complete the study. A longer study that spans the entire course would allow for more data points to truly determine if there is a difference between text and video instructional materials, by using the results from the remedial math courses of an instructor over a period of several terms in order to get a better sample size.

A noteworthy component of this study was the low completion rate. There were 203 students who volunteered to take part in a study about math. I was surprised that so many students were willing to volunteer their time to learn math and take math tests. This was especially surprising because I predicted that students who would select into a remedial math course do not typically enjoy doing math, and thus would be less likely to sign up. However, there was a significant drop in the number of participants who completed the study. Out of the 203 participants, only 78 completed the first module, 36 completed the second module, and 17 completed the third module, which gave a completion rate of all three modules of 8%. As there was no exit interview or survey process for participants who did not complete, this study did not address why so many participants who volunteered for a math study failed to complete even the first module. If this study were done again with students enrolled in the remedial math course, then there would be better tracking as to why they did not finish a course. Advisors and faculty are constantly outreaching to students when they fail to participate in a course.

Limitations of the Study

There were specific limitations that should be notes for this study, even though the study failed to find any statistically significant difference between the text instruction and video instruction groups. These limitations prevented deeper analysis on the subject area of what instructional materials are best suited for online remedial mathematics courses. They are worth mentioning to address in future studies on this topic.

Size of Study

The first limitation was the size of the study. Only two of the datasets did have the minimum number of participants required in order to conduct a meaningful analysis, which was a minimum of 32 participants per group. These datasets contained the results for all three modules combined and the dataset for the first module. The completion rate went down with each module, with which the content became successively more difficult. Even these may have had different results with more participants to get a larger pool of gain scores. However, with the small sample size and the content selected for the tests in this study, it was not enough to find if there was a difference in instructional materials once there are math application problems.

Student Persistence

Another limitation of this study was the low student persistence and the resulting large proportion of participants who failed to finish the study. This study was separate from a for-credit course, resulting in no consequences in regards to grades to deter this attrition from occurring. Some participants emailed me to say that they needed more support for the mathematics content and were hoping for an instructor to ask questions of instead of just using the instructional materials. Others emailed that they did not have the time to complete the study after all. There were a total of 17 participants who emailed to say that they were having problems with the study and would not be able to finish it. However, not every participant who started the study and then failed to complete gave feedback as to why they were not completing, so there is no way of generalizing any of the anecdotal comments to the larger population.

Representation of Population

A third limitation of the study was that the participants self-selected to be in the study. Therefore, they may not have been the same representation as the rest of the university population of students who take a remedial math course as their first math course. The data from the entire online undergraduate population who had not taken a math course, in terms of gender, age, and GPA, was compared against the participants in the study. However, this may not necessarily be the makeup of the population of students needing remedial math courses, as it includes all students who have not taken a math course at the college level yet. While there were no drastic differences between the demographics of the two groups, the participants in the study were older, had a higher GPA, and there were more women.

Length of Study

A final limitation was the short length of the study. Only module one met the minimum sample size, and therefore was the only module that was interpretable. This reduced the usable study data to the span one of module in order to look for results. This may have been too short of a treatment time to have an effect.

Implications for Social Change

Education allows people to improve not only themselves, but also their communities. A college education is required for many careers in the United States or even for advancement within a workplace. However, there are barriers to completing a college education. One issue is that many students are entering college needing to take remedial coursework (Attewell at al., 2006; Bettinger & Long, 2009). This is especially the case in mathematics, where more students need to take a remedial mathematics course than any other remedial courses (Attewell et al., 2006; Bahr, 2007; NCES, 2003).

While previous research has not clearly determined the extent to which remedial college math courses help students in the long run, it is clear from the previous research that students' math performance can impact their educational goals. Mathematics courses, and the success that a student has in them, is an indicator of which students are likely to be retained and graduate. Students who are the most successful in their math courses are also the most likely to persist and graduate within four years (Parker, 2005).

The large number of students taking remedial math courses in two and four year degree granting institutions in the United States suggests that it is important to work on strategies to help students complete the courses successfully and gain the skills needed to continue on with their degree programs. As core classes are typically the first for a student to take, being successful in a remedial math course has the potential to significantly impact both how successful they are in their future math courses and how they view the effectiveness of online courses in general. In addition, math courses or a placement test is a graduation requirement in many colleges, including two-year programs. This puts students who cannot pass their required math courses at an economic disadvantage, as they will be unable to complete their degrees.

Recommendations for Action

While there were no statistically significant results of this study, the information will still be provided to the private university. This information may still be useful to faculty of the remedial math courses and the content designers, to know that text or video instruction is not necessarily better than the other. Focusing on the quality of the instructional materials would then be more important than simply trying to convert current instructional content into whatever the next popular media type is and hoping that will increase student learning.

The real results may be that having multiple options may be best for students, and the university may want to try implementing both types of instructional materials in an actual course and seeing what students prefer. This could be an area of further research, by repeating the study and having the groups have some instructional materials in video format and others in text format. This would show if there are differences at the student by student level with preferences, or if there is still no statistically significant difference between the two instructional material types.

The anecdotal information shared by the participants, including the ones that stated they were hoping to have an instructor to work with, will also be shared. These were comments given by students who decided not complete the study. With so many online courses going to third party platforms to have students work through the content independently, this may be something they want to look into with their student population. The students who decided not to complete the study due to not having an instructor to work with may also be the population of students who do not successfully complete online remedial math courses that do not have a strong instructor presence.

Recommendations for Further Study

The results of this study help to address the gap in the literature around the effectiveness of video instruction in online remedial mathematics courses. While the results of the study did not find any statistically significant difference between text and video instruction for online remedial math courses, it did suggest a number of potential ways for future research to further address this topic.

Future research should seek to duplicate this study with a larger number of participants. One of the primary limitations for this study was with the sample size. It may also be beneficial to run this study with actual courses instead of as a separate study, as a way of having more students follow through and complete all of the sections. If this study was done again without being part of courses, then having some type of exit interview would be useful to find out why there were so many participants who did not persist and complete all of the modules.

Future research done with different content would also help determine if there is a difference between text and video instruction for different types of instruction. This could be different ways of explaining the same content covered in this study or going with different topics than covered in this study.

Conclusion

This study evaluated whether text or video instruction assisted students more in online remedial math courses. A quantitative, quasi-experimental study was used to evaluate a dataset of pre- and posttest scores for remedial math topics completed by online students from a private university. An analysis of variance of gain scores test was then done on the overall results and broken out by content area.

While the results of the study did not find any significant difference between text and video instruction, it did help add to the literature on online course development and instruction for remedial math courses. The study also brought up other areas of research and suggestions for running this study again, to see if that changes the results. It is important to work on methods of improving remedial math courses, as many students entering colleges in the United States need to take these courses and being successful in a remedial math course has the potential to significantly impact both how successful a student is in their future math courses and their ability to complete their degree program.

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Appendix A: Text-Based Instructional Materials

Module 1

Module 1 Solving Linear Equations

Equations of the form x + a = b

To solve an equation means to find a solution of the equation. You need to isolate the variable of the equation by stripping the variable terms of all surrounding constants and coefficients. In general, your goal is to get:

variable = constant

We use inverses to simplify equations. Anytime you add, subtract, multiply or divide both sides of an equation by the same number your resulting equation is equivalent to the original equation. To solve addition and subtraction equations we will add the opposite to simplify the side of the equation containing the variable.

- Inverse Property of Addition $a + (-a) = (-a) + a = 0$
- Addition Property of Zero $a + 0 = 0 + a = a$

Study the following equations to see how they are solved.

1) $x + 2 = 9$
   $x + 2 - 2 = 9 - 2$ Add -2 to each side of the equation.
   $x + 0 = 7$
   x = 7 Simplify to get x.
2) $x - 4 = 2$
   $x - 4 + 4 = 2 + 4$ Add +4 to each side of the equation.
   $x + 0 = 6$
   x = 6 Simplify to get x.
3) $-8 = n + 1$
   $- 8 - 1 = n + 1 - 1$ Add -1 to each side of the equation.
   $-9 = n$ Simplify to get n.
   or **n = -9**
4) $-6 = y - 5$
   $-6 + 5 = y - 5 + 5$ Add +5 to each side of the equation.
   $-1 = y$ Simplify.
   or **y = -1**
5) $y + 3/4 = 1/3$
   $y + 3/4 - 3/4 = 1/3 - 3/4$ Add -3/4 to each side of the equation.
   y = -5/12 Simplify.
6) $5/6 = y - 3/8$
   $5/6 + 3/8 = y - 3/8 + 3/8$ Add +3/8 to each side of the equation.
   $29/24 = y$ Simplify.
   y = 29/24 or 1 5/24 Answers may be improper fractions.

Equations of the form ax = b

To solve multiplication and division equations, we will multiply each side of the equation by the reciprocal of the coefficient of the variable. Note: the reciprocal has the same sign as the number you are eliminating.

- Inverse Property of Multiplication $a(1/a) = (1/a)a = 1$
- Multiplication Property of One $a(1) = 1(a) = a$

Study the following equations to see how they are solved.

1) $2x = 6$
$1/2(2x) = 1/2(6)$ Multiply each side of the equation by 1/2. (or divide by 2)
$\mathbf{x = 3}$ Simplify.

2) $-8x = 24$
$-1/8(-8x) = -1/8(24)$ Multiply each side of the equation by -1/8. (or divide by -8)
$\mathbf{x = -3}$ Simplify.

3) $0 = -5a$
$-1/5(0) = -1/5(-5a)$ Multiply each side of the equation by -1/5. (or divide by -5)
$0 = a$ Simplify.
$\mathbf{a = 0}$

4) $3/4\ z = 9$
$4/3(3/4\ z) = 4/3(9)$ Multiply each side of the equation by 4/3.
$\mathbf{z = 12}$ Simplify.

5) $\frac{-b}{3} = 6$
$1/3\ b = 6$ -b/3 means -1/3 b
$-3(-1/3b) = -3(6)$ Multiply both sides of the equation by -3.
$\mathbf{b = -18}$ Simplify.

6) $\frac{-3z}{8} = 9$
$-3/8\ z = 9$ -3z/8 means -3/8 z
$-8/3(-3/8\ z) = -8/3(9)$ Multiply each side of the equation by -8/3.
$\mathbf{z = -24}$

7) $-\frac{6}{7} = -\frac{3}{4}b$
$-4/3(-6/7) = -4/3\ (-3/4\ b)$ Multiply each side of the equation by -4/3.
$8/7 = b$ Simplify.
$\mathbf{b = 8/7}$

8) $4x - 8x = 16$
$-4x = 16$ Combine like terms.
$-1/4(-4x) = -1/4(16)$ Multiply each side of the equation by -1/4.

(or divide by -4)

x = -4 Simplify.

Solving Equations of the form ax + b = c

To solve any linear equation our goal is to rewrite the equation so that

variable = constant

- Sometimes we need to apply both the addition property (adding opposites to both side of an equation) and the multiplication property (multiplying both sides of the equation by the reciprocal or divide both sides) in order to do this. Reminder: Opposites have different signs, but reciprocals have the same sign as each other.
- Although it doesn't really make a difference with equations, it is usually better to make sure your variable term ends up on the left hand side of the equation.
- Unlike the order of operations, we use the addition property before using the multiplication property.

1) 3x - 7 = -5	
3x - 7 + 7 = -5 + 7	Add 7 to both sides.
3x = 2	Simplify.
1/3(3x) = 1/3(2)	Multiply both sides by 1/3 (or divide by 3).
x = 2/3	Simplify.
2) 5 = 9 - 2x	
5 + 2x = 9 -2x + 2x	Add 2x to both sides.
5 + 2x = 9	Simplify.
5 + 2x -5 = 9 - 5	Add -5 to both sides.
2x = 4	Simplify.
x = 2	Divide both sides by 2.
3) 5x + 7 = 10	
5x + 7 - 7 = 10 - 7	Add -7 to both sides.
5x = 3	Simplify.
x = 3/5	Divide both sides by 5.
4) 2 = 11 + 3x	
2 - 3x = 11 + 3x - 3x	Add -3x to both sides.
2 - 3x = 11	Simplify.
2 - 3x - 2 = 11 - 2	Add -2 to both sides.
-3x = 9	Simplify.
x = -3	Divide both sides by -3.
5) 3/4 x - 2 = -11	
3/4 x - 2 + 2 = -11 + 2	Add 2 to both sides.
3/4 x = -9	Simplify
4/3(3/4 x) = 4/3(-9)	Multiply both sides by the reciprocal of 3/4.
x = -12	Simplify.
6) x/4 - 6 = 1	
x/4 - 6 + 6 = 1 + 6	Add 6 to both sides.

x/4 = 7 Simplify.
4(x/4) = 4(7) Multiply both sides by 4 (x/4 means 1/4 x).
x = 28 Simplify.

7) 2x + 4 - 5x = 10
-3x + 4 = 10 Combine like terms (2x & -5x) on the left.
-3x + 4 - 4 = 10 - 4 Add -4 to both sides.
-3x = 6 Simplify.
x = -2 Divide both sides by -3.

8) x - 5 + 4x = 25
5x - 5 = 25 Combine like terms (x means 1x)
5x - 5 + 5 = 25 + 5 Add 5 to both sides.
5x = 30 Simplify.
x = 6 Divide both sides by 5.

Solving Longer Equations ax + b = cx + d

No matter how long the equations are, the principles are the same. Generally we collect all of the variable terms on the left side of the equation and then collect all of the constant terms on the right side of the equation.

1) 2x + 3 = 5x - 9
2x + 3 - 5x = 5x - 9 - 5x Add -5x to both sides.
-3x + 3 = -9 Simplify.
-3x + 3 - 3 = -9 - 3 Add -3 to both sides.
-3x = -12 Simplify.
x = 4 Divide both sides by -3.

2) 5x + 4 = 6 + 10x
5x + 4 - 10x = 6 + 10x - 10x Add -10x to both sides.
-5x + 4 = 6 Simplify.
-5x + 4 - 4 = 6 - 4 Add -4 to both sides.
-5x = 2 Simplify.
x = -2/5 or -.4 Divide both sides by -5 (-2/5 = .4)

3) 3x + 4 - 5x = 2 - 4x
-2x + 4 = 2 - 4x Combine like terms on the left.
-2x + 4 + 4x = 2 - 4x + 4x Add 4x to both sides.
2x + 4 = 2 Simplify.
2x + 4 - 4 = 2 - 4 Add -4 to both sides.
2x = -2 Simplify.
x = -1 Divide both sides by 2.

4) 5x - 10 -3x = 6 - 4x
2x - 10 = 6 - 4x Combine like terms.
2x - 10 + 4x = 6 - 4x + 4x Add 4x to both sides.
6x - 10 = 6 Simplify.
6x - 10 + 10 = 6 + 10 Add 10 to both sides.

$6x = 16$ Simplify.

$\mathbf{x = 8/3}$ Divide both sides by 6

Leave your answer as an improper fraction rather then a repeating decimal.

Solving Equations with Parenthesis

When an equation contains parenthesis we need to use the distributive property first to remove the parenthesis.

Study these examples.

1) $5x - 4(3 - 2x) = 2(3x - 2) + 6$

$5x - 12 + 8x = 6x - 4 + 6$	Distribute
$13x - 12 = 6x + 2$	Combine like terms
$13x - 12 - 6x = 6x + 2 - 6x$	Add -6x to both sides.
$7x - 12 = 2$	Simplify.
$7x - 12 + 12 = 2 + 12$	Add 12 to both sides.
$7x = 14$	Simplify.
$\mathbf{x = 2}$	Divide both sides by 7.

2) $-2[3x - 5(2x - 3)] = 3x - 8$

$-2[3x - 10x + 15] = 3x - 8$	Distribute to remove the inner parenthesis.
$-6x + 20x - 30 = 3x - 8$	Distribute to remove the outer brackets.
$14x - 30 = 3x - 8$	Combine like terms.
$14x - 30 - 3x = 3x - 8 - 3x$	Add -3x to both sides.
$11x - 30 = -8$	Simplify.
$11x - 30 + 30 = -8 + 30$	Add 30 to both sides.
$11x = 22$	Simplify.
$\mathbf{x = 2}$	Divide both sides by 11.

Module 2

Module 2: Linear Equations

Linear Equations – Slope/Intercept Form

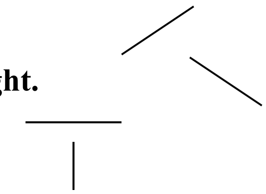
- **Slope/Intercept Form** $\mathbf{y = mx + b}$
  Where m = slope, b = y-intercept & (x,y) are the points on that line

---

Finding the Slope

The slope of a line shows the slant of the line. It measures the ratio of change in y values compared to change in x values between any two points on the line.

- A line with a **positive slope** slants **up and to the right**.
- A line with a **negative slope** slants **down and to the right.**
- A line with a **slope of zero** is a **horizontal line**.
- A line with an **undefined slope** is a **vertical line**.



Finding the y-intercept of a straight line

- The **y-intercept** (0,y) of a line is the place where the line crosses the **y-axis**.

Finding the Slope and y-intercept of a straight line

Find the slope and y-intercept of the line.

1) y = -3x + 6

y = -3x + 6

m = -3

y-intercept = 6

2) y = 1/2x - 10

y = 1/2x - 10

m = 1/2

y-intercept = -10

3) y = 4x - 6

y = 4x - 6

m = 4

y-intercept = -6

Writing the Equation of a Line (given the y-intercept and the slope)

Slope/Intercept Form **y = mx + b**

Most of the time, we use Slope/Intercept Form to name the line. To do this we must have:

- the slope "m" and
- the y-intercept "b"

<u>Write the equation of each line in slope/intercept form.</u>

1) slope 3 & y-intercept -1

y = mx + b m = 3 & b = -1

y = 3x -1

2) slope -1/2 & y-intercept 0

$y = mx + b$ $m = -1/2$ & $b = 0$

$y = -1/2\ x + 0$

$y = -1/2\ x$

3) slope -2 through (0,3)

$y = mx + b$ $m = -2$ & $b = 3$

$y = -2x + 3$

Writing the Equation of a Line (given a point and the slope)

Point/Slope Form **$y - y_1 = m(x - x_1)$**

Where m = slope, (x_1,y_2) is a specific point on the line & (x,y) are the general points on that line

If you're given the slope and a point on the line, but not the y-intercept, you can't use the Slope/Intercept Form to name the line. Instead, we use the Point/Slope Form. To do this we must have:

- the slope "m" and
- a point

<u>Write the equation of each line in slope/intercept form.</u>

1) slope 3 through (1,5)

$y = mx + b,\ m = 3$

Since we don't know b, so use the point/slope form instead.

$y - y_1 = m(x - x_1)$ $m = 3$ & $(x_1,y_1) = (1,5)$

$y - 5 = 3(x - 1)$

$y - 5 = 3x - 3$

$y = 3x - 3 + 5$

$y = 3x + 2$

2) slope 1/2 through (-2,3)

$y - y_1 = m(x - x_1)$ $m = 1/2$ & $(x_1,y_1) = (-2,3)$

$y - 3 = 1/2(x + 2)$

$y - 3 = 1/2\ x + 1$

$y = 1/2\ x +1 + 3$

$y = 1/2x + 4$

3) slope 1/4 through (3,2)

$y - y_1 = m(x - x_1)$ $m = 1/4$ & $(x_1,y_1) = (3,2)$

$y - 2 = 1/4(x - 3)$

$y - 2 = 1/4x - 3/4$

$y = 1/4x - 3/4 + 8/4$

$y = 1/4x + 5/4$

Module 3: Applications of Linear Equations

Applications – Equation of a Line

When working with real data, we often want to use that data to develop an equation to represent our situation. To do this we will need to apply what we know about points and slope to forming the equation of the line. Because data points usually do not perfectly fit a linear equation, we will use the "line of best fit" or "trendline" as our estimate of the line's equation. Ultimately, our final equation should be expressed in slope/intercept form.

- **Slope/Intercept Form** **$y = mx + b$**
  Where m = slope, b = y-intercept & (x,y) are the points on that line

- **Point/Slope Form** **$y - y_1 = m(x - x_1)$**
  Where m = slope, (x_1,y_2) is a specific point on the line & (x,y) are the general points on that line

---

1) The sales of a small company **increased** in value $12,000 each year. The sales were $63,000 after 5 years. Write an equation of a line that gives the value, **y**, of the **sales** in terms of the number of **years**, **x**, since the start.

Goal: $y = mx + b$ We need some of the values to complete this equation.

The slope is 12000
The slope is positive because the value is increasing.
Our data point is (5, 63000)
(x,y) = (year, sales)
The order of your values is very critical
Remember Ordered Pairs must have x first.

Now use this information and the point/slope form to find your equation.

$y - y_1 = m(x - x_1)$ $m = 12000$ & $(x_1,y_1) = (5,63000)$
$y - 63000 = 12000(x - 5)$
$y - 63000 = 12000x - 60000$
$y = 12000x - 24000 + 63000$
$\mathbf{y = 12000x + 3000}$

Interpretation

- Slope = 12000 which means that sales are increasing approximately $12,000 per year of operation.
- y-intercept = 3000 which means that initially the sales were $3000.

2) Office equipment **decreases** in value \$1,800 each year. The equipment was worth \$2,000 after 10 years. Write an equation of a line that gives the value, **y**, of the **office equipment** in terms of the number of **years**, **x**, since the purchase.

Goal: $y = mx + b$ We need some of the values to complete this equation.

The slope is -1800

The slope is negative because the value is decreasing.

Our data point is (10, 2000)

(x,y) = (year, value)

Now use this information and the point/slope form to find your equation.

$y - y_1 = m(x - x_1)$ $m = -1800$ & $(x_1,y_1) = (10,2000)$

$y - 2000 = -1800(x - 10)$

$y - 2000 = -1800x + 18000$

$y = -1800x + 18000 + 2000$

$\mathbf{y = -1800x + 20000}$

Interpretation

- Slope = -1800 which means that the office equipment is decreasing in value approximately \$1,800 per year.
- y-intercept = 20000 which means that initially the equipment was valued at \$20,000.

3) A bond **increases** in value by \$500 each year. The bond was worth \$8,500 after 6 years. Write an equation of a line that gives the value, **y**, of the **bond** in terms of the number of **years**, **x**, since the purchase.

Goal: $y = mx + b$ We need some of the values to complete this equation.

The slope is 500

The slope is positive because the value is increasing.

Our data point is (6, 8500)

(x,y) = (year, value)

Now use this information and the point/slope form to find your equation.

$y - y_1 = m(x - x_1)$ $m = 500$ & $(x_1,y_1) = (6,8500)$

$y - 8500 = 500(x - 6)$

$y - 8500 = 500x - 3000$

$y = 500x - 3000 + 8500$

$\mathbf{y = 500x + 5500}$

Interpretation

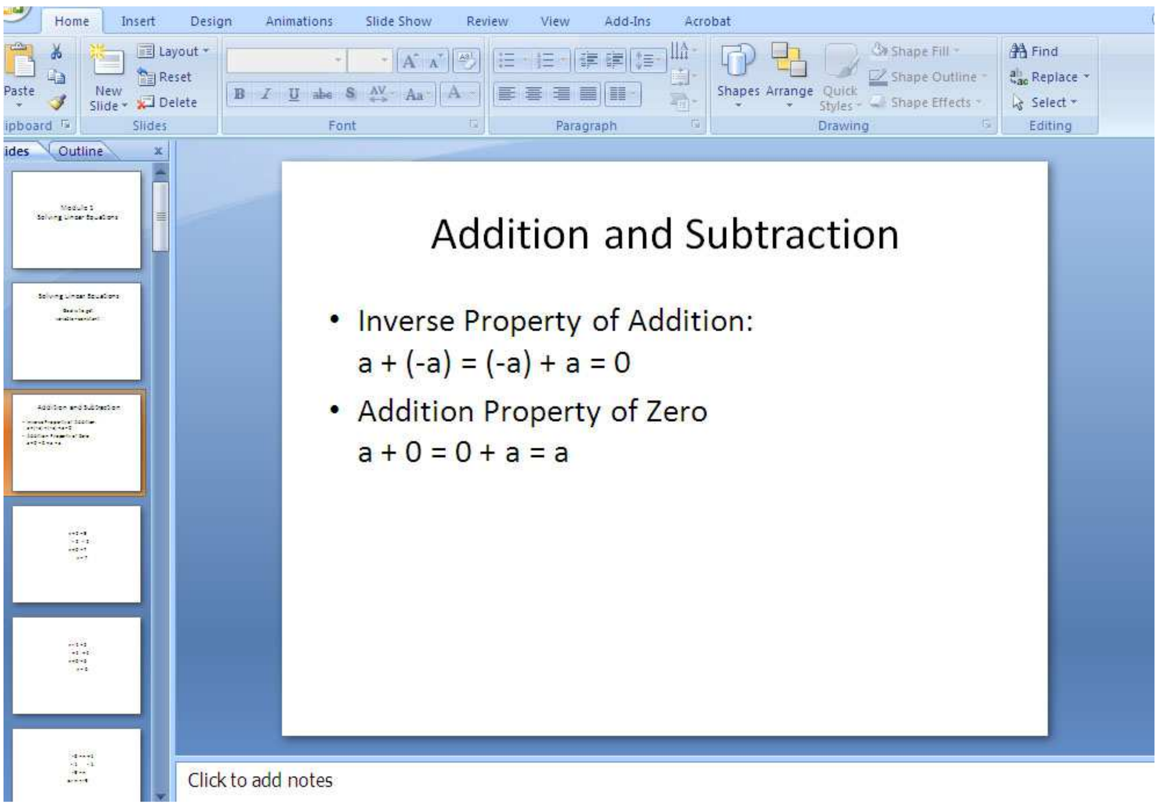
- Slope = 500 which means that the bond is increasing in value approximately \$500 per year.

- y-intercept = 5500 which means that initially the bond was valued at \$5,500.

Appendix B: Video Instructional Materials

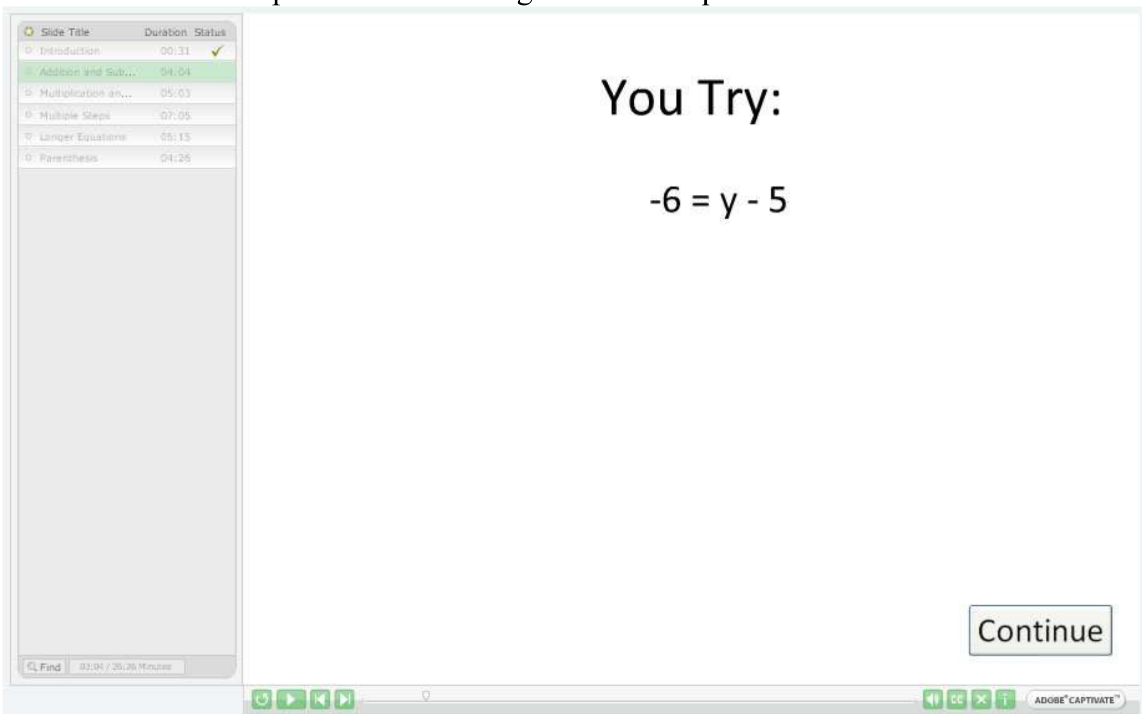
Each module video was structured to match the text-based notes. All of the definitions and descriptions of the process are described the same way, although visually the videos have bullet points instead of full text. All of the sample problems are the same. The videos were created using design principles from cognitive load theory and Universal Design.

Video Creation Process
The videos were first created as PowerPoint slides.

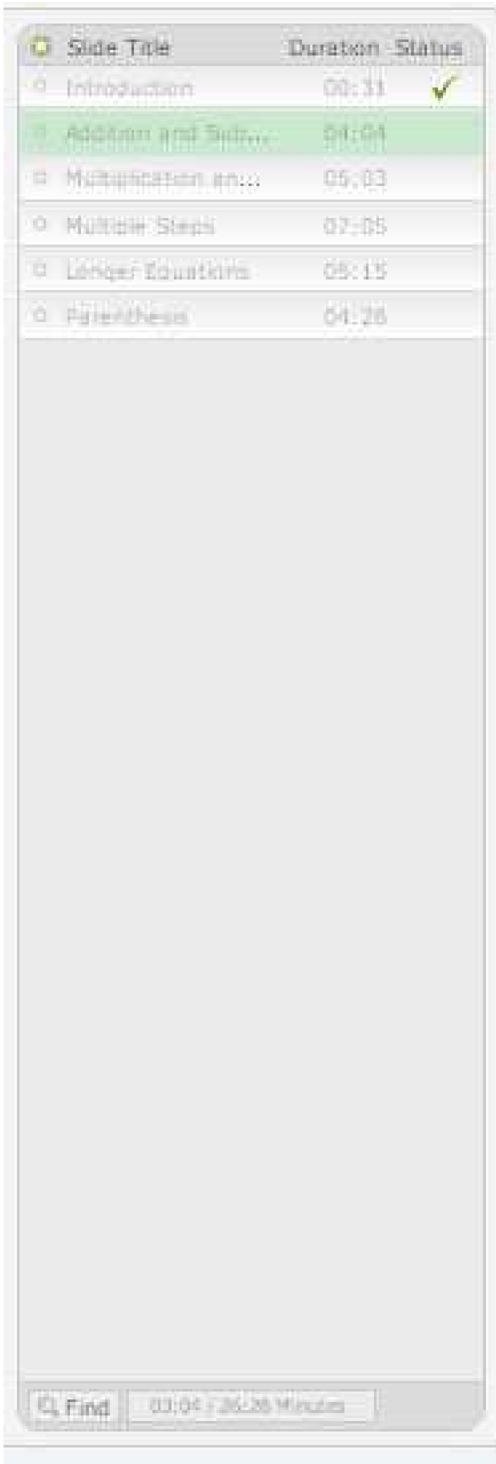


The slides were then brought into Adobe Captivate, where the audio was recorded and closed captions were added. Following cognitive load theory, the audio being used provides concise instruction. The audio describes each step, leaving just the terms or problem being discussed displaying, preventing split-attention affect and reducing redundancy, according to cognitive load theory. However, some people may not be able to access the audio portion, so closed captions are available to be turned on for those that need it, following Universal Design principles.
In addition to the directions and sample problems that are done out, check points where the video pauses for the viewer to try solving a problem on their own were added. Once the viewer attempts the problem, they can click on the button on the screen to continue on

and check their work against the video. This allows the viewer to check and see if they understand the concepts without showing the answer up front.



Finally, a table of contents was added to each video so that the viewer can skip around in the video or go back to different sections to review content.


Slide Title
Duration
Status
Introduction
00:31
Addition and Sub...
04:04
Multiplication an...
05:03
Multiple Steps
07:05
Longer Equations
05:15
Parenthesis
04:28
Find

Appendix C: Pre- and Posttests

Module 1

Pretest

1. Solve: $n + 3 = -5$
2. Solve: $x - 3 = -7$
3. Solve: $-y = 6$
4. Solve: $v/4 = -8$
5. Solve: $a/-2 = 1$
6. Solve: $-a = -7$
7. Solve: $(2/3)y - 3 = -9$
8. Solve: $(4z)/2 = 8$
9. Solve: $8x + 16 = -24$
10. Solve: $3y + 2 = 20$
11. Solve: $9 - z = -6$
12. Solve: $-w + 4 = 3$
13. Solve: $9x + 13 = 7x + 19$
14. Solve: $2x - 3 = 5(x + 3)$
15. Solve: $-2(3n - 1) = -7n$
16. Solve: $11x + 2 = -x +26$
17. Solve: $7 - 2x = 3x - 13$
18. Solve: $12a = -2(a - 7)$
19. Solve: $14x - 1(8x - 13) = 12x + 1$
20. Solve: $3(x + 6) - 1(x + 3) = 4x + 5$

Posttest

1. Solve: $x - 2 = -8$
2. Solve: $n + 1 = -7$
3. Solve: $v/2 = -4$
4. Solve: $-y = 5$
5. Solve: $-a = -3$
6. Solve: $a/-3 = 2$
7. Solve: $(3z)/4 = 6$
8. Solve: $(1/4)y - 2 = -18$
9. Solve: $2y + 3 = 9$
10. Solve: $6x + 15 = -27$
11. Solve: $-w + 6 = 4$
12. Solve: $7 - z = -8$
13. Solve: $3x - 3 = 6(x + 2)$
14. Solve: $5x + 19 = 2x + 28$
15. Solve: $10x + 1 = -x + 23$
16. Solve: $-3(3n - 1) = -10n$
17. Solve: $16a = -4(a - 5)$
18. Solve: $9 - 4x = 5x - 18$

19. Solve: $2(x + 5) - 1(x + 4) = 7x + 18$
20. Solve: $12x - 1(7x + 21) = 10x + 1$

Module 2
Pretest
1. What is the slope of the graph of $y = 3x - 6$?
2. What is the y-intercept of the graph of $y = 3x - 6$?
3. What is the slope of the graph of $y = -4x + 3$?
4. What is the y-intercept of the graph of $y = -4x + 3$?
5. What is the slope of the graph of $y = -2x - 3$?
6. What is the y-intercept of the graph of $y = -2x - 3$?
7. What is the slope of the graph of $y = -x + 1$?
8. What is the y-intercept of the graph of $y = -x + 1$?
9. What is the slope of the graph of $y = 1/3x - 5$?
10. What is the y-intercept of the graph of $y = 1/3x - 5$?
11. Find an equation of the line with slope 2 that passes through the point (0, 6).
12. Find an equation of the line with slope 3 that passes through the point (0, -8).
13. Find an equation of the line with slope 4 that passes through the point (2, 8).
14. Find an equation of the line with slope -2 that passes through the point (2, 6).
15. Find an equation of the line with slope 3 that passes through the point (3, -2).
16. Find an equation of the line with slope 2 that passes through the point (3, 2).
17. Find an equation of the line with slope -3 that passes through the point (2, -4).
18. Find an equation of the line with slope 2/3 that passes through the point (4, 2).
19. Find an equation of the line with slope 1/2 that passes through the point (0, -4).
20. Find an equation of the line with slope -3 that passes through the point (-5, 2).

Posttest
1. What is the slope of the graph of $y = -5x + 10$?
2. What is the y-intercept of the graph of $y = -5x + 10$?
3. What is the slope of the graph of $y = -3x + 2$?
4. What is the y-intercept of the graph of $y = -3x + 2$?
5. What is the slope of the graph of $y = -2x - 6$?
6. What is the y-intercept of the graph of $y = -2x - 6$?
7. What is the slope of the graph of $y = -x - 2$?
8. What is the y-intercept of the graph of $y = -x - 2$?
9. What is the slope of the graph of $y = 1/2x - 5$?
10. What is the y-intercept of the graph of $y = 1/2x - 5$?
11. Find an equation of the line with slope 3 that passes through the point (0, 5).
12. Find an equation of the line with slope -2 that passes through the point (0, 4).
13. Find an equation of the line with slope 2 that passes through the point (3, 5).
14. Find an equation of the line with slope 4 that passes through the point (2, -6).
15. Find an equation of the line with slope 3 that passes through the point (4, -2).
16. Find an equation of the line with slope 2 that passes through the point (3, 8).
17. Find an equation of the line with slope -4 that passes through the point (2, -3).

18. Find an equation of the line with slope 2/3 that passes through the point (6, -2).
19. Find an equation of the line with slope 1/2 that passes through the point (0, -1).
20. Find an equation of the line with slope -1 that passes through the point (-2, 6).

Module 3

Pretest

1. A car decreases in value by $2,500 a year. The car was worth $25,000 when it was purchased. Write an equation that gives the value, y, of the car in terms of the number of years, x, since the purchase.
2. A car decreases in value by $1,600 a year. The car was worth $30,000 when it was purchased. Write an equation that gives the value, y, of the car in terms of the number of years, x, since the purchase.
3. A retirement plan increases in value by $1,200 a year. The plan was worth $6,300 after two years. Write an equation that gives the value, y, of the retirement plan in terms of the number of years, x, since the purchase.
4. A retirement plan increases in value by $1,800 a year. The plan was worth $4,600 after six years. Write an equation that gives the value, y, of the retirement plan in terms of the number of years, x, since the purchase.
5. A television decreases in value by $300 a year. The television was worth $700 one year after it was purchased. Write an equation that gives the value, y, of the television in terms of the number of years, x, since the purchase.
6. A television decreases in value by $200 a year. The television was worth $900 three years after it was purchased. Write an equation that gives the value, y, of the television in terms of the number of years, x, since the purchase.
7. A savings plan increases in value by $87.23 a year. The plan was worth $47,000 after 36 years. Write an equation that gives the value, y, of the savings plan in terms of the number of years, x, since the purchase.
8. A savings plan increases in value by $65.57 a year. The plan was worth $39,000 after 24 years. Write an equation that gives the value, y, of the savings plan in terms of the number of years, x, since the purchase.
9. A CD increases in value by $30 a year. The CD was worth $600 after 3 years. Write an equation that gives the value, y, of the CD in terms of the number of years, x, since the purchase.
10. A CD increases in value by $40 a year. The CD was worth $800 after 4 years. Write an equation that gives the value, y, of the CD in terms of the number of years, x, since the purchase.

Posttest

1. A piece of lab equipment decreases in value by $500 a year. The item was worth $8,000 when it was purchased. Write an equation that gives the value, y, of the equipment in terms of the number of years, x, since the purchase.
2. A piece of lab equipment decreases in value by $600 a year. The item was worth $12,000 when it was purchased. Write an equation that gives the value, y, of the equipment in terms of the number of years, x, since the purchase.

3. A collector's item increases in value by $80 a year. The item was worth $1,260 after three years. Write an equation that gives the value, y, of the item in terms of the number of years, x, since the purchase.
4. A collector's item increases in value by $50 a year. The item was worth $1,480 after five years. Write an equation that gives the value, y, of the item in terms of the number of years, x, since the purchase.
5. An investment increases in value by $200 a year. The investment was worth $14,000 after one year. Write an equation that gives the value, y, of the item in terms of the number of years, x, since the purchase.
6. An investment increases in value by $350 a year. The investment was worth $21,000 after four years. Write an equation that gives the value, y, of the item in terms of the number of years, x, since the purchase.
7. A truck decreases in value by $3,000 a year. The truck was worth $17,000 after 9 years. Write an equation that gives the value, y, of the truck in terms of the number of years, x, since the purchase.
8. A truck decreases in value by $2,000 a year. The truck was worth $19,000 after 6 years. Write an equation that gives the value, y, of the truck in terms of the number of years, x, since the purchase.
9. A savings plan increases in value by $52.85 a year. The savings plan was worth $1,250 after 4 years. Write an equation that gives the value, y, of the savings plan in terms of the number of years, x, since the purchase.
10. A savings plan increases in value by $73.38 a year. The savings plan was worth $74,250 after 44 years. Write an equation that gives the value, y, of the savings plan in terms of the number of years, x, since the purchase.

Appendix D: Consent Forms

CONSENT FORM - Pilot

You are invited to take part in a research study to assess the impact of different instructional materials for the online [CLASS NUMBER] class, Fundamentals of Algebra. The researcher is inviting you to take part in a pilot of the tests that will be used as part of the study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Elizabeth Henley, who is a doctoral student at Walden University. You may already know the researcher as the Associate Director of the Office of Disability Services, but this study is separate from that role.

Background Information:
The purpose of this study is to assess the impact of different instructional materials for the online [CLASS NUMBER] class, Fundamentals of Algebra. The course description for [CLASS NUMBER] is as follows: This course includes a review of basic arithmetic and an introduction to elementary algebra. Topics may include: pre-algebra review; real numbers; algebraic expressions; linear and quadratic equations, graphs and applications; systems of equations; exponents; polynomials and rational expressions.

Procedures:
If you agree to be in this pilot, you will be asked to:

- Complete a test that covers three content areas contained in [CLASS NUMBER] without accessing outside help
- Completing the test should take no more than 2 hours

Voluntary Nature of the Study:
This pilot is voluntary. Everyone will respect your decision of whether or not you choose to be in the pilot. No one at Private New England College will treat you differently if you decide not to be in the pilot. If you decide to join the pilot now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:
Being in this type of pilot involves some risk of the minor discomforts that can be encountered in daily life, such as fatigue, stress, or frustration. Being in this pilot would not pose risk to your safety or wellbeing.

The benefits of participating in the pilot is that you will be helping to determine what instructional materials are best for online math courses. These findings may be implemented into future courses at Private New England College.

Payment:
There is no payment for participating in this pilot study.

Privacy:

Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Data will be kept secure by being in an Excel file that has participants' names removed. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact the researcher via email at [EMAIL]. You can also contact the chair of the Institutional Review Board (IRB), [IRB CHAIR CONTACT INFORMATION], if you have any questions or concerns.

Statement of Consent:

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Print Name of Participant ___________________________________

Signature of Participant _____________________________________

Date ___________________________
Day/month/year

A copy of this ICF has been provided to the participant.

Print Name of Researcher/person taking the consent ______________________________

Signature of Researcher /person taking the consent _______________________________

Date ___________________________
Day/month/year

CONSENT FORM - Study

You are invited to take part in a research study to assess the impact of different instructional materials for the online [CLASS NUMBER] class, Fundamentals of Algebra. The researcher is inviting all online students who have not taken a math course at Private New England College or transferred in credits for a math course, and who feel that [CLASS NUMBER] would be the appropriate first math course for them to take, to be in the study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Elizabeth Henley, who is a doctoral student at Walden University. You may already know the researcher as the Associate Director of the Office of Disability Services, but this study is separate from that role.

Background Information:
The purpose of this study is to assess the impact of different instructional materials for the online [CLASS NUMBER] class, Fundamentals of Algebra. The course description for [CLASS NUMBER] is as follows: This course includes a review of basic arithmetic and an introduction to elementary algebra. Topics may include: pre-algebra review; real numbers; algebraic expressions; linear and quadratic equations, graphs and applications; systems of equations; exponents; polynomials and rational expressions.

Procedures:
If you agree to be in this study, you will be asked to:

- Complete three modules of content that appears in [CLASS NUMBER] and a survey at the end of the study
- In each module, complete a pre- and posttest, without accessing outside help
- In each module, review the provided instructional materials
- Each module should take no more than 5 hours to complete

Voluntary Nature of the Study:
This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at Private New England College will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:
Being in this type of study involves some risk of the minor discomforts that can be encountered in daily life, such as fatigue, stress, or frustration. Being in this study would not pose risk to your safety or wellbeing.

The benefits of participating in the study is that you will be helping to determine what instructional materials are best for online math courses. These findings may be implemented into future courses at Private New England College.

Payment:

Anyone who participates in this study will be entered into a drawing for two $50 Amazon gift cards. This drawing will be done at the completion of the study and the winners will be notified through their school email accounts.

Privacy:
Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Data will be kept secure by being exported from Blackboard in an Excel file that has participants' names removed. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact the researcher via email at [EMAIL]. You can also contact the chair of the Institutional Review Board (IRB), [IRB CHAIR CONTACT INFORMATION], if you have any questions or concerns.

Please print or save this consent form for your records.

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my involvement. By clicking the link below and entering your contact information in the survey, I understand that I am agreeing to the terms described above.