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A Comparison of Student Final Grades in College Algebra Based on Face-to-Face and Online Course Modalities

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by

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Abstract

As community colleges emerge from the COVID-19 pandemic there may be a tendency to rely on technology to facilitate more online coursework. Online education has been a fixture of higher education since the mid-1990s, but there's always been a question as to whether it is effective as traditional, face-to-face coursework. This is especially important in College Algebra, already viewed as a barrier course for many students. If more students take College Algebra online, will the results be as good as students taking the course in a classroom? The purpose of this quantitative causal-comparative study is to identify the relationship between course modality and final grade percentage, after accounting for instructor and curriculum effects for college algebra courses taught both online and face-to-face.

Previous research studied this question, but a consensus about the efficacy of online education was mixed. Some studies found that online students perform worse than face-to-face students in college algebra (Amro, 2014; Amro et al., 2015; Driscoll, 2012). Other studies found no difference between the modalities (Araeipour, 2013; Harrington et al., 2016; Huang, 2016). Research by Burch and Kuo (2010) and Graham and Lazari (2018) discovered online students perform better than face-to-face students.

This study considered the question through the lens of Moore's Theory of Transactional Distance, which examines the distance between the learner and instructor, course content, interface, and other learners as a psychological distance rather than a spatial distance. Using one instructor teaching both online and face-to-face courses using the same materials was an attempt to keep transactional distance as a constant, mitigating instructor and curriculum effects that could impact a study comparing modalities. Previous research that accounted for the instructor and course materials found no significant difference in outcomes based on modality.

This study looked at final grade percentages in College Algebra courses taught by one instructor with both online and face-to-face sections over the course of the 2017-2018 school year. Data were supplied by a two-year institution located in rural Arkansas. In addition to looking for the relationship between modality and final grade percentages, the study looked for relationships between gender and final grades, a student's age and final grades, as well as an interaction between online students and their age or gender on final grade percentages.

Findings indicated there was no significant relationship between the course modality and final grade percentages. Additionally, there was no relationship between gender or age and final grades based on modality. However, one significant relationship the study found was that when women took online algebra, they scored over 15 points lower than men taking online algebra. There was no interaction between a student's age and taking an online college algebra course.

Further research should expand on the notion of accounting for Transactional Distance while looking at the relationship between course modality and final grade percentages and expand the study to disciplines outside of college algebra. Finally, research should investigate whether the relationship changed after the COVID-19 pandemic altered perceptions and implementation of online courses.

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Chapter 1

Overview of the Study

Introduction

Since the late 1990s, online coursework has become a regular part of a student's educational experience. I began my career in higher education in 1999 working in the online recruitment department of a university. At the time, many students weren't even aware online education existed. Coursework was submitted by uploading files similar to today's process, but all classroom interaction occurred in newsgroups, forums that students would subscribe to that were similar to modern message boards (newsgroups, 2016). The most common question I heard was, "Is online education as good as in a classroom?" It is a question still asked today.

This chapter introduces a proposed study for examining the relationship between course modality and final grade percentages for students taking college algebra at a rural community college in Arkansas. The chapter begins by tracing the rise of online course enrollment since the early 2000s through today, when nearly all classes in higher education are being delivered online or remotely during the 2020 COVID-19 pandemic. It then briefly introduces the comparative research on the effectiveness of online and face-to-face course delivery and discusses the evolution of college algebra instruction in colleges and universities. It then defines the concepts related to course delivery and student outcomes and describes the questions driving the study. The chapter concludes with an explanation of the study's scope and limitations.

Background of the Study

Over the past two decades, online education has had a dramatic effect on higher education. At the beginning of the 21st century, there were nearly 800,000 students enrolled in online courses. By 2006, that number increased to just over 1.9 million (Cejda, 2010), and six

years later, nearly a third of all students completed at least one course online—a staggering 6.7 million students (Allen & Seaman, 2013). In 2019, the National Center for Education Statistics reported over 6.9 million students completed at least one online course. For public two-year schools, almost 35% of the 5.5 million students had taken an online course (NCES, 2019). Online enrollment peaked beginning in March of 2020 when almost every course in the United States switched to a remote or online format in response to the COVID-19 pandemic (Gillis & Krull, 2020). Since the transition from face-to-face (F2F) to online (or remote) coursework was sudden and unplanned (Miller, 2021), this study focuses on courses delivered prior to the Spring 2020 semester.

Driving the demand for online courses was the convenience and access to higher education for working adults or students with transportation challenges (Lease & Brown, 2009). Advances in technology allowed educators to reach larger numbers of students at lower costs, and this incentivized colleges and universities to offer online courses to the point where it became strategically imperative to offer online courses in order to compete with other higher learning institutions (Caruth & Caruth, 2013, Lei & Gupta, 2010; Lease & Brown, 2009).

At the same time online education changed the landscape of higher education, teaching methods in college algebra evolved from a traditional, lecture-centered approach to student-centered instruction. Traditional instruction in college algebra treated the course as a gateway to calculus (Herriott & Dunbar, 2009) and featured an instructor lecturing to a group of students who were expected to memorize formulas (Wynegar & Fenster, 2009; Gordon, 2018). It gradually developed into a required course for most degree-seeking students (Gordon, 2018; Tunstall, 2018).

Community colleges view this requirement as a concern since increasing numbers of students are unable to complete or pass a course perceived by some as a gatekeeper course with traditionally low pass rates, and the course serves as a barrier to degree completion (Hagedorn, 2004). Fifteen percent of students at the proposed school for this study required remediation in math. Of these, 61% passed College Algebra in 2019 and 68% passed in 2020 (ADHE, 2020).

Another factor is the increasing numbers of students enrolled in online courses at community colleges and whether online learning is beneficial or detrimental to student outcomes (Francis et al., 2019; Killian, 2020). Nearly a third of all undergraduates in the United States are enrolled at a community college, making it a significant segment of higher education to study (CCRC, 2020). Among graduates who completed a four-year degree in 2015-2016, half attended a community college within the previous ten years (NSC Research Center, 2017).

Community colleges come with their own set of challenges, though. This includes low graduation rates, decreased enrollment numbers, underprepared students, and the stigma of providing less quality than traditional colleges and universities (Holland, 2015).

This is particularly important to the 22 community colleges in Arkansas. In 2019, 61% of students attending a two-year college were placed in remedial courses for math, English, or reading based on ACT or Accuplacer scores (ADHE, 2020). Since Arkansas is a rural state, many students opt for online courses out of necessity, and their course modality is selected based on convenience rather than a learning preference for online over face-to-face coursework.

As the COVID-19 pandemic gradually diminishes and students return to classrooms in pre-pandemic numbers (At the time of this writing, they have not), colleges will be enticed to offer more online courses that can reach larger numbers of students at lower costs. This study seeks to examine the relationship between course modality and effectiveness by looking at the

final grade percentages of students who took college algebra in the semesters leading up to the pandemic while accounting for both the instructor and course materials. The proposed study will accomplish this using a cross-sectional multiple regression.

Need and Purpose

This study adds to the literature and bridges a gap on the efficacy of online education at community colleges, specifically for college algebra courses. There is disagreement as to whether online education is as effective as F2F instruction. Multiple studies indicated that online students performed worse than students in F2F courses (Driscoll et al., 2012; Sharma et al., 2013), while others concluded no significant difference in grades between the two modalities (Araeipour, 2013; Hatcher et al., 2013; and Wagner et al., 2011). Further research showed evidence that online students outperformed their traditional counterparts (Bennett et al., 2007; Campbell et al., 2011). A more in-depth analysis of these studies will be covered in Chapter 2. For a complete list of studies, see Appendix A.

Part of the inconsistency of research findings can be attributed to factors such as biased samples, courses taught by different instructors, or classes using different materials. This study attempts to address the differences in course modalities by accounting for both the instructor and course materials.

As online education evolves, it is important for research to account for improvements to online course design, increased instructor training, and advancements in technologies and learning management systems (LMS) to see if these elements improve learning outcomes, primarily through final grade percentages. For this reason, the studies addressed in the literature review all took place between 2010 and 2020. It should also be noted that participating students

in this study all used the same top-rated, commercially available LMS and accessed the same publisher-supplied course materials utilizing online technology.

Other important considerations include the demographics of community colleges. According to Duffin (2021), women constitute 57% of community college enrollments. Four-year colleges and universities have a similar makeup (NCES, 2019). Fifty years ago only 40% of community college students were women, although the shift began the early 1980s (Digest of Education Statistics, 2018). Interestingly, 75% of online students are women (Clinefelter & Aslanian, 2017), indicating a possible preference for online coursework. Studies comparing outcomes by course modalities by Bennett et al. (2007) and Amro (2014) indicated women outperformed men while Wagner et al. (2011) found no significant differences.

Two-year schools typically have older student populations than four-year colleges and universities (Brookings, 2017). In 2020, the average age of a community college student was 28, about two years older than students at a four-year institution (AACC, 2021). The mean age of enrolled students at the college for this study was 25 (North Arkansas College, 2018). It is yet unclear whether college algebra students are older or younger than the mean age of students at this institution, but regressions will still be run to see if age affects student grades. This will be covered in greater detail in Chapter 2.

The American Association of Community Colleges (2021) reports 44% of community colleges students as being white, 27% Hispanic, 13% black, and 6% Asian. Many studies outlined in the literature review address racial demographics as an important variable to consider. The institution in this study's enrollment is 84% white and 8% Hispanic. Because of this, differences in student outcomes based on race did not seem appropriate for the study.

The COVID-19 pandemic forced students and administrators to participate in online education, and there's a sentiment that higher education has transitioned to a "next normal" due to online technology's ability to provide flexibility, information accessibility, equity, innovation, and efficiency (Xie et al., 2020). Aspects of the pandemic response are being incorporated into curricula as educators prepare for semesters in a post-pandemic environment. Students will be offered greater flexibility in course modalities, and the lines between traditional and online coursework will be less pronounced as assignments from traditional classes are submitted online and recorded lessons from F2F lectures are made available to online students. As the "next normal" takes shape, it begs the question from the introduction: Is online education as good as in a classroom?

The purpose of this quantitative causal-comparative study is to identify the relationship between course modality and final grade percentage, after accounting for instructor and curriculum effects for college algebra courses taught both online and in-person (face-to-face). As community colleges emerge from the post-COVID-19 pandemic, there may be a propensity for schools to rely more on online course offerings to grow enrollment. Conversely, some administrations could opt for more in-person courses due to faculty preference. This study hopes to offer perspective for colleges considering changes to curriculum or institutional focus.

The study is shaped around Moore's Theory of Transactional Distance which examines the relationship between student and instructor and measures distance in terms of a psychological concept rather than physical space. By focusing on one instructor teaching the same course in online and F2F settings, the study hopes to identify sources of transactional distance to improve the efficacy of each modality.

Definitions

Course Modality: The instructional method used by a course (Richland, n.d.). For this study, course modality refers to a course taught using either face-to-face (in-person) or online learning methods.

Hybrid Learning: A course that blends online and traditional courses where 30-79% of the content is delivered online (Allen & Seaman, 2013). This study does not include any hybrid courses since they are not offered for any college algebra sections.

Online Learning: "Content and instruction are delivered primarily over the internet. The term online learning is used interchangeably with virtual learning, cyberlearning, and e-learning." (Staker & Horn, 2012, p.3). Singh and Thurman (2019, p. 302) offer a more precise definition, "Online learning is defined as learning experienced through the Internet in an asynchronous environment where students engage with instructors and fellow students at a time of their convenience and do not need to be co-present online or in a physical space." Allen & Seaman (2013) denote online courses where at least 80% of the content is delivered online. For this study, online learning refers to asynchronous instruction delivered through the internet excluding instances where the instructor and student met face-to-face during office hours.

Remote Course: A course where the majority of the content is delivered synchronously through web-conferencing software during the regularly scheduled class time (University of Arkansas, n.d.). This study covers coursework prior to the COVID-19 outbreak, so data collected will be from either traditional or online courses.

Rural: The National Center for Education Statistics (NCES) uses the U.S. Census Bureau definition of rural being a territory located more than 25 miles from an urbanized area (50,000 or

more people) and more than 10 miles from an urban cluster (2,500 to 50,000 people) (Geverdt, 2019).

Student-Centered Learning: The concept that course curricula should be based on student needs, abilities, and interests while instructors actively engage in collaborative discovery, giving students the ability to shape their own learning (Slavich & Zimbardo, 2012).

Student Learning Outcome: "Student Learning Outcomes are statements that specify what students will know, be able to do or be able to demonstrate when they have completed or participated in a Course or Program. SLO's specify an action by the student that must be observable, measurable and able to be demonstrated." (Oxnard College, n.d., par 1). For this study, Student Learning Outcomes are observed and measured by the student's final grade percentage earned in the course on a scale of 0-100%.

Traditional Learning: "Participants generally attend training in a centralized location with other learners and interact face-to-face with the trainer." (Klein et al., 2006, p. 669). For this study, traditional learning refers to in-person classroom instruction delivered at a brick-and-mortar facility. The term traditional learning is used interchangeably with in-person or face-to-face instruction.

Statement of the Research Problem

There has been a rapid expansion of online college algebra coursework in community colleges, yet there is no consensus elucidating how course modalities affect student learning. The central research problem seeks to understand the relationship between course modality and final grade percentage after accounting for both the instructor and course materials. Secondary questions ask whether grade percentages differ by age or gender and if these differences change after accounting for course modality.

The following research questions will be examined:

Research Question 1: After accounting for instructor and course materials, what is the relationship between course modality and final grade percentage for students taking college algebra at a rural community college in Arkansas?

Research Question 2: Do final grade percentages in college algebra differ by gender, after accounting for course delivery method?

Research Question 3: Does a student's gender influence the relationship between course modality and course grades?

Research Question 4: What is the relationship between a student's age and the final grade percentage earned in a college algebra course, after accounting for course delivery method?

Research Question 5: Does a student's age influence the relationship between course modality and course grades?

Scope and Limitations

Since previous research failed to conclude whether online education is equal to the quality of education found in F2F settings, this study can only provide insight, not offer a definitive answer. Additionally, participants attended at a rural community college in NW Arkansas, so the sample is not representative of the population of the United States. The experiences of rural students in the South are not the same as students who live in urban settings or even rural communities in other parts of the country. One challenge to rural students is reliable access to the internet. A 2018 study by Hampton, Fernandez, Robertson, and Bauer found that students without dependable broadband or who relied on cell phone internet access had lower homework completion rates, technology skills, and grade point averages (2018). The state of Arkansas addressed this problem during the COVID-19 pandemic by passing the

Arkansas Rural Connect (ARC) grant program to increase broadband throughout rural Arkansas (Arkansas Department of Commerce Broadband Office, n.d.). There are likely differences in the academic backgrounds of the students that cannot be construed as representative of the population as a whole.

Differences in course materials and instruction may also affect course grades and are difficult to control for entirely. It is hard to compare student outcomes if different textbooks are used by different instructors or in different programs. As a result, differences in learning outcomes could vary by course material and not the delivery method. This study attempts to minimize those effects by sampling students from a single instructor using identical materials and similar instructional strategies for both online and F2F courses in the same school year. It would be illogical to assume every instructor teaching college algebra would have commensurate student final grades to other instructors teaching the same course. In an ideal world, the study would look at student outcomes from multiple instructors in multiple locations teaching multiple courses across many disciplines with both online and F2F sections containing at least 30 students per section. This study only has the resources and access to one instructor teaching one course, College Algebra. Within the theoretical framework of the study, Moore's Theory of Transactional Distance, the study attempts to answer whether modality affects transactional distance by comparing grades from online and F2F courses. If, for example, an online course has low transactional distance, the outcomes of students should be no different than in a face-to-face course.

Another limitation is the study cannot account for all the environmental factors that could influence final grades. This could include everything from internet connectivity, weather, or job and family obligations. Since the data were analyzed over a year after the completion of the

courses, personal issues and characteristics could also not be controlled for including things like motivation, attitude toward math, effort put forth in class, sickness, a death in the family, or previous educational experiences and biases. The study was not designed to measure these issues, and the college did not collect data to differentiate students who encountered any of these obstacles.

Finally, the study is based on a sample of students who self-enrolled in a college algebra course, either online or face-to-face. It is not a random sample of students at the institution. The participants of the study are community college students at one institution in rural Arkansas, so results cannot be generalized to a population located in an urban setting or different region of the country. This is in part due to socioeconomic differences, educational backgrounds, and internet access. Additionally, the geographic location is not representative of the United States population as a whole.

Summary

This chapter explored the ideas behind the study of whether course modality has a relationship with final grades for students taking college algebra at a rural community college in Northwest Arkansas. Enrollment in online courses has steadily risen since the early 2000s and became the norm for all students in higher education, particularly since almost every post-secondary institution eliminated in-person classes at the onset of the COVID-19 pandemic. This study attempts to add to the literature regarding the efficacy of online education and determine if a gap exists between traditional and online delivery. Definitions of important terms were provided and a breakdown of the five main research questions was provided. An explanation into the scope and limitations of the study was also discussed.

Chapter 2

Review of Literature

The aim of this chapter is to provide an overview of the literature on the relationship between course modality and learning outcomes in college algebra. Course modality refers to a course taught using either in-person (face-to-face) or online learning methods. The chapter begins with a brief look at community colleges and their function as a bridge between high schools and colleges and universities. What follows is a discussion of the traditional college algebra modality and its transition from lecture-based instruction to student-focused learning during the growth of online instruction. A brief analysis of academic performance in algebra follows along with an examination of how instructors may influence that performance. Finally, Moore's Theory of Transactional Distance is reviewed along with empirical research that informs the hypotheses of this study.

The search strategy began by searching the Ebsco, ProQuest, and Google Scholar databases for sources on the relationship between course modality and student outcomes across multiple disciplines and then narrowing down to outcomes in college algebra specifically. As the studies were examined, more sources materialized, creating a "snowball" effect where each source produced 3-5 additional articles or dissertations to investigate.

Most studies proved inconclusive as no obvious relationship between course modality and final grades emerged. (Amro et al., 2015; Francis et al., 2019). Some studies found online coursework to be most effective while others concluded face-to-face to be the more effective modality. Others found no significant difference between modalities. Table 1 provides a summary of findings:

Table 1. Comparison of Findings Across Multiple Disciplines 2007-present

Year	Author(s)	Modality Findings
2007	Bennett et al.	No Difference
2010	Burch & Kuo	Online
2011	Campbell et al.	Online
2011	Wagner et al.	No Difference
2011	Ary & Brune	No Difference
2011	Ashby et al.	Online
2012	Driscoll et al.	Face-to-Face
2012	Huang	No Difference
2013	Sharma et al.	Face-to-Face
2013	Araeipour	No Difference
2013	Hatcher et al.	No Difference
2013	Johnston	No Difference

Year	Author(s)	Modality Findings
2014	Amro	Face-to-Face
2014	Xu & Jaggars	Face-to-Face
2014	Johnson & Cuellar Mejia	Face-to-Face
2015	Amro et al.	Face-to-Face
2015	Wladis et al.	Face-to-Face
2016	Harrington et al.	No Difference
2017	Jackson-Smith	Face-to-Face
2018	Graham & Lazari	Online
2018	Hart et al.	Face-to-Face
2019	Arviso	No Difference
2019	Francis et al.	Face-to-Face
2020	Milz	No Difference

It is important for community colleges to understand the relationship between course modality and learning outcomes as increasing numbers of students are enrolling to fulfill general education requirements to transfer to four-year institutions. There's also a trend of students taking college algebra as a concurrent course, fulfilling both high school and college requirements. While it may seem the relationship between modality and final grades is a quandary, an examination of these studies within the framework of Moore's Theory of Transactional Distance provides a clearer picture.

College Algebra in the Community Colleges

College algebra has been engrained in the curricula at colleges and universities since the late 18th Century (Tunstall, 2018). It was initially taught as a gateway to calculus (Herriott & Dunbar, 2009), but developed into a prerequisite course for most degree-seeking students, even if the students had no intention of ever taking calculus (Gordon, 2018; Tunstall, 2018). Heriott and Dunbar (2009) looked at data from the University of Nebraska and concluded only about 40% of

college algebra students ever enrolled into a calculus course. Both Anderson (2006) and Reyes (2008) surmised a significant number of students only enroll in college algebra to fulfill a course requirement, and one study noted passing the course had a positive impact on graduation rates (Calcagno et al., 2006).

According to Gallo and Odu (2009), community college students enroll in college algebra courses as members of one of three groups: Science, Technology, Engineering, and Math (STEM) majors; business majors; or liberal arts majors. Liberal arts students take college algebra to satisfy a degree requirement and will likely never enroll in another math course.

A course originally formatted as a gateway to calculus became a gatekeeper course. A gatekeeper course is a required course in a curriculum that is foundational, has high enrollment, traditionally low pass rates, and serves as a barrier to degree completion (Hayward & Willett, 2014; Koch, 2017). Flanders (2017) found that first-year students who didn't complete a gateway course in the fall semester were less likely to enroll in the spring semester. This corresponds with Zhang's finding that early academic success increases the likelihood of degree completion for STEM students (2019). Since college algebra is required for many majors, students that can't pass the algebra requirement are unable to fill the degree requirements to graduate (Stuve, 2015).

Nearly a third of all undergraduates in the United States are enrolled at a community college, making it an important area of higher education to study (Community College Research Center, 2020). Among graduates who completed a four-year degree in 2015-2016, half attended a community college within the previous ten years (NSC Research Center, 2017). Community colleges come with their own sets of challenges including low graduation rates, decreased enrollment numbers, and the stigma of providing less quality than traditional colleges and universities (Holland, 2015).

Part of the struggle for two-year colleges stems from the original mission of community colleges to provide access to higher education for a wider range of students including minority, non-traditional, and low-income (Gregory & Lampley, 2016). Additionally, open-enrollment admissions policies and acceptance of less-academically prepared students magnify the gatekeeper effect of college algebra. Open enrollment means there are no required test scores, so underprepared students are more likely to enroll in community colleges than at four-year colleges or universities (Calcagno et al., 2006).

Traditional College Algebra Modality

Traditionally, college algebra was taught in a lecture format that stressed the memorization of formulas (Wynegar & Fenster, 2009; Gordon, 2018). This method required both students and instructor to convene at a centralized location and interact face-to-face (Klein et al., 2006). Courses were taught at one standard level under the assumption that all enrolled students had the necessary mathematical background to understand and apply concepts (Özyurt et al., 2013).

These assumptions no longer apply to modern students. While the long-established course structure worked for some learners, it failed to account for how some students learn (Bransford, 2000). Community colleges are concerned because increasing numbers of students are taking college algebra but are unable to complete or pass the course. Part of the reason is students are leaving high school underprepared for college mathematics. High schools have focused more on conceptual understanding of algebraic concepts and lean on technology to work through problems (Gordon, 2018).

In 1995, The American Mathematical Association of Two-Year Colleges released new standards for college math called Crossroads Standards. At the time, nearly 60% of students

enrolled at two-year colleges were taking remedial math (Cohen, 1995). A dozen years later, the Mathematical Association of America (MAA) created a committee to identify issues facing college algebra students and to recommend improvements to the curriculum. It sent requests to 1800 mathematics departments across the United States to ask for input in reimagining the course. Over 200 departments responded and 11 were chosen to assist the committee (Tunstall, 2018). Both organizations advocated for a change in teaching strategies away from traditional memorization to make algebra more relevant to learners by including real-world problem solving and a heightened focus on quantitative literacy (MAA, 2007, 2018). While college algebra transitioned and updated its curriculum, higher education was going through a transition of its own.

Distance Learning in the United States

Distance learning in the United States began in 1728 when Caleb Phillips placed an advertisement in the Boston Gazette for an informal "correspondence education" (Ferrer, 2019). Researchers at the University of Tübingen in Germany conceived the idea of "distance education" in the 1960s while applying business and manufacturing principles to education. They called it fernstudium, meaning "distance study" (Moore, 2019). Distance learning can be defined as any learning that occurs when the instructor and students are separated by time or location (Rybarczyk, 2007). Distance learning took many forms including mail, phonograph records, radio and television broadcasts, audio recordings, video tapes, and finally computers (Ferrer, 2019). In 1993, the number of students taking at least one online course was 570,000. By 2013, that number soared to over 6.7 million with a third of all students taking at least one online course (Allen & Seaman, 2013). In 2019, over 6.9 million students were enrolled in at least one online course at the postsecondary institution (NCES, 2019). During the COVID-19 pandemic in

2020, nearly all colleges abruptly moved their courses out of the face-to-face setting (Miller, 2021). Due to differences between asynchronous online courses and synchronous remote courses, it is unclear how many students enrolled in online courses versus remote courses during the pandemic.

Online learning is different from distance learning because most or all of the content is delivered online with no face-to-face (F2F) meetings (Allen & Seaman, 2013). Singh and Thurman (2019) clarify the definition in their literature review of the subject, noting students are not dependent on the physical or virtual location, and instructors are actively developing teaching models and strategies to enhance learning in either the synchronous or asynchronous environment. For the purpose of this study, synchronous learning occurs when instructors and students communicate in real time, and asynchronous learning occurs when interaction between instructors and students happens at different times. This can be through blogs, discussion boards, or email (Chen et al., 2005).

Academic Performance in College Algebra Across Modalities

The final grade is the most common measurement in the community college environment. The grade is usually calculated by compiling results from assignments and exams in a single class. In large classes, homework and tests are usually assessed through multiple choice, true/false, and short-answer questions (Lewis, 2019).

As noted earlier, a large proportion of college students at both the community college and university level must take college algebra to fulfill degree requirements. College Algebra has historically experienced low pass rates with only about 50 percent of students earning an ABC grade (Ganter & Haver, 2011). Reasons for this include a lack of prerequisite knowledge of basic concepts, poor curriculum design, or disengaging material. The principal issue is students'

inability to master the material (Stuve, 2015). This is problematic because students who cannot pass required coursework, cannot graduate.

Concerns over student success drove organizations such as MAA to alter curriculum from standardization to customization. The instructor-led model shifted to a learner-centered model (Reigeluth & Carr-Chellman, 2009). Instead of students focusing on memorization, course objectives changed to help students become comfortable with problem solving, analysis, and critical thinking within the framework of mathematics (Warren, 2018). An emphasis was made to register students in appropriate-level courses. Students are generally enrolled into courses based on scores from a placement exam such as the SAT, ACT, or Accuplacer (Little, 2002).

Researchers took interest in the variables that contributed to student success in algebra. Little (2002) concluded the greatest predictors of success (in order) were: college GPA, mathematics perquisite status, gender, attitude toward the subject, ethnicity, and instructor. Another study looked at the relationship between a student's growth mindset and achievement and found that mindset didn't affect mean final exam scores, but it did reduce failure and withdrawal rates (Lewis, 2019).

Gallo and Odu (2009) explored whether F2F college algebra courses were more effective in the morning versus the evening and discovered class schedules could account for almost 10% of the variance in final exam scores. Another study looked at course lengths but concluded no significant difference between 8-week and 16-week courses (Reyes, 2008).

More recent research has focused on technology in college algebra. All of the major textbook publishers include online supplemental material into their offerings. Pearson's My Math Lab, McGraw Hill's ALEKS, and Cengage's Mindtap all incorporate adaptive learning into their lessons. Adaptive Learning modules are "Web-based application programs that provide a

personalized learning environment for each learner by adapting both the presentation and the wandering in content." (Özyurt, et al., 2013, p. 726). If a student gets a question wrong, the software triggers a response showing the learner where the mistake was made and presents a new question for the learner to demonstrate mastery of the concept. Some research concludes that learners who use adaptive learning material earn significantly higher grades than learners who do not (Stuve, 2015).

The idea that software could teach students college algebra was first tested by Lazari and Simons (2001) at Valdosta State. Instead of a traditional lecture, students were taught using computer software that was mailed to students on compact discs. The software's effectiveness proved inconclusive. For some sections, differences in final exam grades were not statistically significant. For the two sections that did show significant differences, one section scored higher with traditional lectures, while the other scored higher using the software.

Over the next decade, research monitored the increasing effectiveness of computer software in assisting students with homework and exams in online coursework. Bonham, Beicher, and Deardorff (2001) looked at the efficacy of the program WebAssign and learned online student test grades beat traditional students by five percentage points, 82% compared to 77%. Two years later, Hirsch and Weibel (2003) found students using the open-source software WeBWorK scored 4% higher than their traditional counterparts. A 2006 study concluded online college algebra students completing web-based assignments did just as well as traditional students (Safer & Segalla, 2006). Finally, Burch and Kuo (2010) determined online students did better on homework than traditional students when using Pearson's CourseCompass software. They attributed the success to multiple attempts, hints when students encountered barriers, and

instantaneous feedback. They also found online students outperformed face-to-face students on exams.

More recent research suggests technology does improve performance. Shahriari (2019) found that students who used technology such as graphing calculators and smartphone apps in college algebra courses scored higher than students who did not. Hauk and Matlen (2017) observed that community college students who used web-based activities and tests outperformed students who used pencils and paper.

Caution should be used in thinking technology can solve all the problems in college algebra outcomes. Applications such as Photomath allow students to snap a picture of a problem, typed or handwritten, and immediately reveals a step-by-step explanation of the solution to the problem (Photomath, 2022). This can be beneficial to understanding the problem but creates a temptation to cheat.

Student Performance in Algebra by Gender

There is a preconceived notion that women have less mathematic ability than men (Good et al., 2012). Part of this belief originates from studies conducted in the 1980s and 1990s that showed men outperformed women in standardized tests such as the SAT, ACT, or GRE (Smith & White, 2002). Interestingly, women achieve higher grade point averages in math and science than males yet still score lower in both the SAT and ACT (Erde, 2020).

One explanation of the disparity between men and women in math is due to women's lack of desire to pursue math-focused STEM careers (Good et al., 2012). Another explanation is that women are negatively affected by the stereotype that women are not as good at math. Research confirms that stereotypes can affect performance (Lu et al. 2015; Smith & White, 2002).

Smith and White (2002) designed a study to determine whether stereotypes affect results in testing situations. They conducted an experiment where undergraduate women were divided into three groups and asked to take a 10-question exam modeled after the math section of the GRE. A third of the participants were given no background information and took the test. The other two-thirds of the participants read a seemingly true, but concocted article asserting men outperform women in math due to biological differences. Half of those readers were told the researchers' own work found similar results. The other half were told the researcher's results showed no difference in math outcomes—an attempt to neutralize the stereotype. Next, the two groups completed the exam. Both groups that read the mock article affirming the stereotype scored worse than the group who did not.

With respect to online learning, research suggests women may be more engaged than men, and therefore, more successful (Chyung, 2007). These results correspond with other studies comparing students on the basis of gender (Alstete & Beutell, 2004; Chyung, 2007; Xu & Jaggars, 2013). In college algebra, Araeipour (2013) found no statistically significant differences in performance between men and women while Amro (2014) reported women outperformed men. Based on the literature, women should be expected to perform as well in college algebra as men or even outperform men based on increased classroom engagement.

Age as a Predictor of Performance

Community college students are typically older than their four-year-institution counterparts. In 2021, the average age of a community college student was 28, about two years older than the average university student (AACC, 2021). This is supported by research reporting older students more likely to graduate from community colleges (Bremer et al., 2013).

Students enrolled in online classes tend to be older than students in F2F classes (Bennett, 2007; Wladis, 2015). Online courses provide more access to education for adult learners, allowing them to manage jobs, family obligations, geographic barriers, and financial limitations (Huang et al., 2013; Jameson & Fusco, 2014).

Researchers disagree on whether adult learners perform better in online courses than F2F ones. Arghode, Brieger, and McLean (2017) hypothesized that adult learners would succeed in online courses because they tend to be more self-directed than traditional, 18- to 24-year-old students. Rabourn, BrckaLorenz, and Shoup (2018) found that non only are nontraditional students more likely to take classes online but are also more academically engaged. This goes hand in hand with Knowles's (1980) andragogy theory that suggests adult learners are more motivated, ready to learn, and prefer self-direction. Still, some research has shown adult learners perform worse online than in F2F courses (Park & Choi, 2009; Yoo & Huang, 2013).

Other studies found differing results, asserting age is a powerful predictor of student achievement due to increased time spent visiting the online classroom, reading discussion messages, and posting questions (Alstete & Beutell, 2004; Hoskins & van Hoof, 2005). Araeipour (2013) found older students outperformed 18- to 24-year-olds in online classes but scored lower in F2F classes. Coldwell et al. (2008) predicted younger students would not be disciplined or self-directed enough to be successful in online courses, but their results compared to non-traditional students were negligible. These findings were supported by Woods and Frogge (2017) who found that nontraditional students spent more time studying but no differences in course outcomes.

While comparing online and F2F formats, Spencer and Temple (2021) found age had no effect on course grades within each modality. However, an age interaction was observed when

coupling age and modality. Traditional students taking online courses were less likely to receive an ABC grade than if the same course was taken F2F. For nontraditional students, the opposite was true. Nontraditional students taking online classes were more likely to receive an ABC grade. This matched prior research by Slover and Mandernach (2018) who also observed an *age x modality* interaction

In college algebra, the longer removed from taking a math class, the more students struggle (Boylan, 2011; Jameson & Fusco, 2014). In an interview with Boylan, Paul Nolting put it best, "Think of math as a foreign language: If you do not use it, you will lose it" (Boylan, 2011, p.20). Another contributing factor is anxiety and the stereotype that older adults are not as adept as younger students in mathematics. Hollis-Sawyer reported higher levels of test anxiety and negative perceptions of their own abilities for undergraduates over the age of 40. Interestingly, the anxiety and negative stereotypes regarding older students showed no significant differences in math test performance, nor was there a gender interaction between ages (Hollis-Sawyer, 2011).

It seems older students have the ability to keep up and even surpass younger students, but they are facing different challenges including family and work obligations and being removed from a formal classroom setting. The equalizer is student engagement. The more engaged the student, the better the results. This idea is largely substantiated in Moore's Theory of Transactional Distance addressed later in the chapter.

Modality and Student Success

The question of whether modality affects student success has been asked by multiple researchers, but the answers vary. Young and Duncan (2014) found that instructors who taught both face-to-face (F2F) and online courses scored higher on student evaluation forms in the areas

of communication, student/faculty interaction, and overall score. The study didn't address student success.

A literature review by Amro, et al. (2015) regarding the relationship between modality and success reported mixed results. Thirteen studies found no statistical significance between online and traditional modalities. Seven studies reported online students significantly outperformed traditional students, and ten studies concluded the opposite.

More recent research uncovered similar ambiguous outcomes. Araeipour (2013) compared student grades in an algebra course taught by the researcher and found no significant differences. A study of incoming Science, Technology, Engineering, and Math (STEM) students who took an online summer algebra course had significantly higher pass rates than first-year students who took the same course with the same instructor in a traditional setting (Harrington et al., 2016). A review of student grades from a developmental math course in a Baltimore community college determined F2F students performed worse than online students (Ashby et al., 2011) whereas findings from a community college in south Texas showed the average grades of F2F students being higher than online students (Amro, 2014).

As online instruction continues to experience growth at colleges and universities, the need for research on how technology promotes learning in online environments continues (Warren, 2018). Most of what we know about teaching and learning comes from research in face-to-face settings (FitzPatrick, 2001). Even with the improved technology and resources available, online-math courses have higher drop rates than online courses in other disciplines, a phenomenon that is not matched in traditional settings (Warren, 2018). Students may drop because they don't have the math study skills required to learn the material (Boylan, 2011).

A review of studies conducted since 2010 comparing online with F2F courses in college algebra revealed no obvious verdict (see Table 2). Studies by Burch and Kuo (2010) and Graham and Lazari (2018) found online students performed better whereas Huang (2012), Araeipor (2013), Harrington et al. (2016), and Arviso (2019) found no difference between modalities. These findings are contrasted by findings from Amro (2014) and Amro et al. (2015) that F2F students performed better. There's no trend pointing to one modality being more effective than another.

Although course modality is important, it's not the only factor in student success. Another significant component is the instructor influence on student outcomes. In the next section, the influence of the instructor on academic performance is investigated along with the instructor impact on course modality.

Table 2. Comparison of Findings in College Algebra 2010-present

Year	Author(s)	Modality Findings
2010	Burch & Kuo	Online
2012	Huang	No Difference
2013	Araeipour	No Difference
2014	Amro	Face-to-Face
2015	Amro et al.	Face-to-Face
2016	Harrington et al.	No Difference
2018	Graham & Lazari	Online
2019	Arviso	No Difference

Instructor Influence on Academic Performance and Course Modality

In both traditional and online environments, students learn best when there are positive interactions with the instructor, other learners, and the course content (Hillman et al., 1994;

Keegan, 1990; Moore & Kearsley, 2005). Interaction is "the learner's engagement with the course content, other learners, the instructor, and the technological medium used in the course" (Thurmond, 2003, p. 4). Interaction is particularly important in the online setting. Online instructors must become facilitators, and interactions should be aimed at increasing student motivation to learn (Moore & Kearsley, 2005). Hirumi (2002) identified seven key instructor/learner interactions including: establishing learning outcomes and objectives, providing timely and appropriate feedback, facilitating information presentations, monitoring and evaluating student performance, providing learning activities, facilitating class discussions, and determining learning needs and preferences. Research points to frequent and constructive feedback being critical to student success and satisfaction (Gaytan & McEwan, 2007; Vaden-Goad, 2009; Zen, 2008).

Anderson et al. (2001) argued teaching presence is comprised of three components: design and organization, facilitating discourse, and direct instruction. Effective teaching presence starts before the course even begins in the instructional design phase. While designing the course, teachers become the learners, and the planning and organization drives the activities, assignments, and course discussions. During the course, the instructor adapts to situations and provides direct instruction when needed.

Another consideration is the relationship between teaching presence and student motivation and learning. Baker (2010) examined instructor immediacy and presence in online classes. Immediacy refers to verbal and non-verbal communication between an instructor and students. In F2F settings, these cues can be identified by voice inflection or body language. In online settings, the visibility of the instructor is reflected by interactions with students in the form of feedback on assignments, comments in online discussions, or emails. Instructors must be

"seen" to be perceived as present in an online class. Baker (2010) concluded instructor immediacy as a significant predictor of learning, cognition, and motivation.

Matika (2012) surveyed students and instructors in F2F and online courses for their perceptions on the factors that influence student success and found online students were generally satisfied with the amount of instructor interaction while instructors desired more interaction. Face-to-face students felt there was not enough instructor interaction even though F2F sections had better retention and final exam scores. This could point to differing expectations of online and F2F students.

Hosler and Arend (2012) found online students believed instructor presence influenced their critical thinking. The study measured student perceptions of instructional design, class discussions, and direct instruction in online and F2F courses. Students in both modalities indicated the most important factors to their success were an organized course with clear expectations, relevant assignments, timely feedback, and course discussions that kept everyone engaged. This is a far cry from the traditional role of an instructor as a subject matter expert lecturing on the course content.

When the instructor/learner connection is strong, student engagement increases. Student engagement can be described as students being on-task, participating in all classroom activities, actively interacting with the teacher, completing assignments on-time, and reflecting on learning (Gningue et al., 2013). When interactions between the student, instructor, course content, and other learners is poor, students lose interest or become bored. Uninterested students learn less and perform worse than their peers who are interested and actively engaged in coursework (Ismail & Groccia, 2018). This confirmed earlier research that indicated a significant, positive

relationship between perceptions of student interactions and perceptions of the quality of their learning (Piccino, 2002).

Timely feedback is another important factor in positive interactions. In traditional settings, feedback can be immediate through verbal or nonverbal expressions (Linton, 2014). Feedback can be defined as an exchange of information between a student and instructor that results in enhanced learning (Thurmond & Wambach, 2004). Online instructors have a different challenge. Asynchronous feedback is provided through methods such as email, discussion-board posts, text messaging, or comments attached to assignments, while synchronous feedback occurs during web conferences or live chats.

Zen (2008) argued effective feedback can take many forms. It should first and foremost be aimed toward facilitating learning. Feedback is more effective if the instructor is perceived as a participant or facilitator, rather than a knowledge provider. For example, if an instructor offers a personal experience related to the discussion, it is effective feedback.

Both traditional and online instructors can be assisted through the use of course software. All of the major college algebra textbook publishers offer software solutions. Adaptive learning, mentioned earlier, is an excellent way for students to master material since immediate feedback on correct and incorrect answers can be helpful for learning material (Burch & Kuo, 2010).

This is not to say computers and artificial intelligence (AI) are ready to replace instructors just yet. Hegeman (2015) studied student performance in a College Algebra and found that students introduced to content via instructor-created video lectures performed better than students who only had access to textbook publisher-created resources. Hegeman was both the instructor and researcher in the study, so there was potential for unintentional bias to occur.

Instructor influence in any course can be subjective. It seems safe to conclude it starts with a well-designed course that takes into consideration the needs of its students, whether the course is online or F2F. Additionally, instructors that assume the role of facilitator rather than lecturer have a better chance to improve student engagement and promote critical thinking. Finally, instructors need to provide timely feedback for students to learn from their successes and failures.

Theoretical Framework

This study is framed by Moore's Theory of Transactional Distance. Michael G. Moore was one of the first theorists to focus on distance education. He described Transactional Distance as a pedagogical concept rather than a physical separation between teachers and learners. Zhang (2003) noted the theory shifted the view of "distance" in distance education from a physical science perspective to a social science perspective. It is a relative concept that differs from individual to individual. "With separation there is a psychological and communications space to be crossed, a space of potential misunderstanding between the inputs of instructor and those of the learner. It is this psychological and communications space that is the transactional distance." (Moore, 1997, p.1). This fits nicely with the study because it focuses not only on the factors that influence academic performance but also incorporates instructor influence on academic performance.

The degree of transactional distance can be inferred based on the relationship between the structure of the course and the dialog within the course. The structure of the course is the design of the lesson or lessons based on learning objectives, materials, textbooks, presentations, activities, and assessments formulated prior to the start of the class (Moore, 2019). Dialog is the constructive interaction between the student and instructor. As the instructor communicates, the

learner actively engages and responds. The conversation builds to the point where knowledge is transferred (Moore, 2019). "It should be clear that the extent of the dialogue and the degree of structure varies from course to course" (Moore, 2019, p.71). Figure 1 shows the relationship between structure and dialog and their effect on transactional distance.

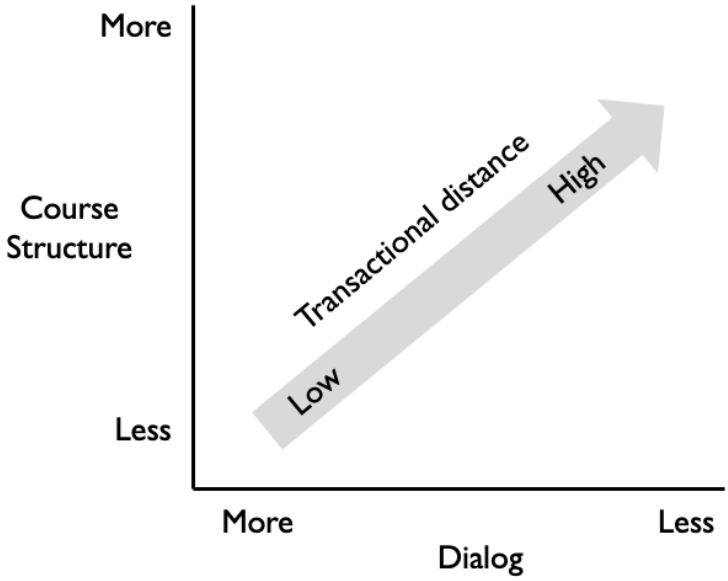

Figure 1. Relationship Between Course Structure and Dialog in Transactional Distance

Courses designed with low transactional distance, i.e., more dialog and less structure, allow modifications to satisfy the needs of the class. Interactions between the instructor and learners are ongoing and the pace can adjust based on students' understanding of the material (Moore, 2019). Conversely, self-directed learners may prefer a structured course allowing students to navigate material at their own pace. "In other words, the greater the transactional distance, the more learners have to exercise autonomy" (Moore, 2019, p.73). It is possible that self-directed learners choose online courses for this very reason.

Arguments have been made against comparing modalities under the assumption that only the instructor and materials matter. Surry & Ensminger (2001) cautioned against media comparison studies because mediums are simply a way to deliver information and no medium (or

modality) is inherently better or worse. They built on Clark's (1983) idea that only content matters. When a delivery truck transports food to grocery stores, the truck is not responsible for whether or not the food is healthy or unhealthy. Course modalities should be treated accordingly. The problem with this reasoning is that some research has shown that course modality does matter. Both students and instructors have personal preferences for F2F and online courses and almost no one views them interchangeably. Perhaps the role of the instructor is to not only deliver content but reduce transactional distance. This study attempts to account for transactional distance by using one instructor using the same course materials for both online and F2F classes.

In 1998, Moore followed up on his theory by identifying three interaction modes that bridge the gap in Transactional Distance. He called these: Learner-Content, Learner-Instructor, and Learner-Learner.

Learner-Content is the most important interaction because if there is no content, there is nothing to learn. Content can be delivered in the form of print or electronic textbooks, online videos, labs, simulations, online or group discussions, or games. Online access makes it possible to deliver content inexpensively and to scale (Hodges et al., 2020). Research supports the idea that increased interactions between the learner and content results in better understanding of the material (Gunawardena & Boverie, 1993; Hirumi, 2002; Thurmond & Wambach, 2004).

In Learner-Instructor interactions, the instructor plans the curriculum to be covered in a manner that stimulates student interest. Material is presented to students to identify goals, demonstrate skills, provide examples, answer questions, and provide support (Mortera-Gutierrez & Murphy, 2000). The most valuable interactions from the instructor come from timely feedback so students can apply learning promptly and gain understanding (Moore & Kearsley, 2005). Thurmond and Wambach (2004) found prompt feedback increases student satisfaction. Wheeler

(2002) proposed online students might expect less academic support due to their own independent-learner status while face-to-face learners may demand less social and practical support due to a lower transactional distance between themselves and the instructor.

Learner-Learner interactions occur between members of the class. These can take place in live settings, web conferences, discussion boards, emails, text messages, or study groups. Students can "work together to analyze and interpret data, solve problems, and share information, opinions, and insights" (Hirumi, 2002, p.145). Research demonstrates that students in STEM disciplines who work in small groups perform better and develop more favorable attitudes toward learning than students working alone (Springer et al., 1999). "Findings regarding learner-learner interaction indicated that students who interacted more in a web-based course may perceive greater learning" (Warren, 2018, p.33). Zhang (2003) developed an instrument to measure transactional distance and reported Learner-Learner (identified in the study as TDSS, transactional distance between student and student) as the strongest factor in decreasing transactional distance. Interestingly, Zhang's least influential factor was Learner-Content, contrasting findings by Cho (2011), Gunawardena and Boverie (1993), Hirumi (2002), and Thurmond and Wambach (2004).

Hillman, Willis, and Gunawardena (1994) added a fourth interaction to Moore's theory, Learner-Interface, sometimes referred to as Learner-Technology (Mortera-Gutierrez & Murphy, 2000). This delineates the manner in which students interact with technology and how it impacts learning (Hillman et al., 1994). Although reflected in the literature, the Learner-Interface may have a negligible impact on interaction since most American learners are comfortable with technology (Chen, 2001; Cho, 2011; Okonta, 2010). Clouse (2001) noted that the transactional distance in an online MBA course was lower in a live chat and higher in a threaded discussion.

Note that the studies citing Learner-Interface occurred when online technology was relatively new and fewer students had experience attending class with computers.

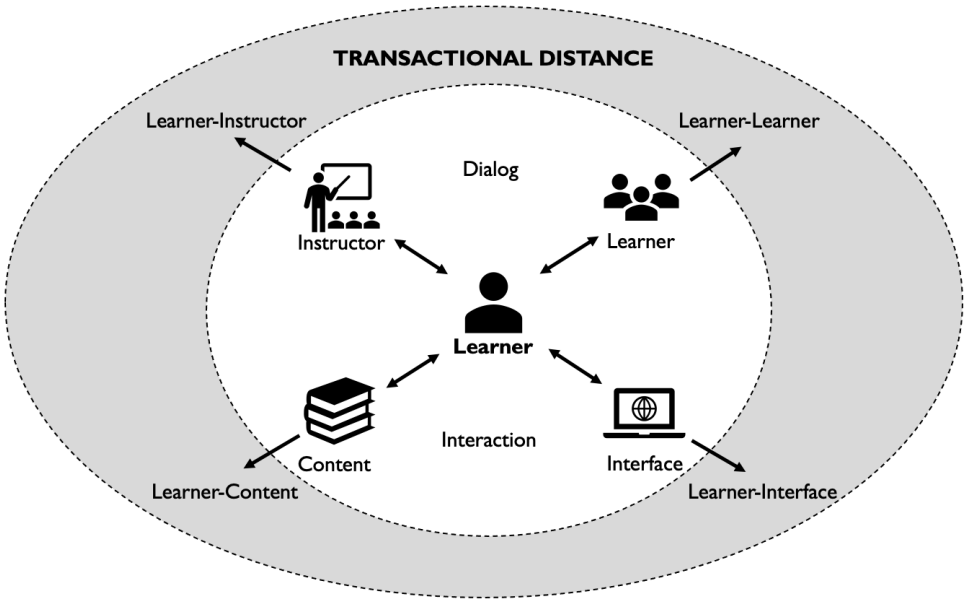

Figure 2. Transactional Distance and the Four Interactions

Cho (2011) studied the impact of the four types of interaction in online courses to identify the relationship among the different types of interaction and student satisfaction. Learner-Content was the most significant interaction, predicting 54% of student satisfaction, followed by Learner-Instructor and Learner-Learner. "This study revealed no statistically valid relationship between learner-interface interaction and learner satisfaction; however, it is still true that the use of technologies, including hardware and software, play a pivotal role in the online class" (Cho, 2011, p.121).

In Moore's own literature review on transactional distance, he points out the theory usage has become mainstream in the field, and as a result, is sometimes not properly cited (Moore, 2019).

Prior to addressing the theoretical framework, the literature failed to point to any conclusion as to whether online or F2F outcomes are better for students (see Tables 1 & 2). Since this study is ex-post facto, meaning the data exists already, I looked for variables that fit into the

theory of Transactional Distance to see if any trends emerged. The results were encouraging. Revisiting the data from Table 2 and accounting for instructor (Learner-Instructor) and course materials (Learner-Content), a different story emerges.

Table 3. Comparison of Findings in College Algebra 2010-present, Controlling for Instructor and Materials

Year	Author(s)	Modality Findings	Control for Instructor?	Control for Materials?
2010	Burch & Kuo	Online	No	No
2012	Huang	No Difference	Yes	Yes
2013	Araeipour	No Difference	Yes	Yes
2014	Amro	Face-to-Face	No	No
2015	Amro et al.	Face-to-Face	No	No
2016	Harrington et al.	No Difference	Yes	Yes
2018	Graham & Lazari	Online	No	No
2019	Arviso	No Difference	No	Yes

Among studies where the researcher controlled for course materials, there was no difference in student outcomes (Araeipour, 2013; Arviso, 2019; Huang, 2012). Arviso (2019) used archived data from 600 students studying at a university in New Mexico. The research controlled for materials, but not instructor.

Studies that did not control for instructor or course materials we unable to determine which modality contributed to student success with Amro (2014) and Amro et al. (2015) concluding F2F classes more effective and Burch and Kuo (2010) and Graham and Lazari (2018) finding online courses more effective. These findings drove my hypotheses in the next section.

Hypotheses

The study attempts to answer five research questions related to the relationship between course modality and a student's final grade percentage after accounting for instructor and course materials. The course modalities compared are face-to-face and asynchronous online courses taken between Fall of 2018 and Fall of 2019.

These hypotheses are predicated on the idea that online courses have similar constructive interactions between the students and the content, instructor, and other learners. Online courses don't allow students to show up for class and sit in the back of the room. Learners are required to self-direct and learn the material during times convenient to the student. Many online classes require weekly discussions from students, but it is not clear whether this is a requirement in a college algebra course.

Research Question 1: After accounting for instructor and course materials, what is the relationship between course modality and final grade percentage for students taking college algebra at a rural community college in Arkansas?

Research Hypothesis H.1: Learners who take online courses achieve at least the same grade percentages as students in face-to-face courses.

Research Question 2: Do final grade percentages in college algebra differ by gender, after accounting for course delivery method?

Research Hypothesis H.2: Men achieve higher grade percentages than women.

Research Question 3: Does a student's gender influence the relationship between course modality and course grades?

Research Hypothesis H.3: For women, online learning is associated with higher grades. But for men, online learning is associated with lower grades.

Research Question 4: What is the relationship between a student's age and the final grade percentage earned in a college algebra course, after accounting for course delivery method?

Research Hypothesis H.4: Younger learners achieve higher grade percentages than older learners.

Research Question 5: Does a student's age influence the relationship between course modality and course grades?

Research Hypothesis H.5: For younger students, online learning is associated with lower grades. But for older students, online learning is associated with higher grades.

Summary

This study examined the ongoing research regarding the relationship between course modality and student outcomes in college algebra with special attention paid to studies conducted in the past two decades. Distance education in the United States is becoming a greater part of most students' academic experience, and this is particularly true in community colleges. Since the COVID-19 pandemic forced distance education on nearly every educational institution in the United States, there may be a tendency to pursue more online programs for their ability to provide education to students at scale. Considerations must be made to ensure student academic needs are met, especially in gateway courses like college algebra.

The studies in this chapter provide insight for which variables most impact college algebra students' final grades, namely engagement and interactions. Within Moore's theoretical framework of Transactional Distance, it seems communication between the student and instructor and the student and content are paramount to success. Instructor presence seems to have a strong influence on students' perceptions about motivation and success in a course

(Baker, 2010; Matika, 2012) as well as critical thinking (Hosler & Arend, 2012). Anderson et al. (2001) asserted that instructor presence begins with the design and organization of the course and the planning involved choosing appropriate course materials and activities to promote learning. This is supported by multiple studies that found interactions between student and content the most important factor for student success (Cho, 2011; Gunawardena & Boverie, 1993; Hirumi, 2002; Thurmond & Wambach, 2004).

I expected to find multiple studies pointing to one or two variables showing a relationship between course modality and student outcomes, but nothing emerged until accounting for instructor and course materials. Reading through the literature increased awareness of my own shortcomings in creating usable research.

It appears modality is secondary to content. Clark (1983) and Surry and Ensminger (2001) surmised over twenty years ago that no modality is superior or inferior to another. All that matters is the information being conveyed. The information needs to be shared in a matter that reduces Transactional Distance and encourages student engagement. My hope is this study continues to make the case so more emphasis can be placed on other areas that contribute to student success.

Chapter 3 Methodology

Introduction

This study attempts to determine the association between course modality and final grade percentages, after accounting for both the instructor and course materials. In doing so, it focuses on students taking college algebra at a rural community college in Arkansas. Further analysis seeks to determine whether the effects of course modality differ based on the gender or age of the student. The study will be performed using quantitative methods within a causal-comparative design using data captured by the school.

This chapter outlines the study's methodology. It begins with a summary of the research questions and corresponding hypotheses. It then details the study's design, including the setting, participants, and sampling process. Next it describes the proposed data used and the measures used to test this study's hypotheses. Finally, it discusses how the design addresses threats to internal and external validity.

Research Questions and Hypotheses

Research Question 1: After accounting for instructor and course materials, what is the relationship between course modality and final grade percentage for students taking college algebra at a rural community college in Arkansas?

Research Hypothesis H.1: Learners who take online courses achieve at least the same grade percentages as students in face-to-face courses.

Null Hypothesis: $H0: b1 = 0$

Alternative Hypothesis: $HA: b1 \geq 0$

Research Question 2: Do Final grade percentages in college algebra differ by gender, after accounting for course delivery method?

Research Hypothesis H.2: Women have lower grade percentages than men.

Null Hypothesis: H0: $b2 = 0$

Alternative Hypothesis: HA: $b2 < 0$

Research Question 3: Does a student's gender influence the relationship between course modality and course grades?

Research hypothesis H.3: For women, online learning is associated with higher grades. But for men, online learning is associated with lower grades.

Null Hypothesis: H0: $b3 = 0$

Alternative Hypothesis: HA: $b3 > 0$

Research Question 4: What is the relationship between a student's age and the final grade percentage earned in a college algebra course, after accounting for course delivery method?

Research Hypothesis H.4: As age increases, grade percentage decreases.

Null Hypothesis: H0: $b4 = 0$

Alternative Hypothesis: HA: $b4 < 0$

Research Question 5: Does a student's age influence the relationship between course modality and course grades?

Research hypothesis H.5: For younger students, online learning is associated with lower grades. But for older students, online learning is associated with higher grades.

Null Hypothesis: H0: $b5 = 0$

Alternative Hypothesis: HA: $b5 > 0$

Methods

Study Design

This cross-sectional study will use a causal-comparative design. The design is appropriate for comparing two intact groups of students after an event already occurred (Cresswell, 2018) and to determine the relationship between any differences that emerged (Fraenkel et al., 2012).

The study will examine data gathered from courses previously completed at a community college in Arkansas. Enrolled students chose their specific course section, but only student records from the same college algebra course, MAT-1223 College Algebra, taught by a single instructor who taught both online and face-to-face courses in the same semester will be examined. Additionally, course materials in all sections must be identical, including textbooks and supplemental materials. Approximately 130 records are expected to be analyzed.

Setting

The rural community college used in this study is located in north Arkansas, serving a local population of around 13,000 and a county population of just over 37,000. The majority of coursework is offered at its North or South campuses, but there is also a remote location 30 miles northwest of the main locations. Students also have the ability take courses online. It is one of 22 community colleges in Arkansas and ranked as the most affordable in the state (Community College Review, 2021).

Total enrollment at the college was 1815 in 2018 with an average age of 23.5 years and a median age of 19 years. (North Arkansas College, 2018). The ethnicity breakdown was as follows: 84% White, 8% Hispanic/Latino, 5% multiracial, 1% Asian, 1% Unknown, and <1% Black or African American. Forty percent of students were men while sixty percent were women (US News, 2019).

Participants and Sample Selection

The participants selected for the study self-enrolled into the specific section of the MAT-1223 College Algebra course. Eligible records had to meet the following criteria: The student had to be enrolled in an online or face-to-face section of MAT-1223, College Algebra, taught by a single instructor using identical course materials for both sections. The sample was a convenience sample gathered from the college's database. Since college algebra is a required course for all students in associate of science or business programs, the demographics for college algebra was similar to demographics of the student population.

Students enrolled into MAT-1223, College Algebra, had to successfully complete and earn a C or higher in either Foundations of Algebra (CP-0933) or Applied Algebra Career & Tech (MAT-1123), or they had score at least a 21 on the Math section of the ACT (American College Testing) or a 255 on the Accuplacer placement exam (North Arkansas College, 2020).

The required sample size was determined by an a priori G*Power 3.1 power calculation using the following inputs: Linear multiple regression, fixed model, R2 deviation from zero, five predictors, medium effect, and .05 type-1 error probability. At least ninety-two participants are required for the study (Faul et al., 2009).

The instructor chosen for this course taught college algebra at the participating school since 2010. The instructor used a “student-centered classroom” approach since 2016 where students began each section with a preparation activity that covered important definitions and algorithms. Next, a brief lecture would cover examples and applications. Finally, students would practice problems with their peers in class where the instructor could assist if needed. This approach was used for both online and F2F sections (See Appendix C for a copy of the syllabus used for both online and face-to-face sections). Additionally, student workbooks were created for

the course comprised of lecture guides for each lesson. Video lectures for each lesson were also posted on the LMS.

Materials

Data will be gathered from institutional data provided by the participating college from courses completed from Fall 2017 and Spring 2018 semesters. All records eligible for the study will be used to avoid intended or unintended bias from the researcher.

Measures

This study will use one dependent variable, three independent variables, and two moderating variables. This section identifies and defines each of the variables in detail.

The dependent variable is the final grade percentage earned in a college algebra course based on a scale of 0-100%. The final grade percentage will be retrieved from institutional data collected by the college.

The first independent variable is course modality. The study only uses two levels: face-to-face (F2F) or online. The F2F learning method occurs when students and faculty meet at a centralized location and interact in-person (Klein et al., 2006). This study assumes that students and the instructor in the F2F setting met bi-weekly in a classroom on the college campus based on the class schedule. This assumption will be confirmed with the instructor that classes did meet F2F during the semester. It is possible that students communicated with the instructor through the Learning Management System (LMS) or via email to turn in assignments, ask questions outside of class, or complete exercises or assignments online. Online learning occurs when content is delivered online with no face-to-face class lectures (Allen & Seaman, 2013). For the purpose of this study, online students completed 100% of the course online and did not meet

with the instructor in person with the exception of possible face-to-face meetings during the instructor's office hours.

Some research identifies a third level, a hybrid course. Hybrid courses are defined as having 30-80% of the course content delivered online while the rest is delivered face-to-face (Allen & Seaman, 2013). Since these courses are not offered at the participating college for college algebra courses, this level was ignored.

The second independent variable is gender, either man or woman. Student demographics at the college do not include categories outside of men and women, and students were not given the option to self-identify for this study since the data will be gathered after the course was completed. Gender was treated as a binary variable.

The final independent variable is the age of the student measured in years. This is a continuous variable ranging from ages 14 to 50.

Data Analysis

The study uses the general linear model to construct multiple linear regression models on the data. Multiple linear regression is appropriate since outcomes are predicted by a combination of two or more predictor variables (Field, 2017). This study seeks to find the relationship between the predictor variable, course modality (online or F2F classes) and an outcome variable, final grade percentage.

Field (2017) offers four assumptions that must be applied to the general linear model in social sciences. They are additivity and linearity, normality, homoscedasticity/homogeneity of variance, and independence.

Additivity and linearity means the equation accurately shows a linear relationship between the predictors and the outcome variable and the combined effect of multiple predictors

is best described by adding their effects together. If this assumption is not met, the model would be invalid. Since this study contains multiple variables of modality, gender, and age, the combined effect of the variables on final grade percentages can best be explained by adding their effects together.

Normality denotes a normal sampling distribution of the outcome variable (dependent variable or residual). According to the central limit theorem, the distribution of sample means will approximate a normal distribution (like a bell curve) as long as there are enough samples. A minimum sample size of 30 is considered sufficient for the central limit theorem to hold, but as more variables are added, the number of required samples increases. This study calls for a data size of 92 or more samples, verified by a G*Power 3.1 calculation (Faul et al., 2009).

Homoscedasticity/homogeneity of variance assumes the variance around the data points are roughly the same for all data points and are stable around all levels of the predictor value. This is generally tested with a scatterplot.

Finally, independence means observations are independent of each other. In this study, the final grade percentage of one student is not based on the score of another student.

For the general linear model to work in this study, these four assumptions need to be met. If any of the assumptions are violated, the results will be erroneous.

Main-Effect Model

The main-effect model (Model 1) is:

$$Y = b0 + b1(online) + b2(woman) + b4(age)$$

This model addresses Research Questions 1, 2, and 4:

1. After accounting for instructor and course materials, what is the relationship between course modality and final grade percentage for students taking college algebra at a rural community college in Arkansas?

2. Do Final grade percentages in college algebra differ by gender, after accounting for course delivery method?

4. What is the relationship between a student's age and the final grade percentage earned in a college algebra course, after accounting for course delivery method?

Multiple linear regressions were run using IBM's SPSS software version 28 (IBM, 2017).

The next step is to determine if interactions existed after accounting for the independent variables, gender and age. Interactions are “the combined effect of two or more predictor values on an outcome” (Field, 2017, p. 495). To do this, two additional models were created.

Model 2 looks at the interaction between gender and modality:

$Y = b0 + b1(online) + b2(female) + b3(online \times female) + b4(age)$

This model answers research question 3:

3. Does a student's gender influence the relationship between course modality and course grades?

Model 3 looks at the interaction between age and modality:

$Y = b0 + b1(online) + b2(female) + b4(age) + b5(online \times age)$

Model 3 answers research question 5:

5. Does a student's age influence the relationship between course modality and course grades?

Figure 3 (below) outlines the variables and interactions for all three models.

Data w	X_1 Online	X_2 Sex	X_3 Online x Female	X_4 Age	X_5 Online x Age
b_0	b_1	b_2	b_3	b_4	b_5
	Level 1 Lower-order effect	Level 1 Lower-order effect	Level 2 Interaction	Level 1 Lower-order effect	Level 2 Interaction
	Categorical	Categorical	Categorical	Continuous	Categorical
	Dummy Code: 0 = Face-to-Face 1 = Online	Dummy Code: 0 = Male 1= Female		Dummy Code: None	
	b_1 (online)	b_2 (female)	b_3 (online x female)	b_4 (age)	b_5 (online x age)

Figure 3. Variables for Main-Effect Model

Validity

Salkind (2008, p. 995) defined validity as "the extent to which empirical evidence and theory lend support to the interpretation and inferences made about particular uses." Essentially, the study needs to accurately assess what the researcher is attempting to measure. There are both internal and external threats to validity in a particular study.

Internal validity is the degree or approximate truth to which a study demonstrates a causal relationship (Trochim, 2020). Creswell identifies internal validity threats as procedures or treatments that hamper a researcher's ability to draw correct conclusions about a study. Common internal validity threats include: Confounding Variables, History, Maturation, Regression to the mean, Selection, Mortality. Diffusion of Treatment, Compensatory Rivalry, Testing, and Instrumentation (2017). For the sake of this study, only internal threats that are applicable to the study will be detailed.

The largest internal threat to this study would be a confounding variable, a third variable not part of the study that has a relationship with both the independent and dependent variables and is unaccounted for (Glen, 2020). Potential confounding variables could be incoming high school GPA or student IQ. High school GPA information would be appropriate to gather if all

students in the study were fresh out of high school, or at least out of high school for the same amount of time. Since some students graduated high school within a year or two of taking College Algebra while others may have graduated 10-15 years prior, high school GPA was unsuitable for the study. Student IQ is not gathered by the college, and the data were gathered a year after the courses were complete, so there was no way to minimize this threat. Based on this logic, it was also impossible to distinguish between learners who may prefer online or F2F courses for reasons other than convenience. In a perfect world, being able to control for these confounding variables would be ideal. I could gather random samples to eliminate selection bias. Unfortunately, this isn't possible since the data were collected from a data set without the potential confounding variables.

External validity is whether the conclusions of a study can be applied to a population outside the context of the particular study (Trochim, 2020). It involves making general conclusions about a larger population. For this study, the obvious external threat is the study was conducted at a rural community college in Arkansas. The population was racially homogeneous, made up of almost 85% white students. Conclusions from this study cannot be generalized to community college students in urban environments or to students at four-year universities. Multiple studies would need to be conducted to conclude the results hold true at the participant community college.

Summary

This section delineated the cross-sectional study used to determine the relationship between course modality and final grade percentage at a rural community college in Arkansas. The research questions were revisited and matched with corresponding substantial and statistical hypotheses. The causal-comparative design of the study was described in detail along with the

participants and setting for the study. Additionally, each variable was defined and explained and specifics for how the data were managed was provided. Finally, internal and external threats to validity were identified and explained to strengthen the study's reliability.

Chapter 4

Findings

The purpose of this study was to examine the relationship between course modality and final grade percentages for students taking college algebra at a rural community college in Arkansas. This chapter describes the dataset and presents the findings by research question and hypothesis. I conclude with a brief summary.

Data Demographics

Participants were drawn from a rural two-year community college in Northwest Arkansas. The study examined final grade percentages of five sections of college algebra (3 face-to-face and 2 online) taught by one instructor using identical course materials over the 2017-2018 school year. Data for this convenience sample were supplied by the participating college. Initially, 106 participants were chosen, but once students who withdrew from the course were removed, 79 remained. Of those 79, 26 were men and 53 were women. Participants' ages ranged from 16 to 48 (M = 22.38 years, SD = 7.24). The average age of women was 23.07 (SD = 7.46) and men 20.96 (SD = 6.68). Students self-enrolled in the modality of their choice. A summary of gender enrollment by modality is in table 4.

Table 4. Gender Enrollment by Modality

	Online	F2F	Total
Men	8	17	25
Women	31	20	51
Totals	39	37	76

Test & Data Collection Methods

Multiple linear regression was used to evaluate mean differences between groups' final grades. Multiple linear regression is appropriate since grade outcomes can be predicted by a

combination of two or more predictor variables, in this case, course modality, gender, and age. Hypotheses 1, 2, and 4 were tested using model one, while models two and three were used for Hypotheses 3 and 5, respectively. The analysis was conducted using SPSS v.28 software.

Preliminary Analyses

Descriptive statistics of course grades appear in Table 5 while the grade distribution by age for men appears in Figure 4 and the grade distribution by age for women appears in Figure 5. It is also important to note that final grade percentages translated to letter grades in the following manner:

90-100 = A

80-89 = B

70-79 = C

60-69 = D

Below 59 = F

Table 5. Distribution of course grades

	Face to Face	Online
Initial Count	49	57
Initial Count Men	26	15
Initial Count Women	23	42
Withdrawals	12	15
Withdrawals Men	9	6
Withdrawals Women	3	9
Completed Course	37	42
Completed Course Men	17	9
Completed Course Women	20	33
Mean Score	82.30	79.6
Mean Score Men	79.12	89.89
Mean Score Women	85	76.79

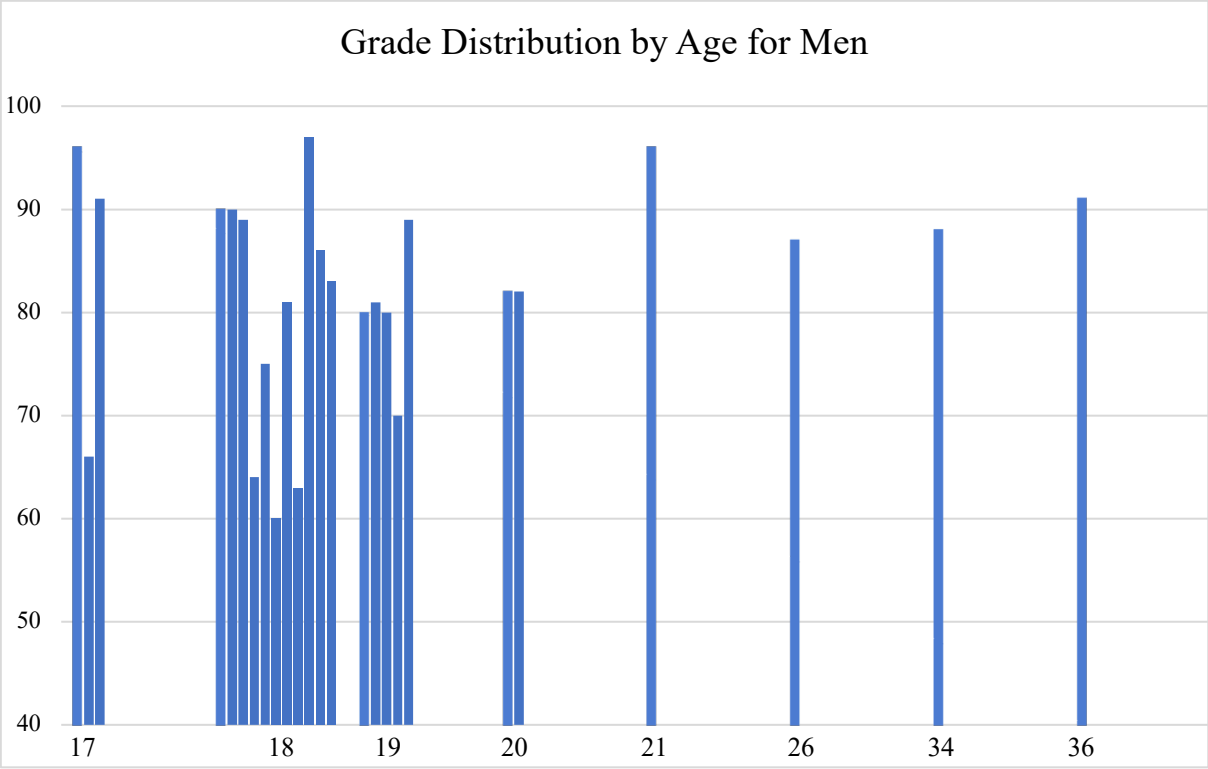

Figure 4. Grade Distribution by Age for Men

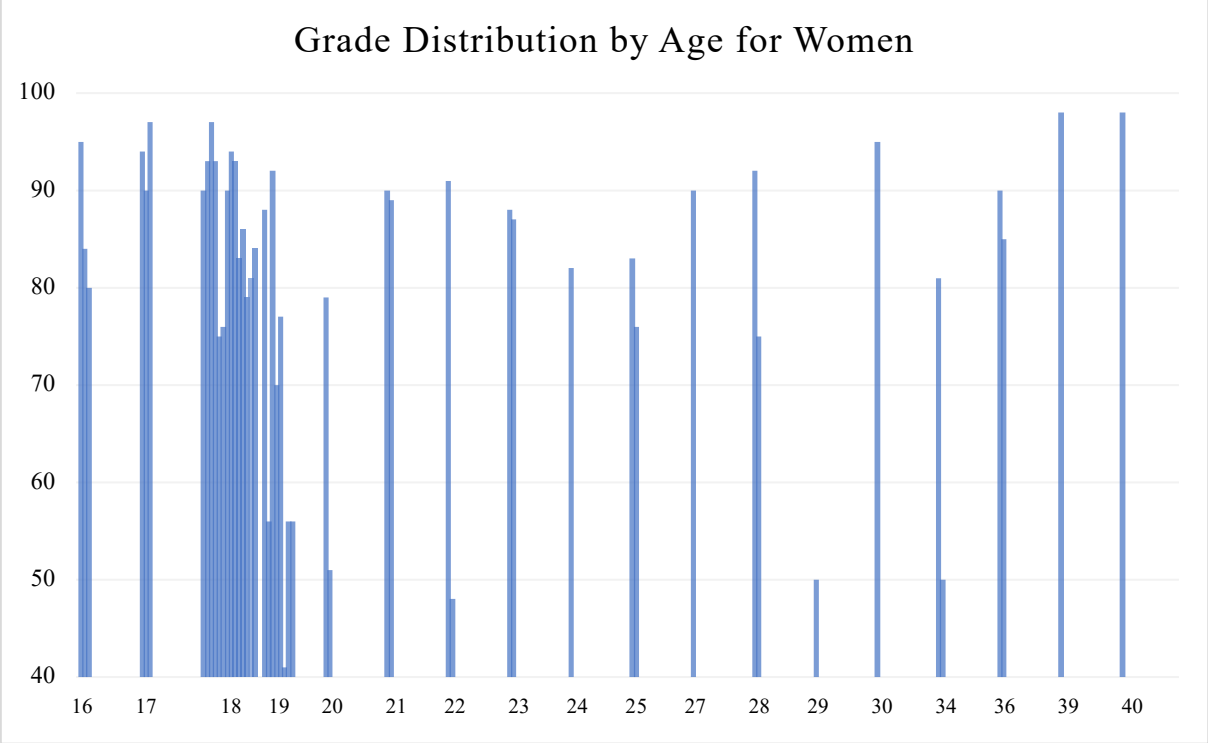

Figure 5. Grade Distribution by Age for Women

Before analyzing the data, four assumptions of multiple linear regression were tested to ensure unbiased parameter estimates: additivity and linearity, normality, homoscedasticity/ homogeneity of variance, and independence.

An analysis of standardized residuals was carried out to determine any outliers. There was one outlier where a student (woman, online) scored 0% did not drop the course. This variable was removed because the student made no attempt to complete the coursework and its inclusion would bias the results. Additionally, its standardized residual score (-4.95) was well outside the ±3 rule for identifying multivariate extreme scores recommended by Osborne (2013). Residuals in the remaining data ranged from -.22 to 1.22 and were deemed acceptable.

Linearity was checked by creating a scatterplot comprised of final grade percentage and the independent variable, age. No curvilinear pattern emerged. Multicollinearity was not a concern (Modality, Tolerance = .82, VIF = 1.22; Gender, Tolerance = .93, VIF = 1.07; Age, Tolerance = .86, VIF = 1.16) since none of the VIF (Variance Inflation Factor) calculations were greater than 10 (Field, 2017). To check normality, a histogram of residuals was created, revealing a negative skew (See Figure 6). A p-plot confirmed a negative, leptokurtic skew (See Figure 7). Osborne (2013) recommends removing any extreme univariate scores, defined by being ±3, by performing a z-transformation of the data. This was executed in SPSS and two z-scores (3.08, 3.64) were removed. The data corresponded to two online students: a man, aged 44 with a 97% score and a woman, aged 48 with a 93%. Next, a descriptive analysis of the residuals of the skewness and kurtosis stats were divided by their corresponding standard error. None of the calculations exceeded ±1.96. Homoscedasticity was verified using a plot of z-predicted versus z-residual values and revealed no concerns. Since no student scores were dependent on another student's performance, the assumption of independence was met.

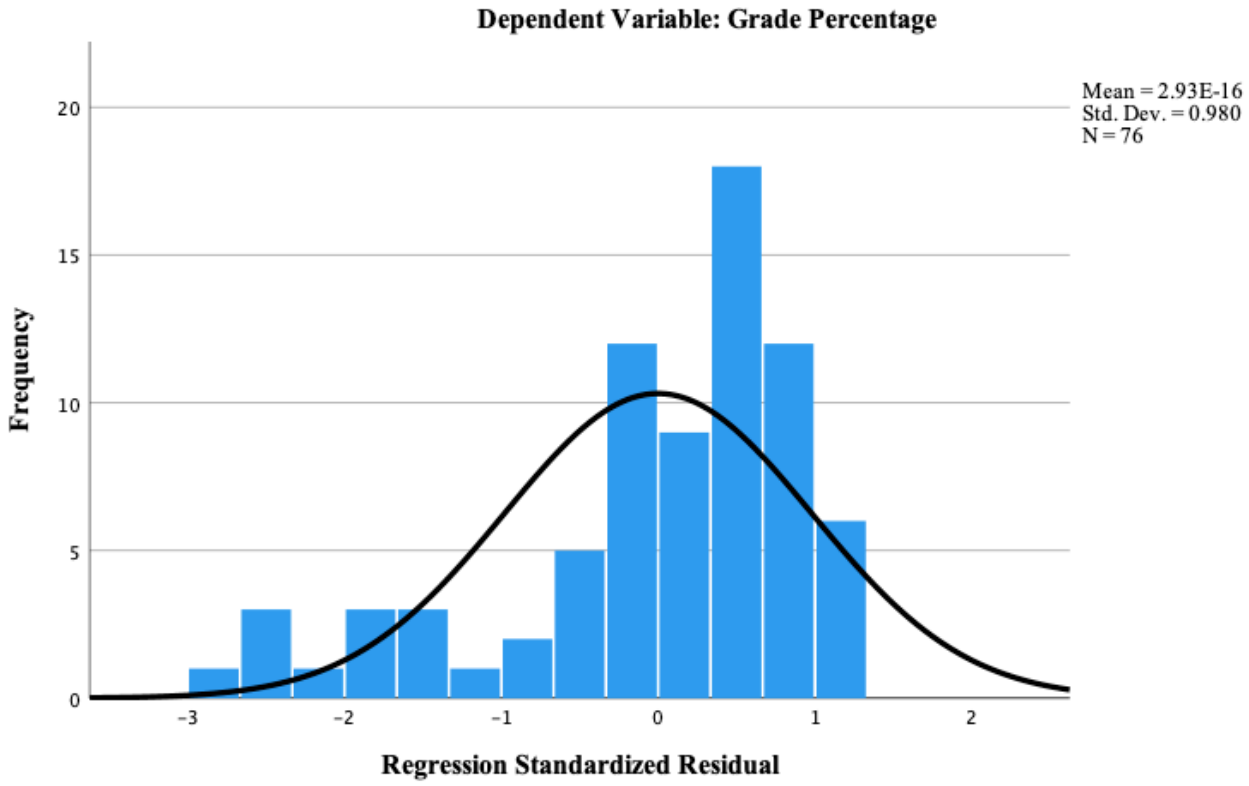

Figure 6. Normality Test

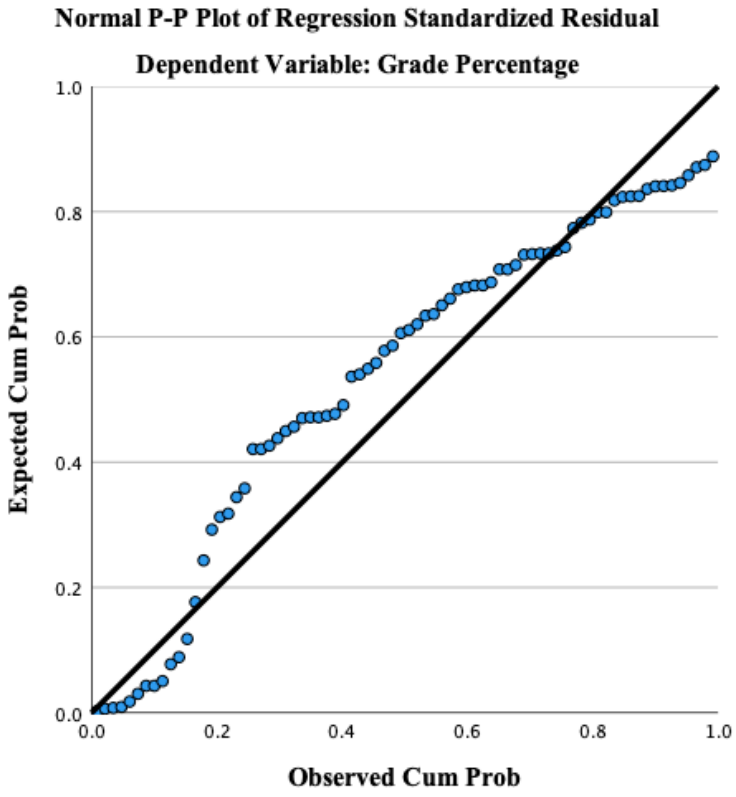

Figure 7. P-Plot

Findings for Hypotheses 1, 2, & 4

Hypothesis 1 stated that learners who took online courses would achieve at least the same final grade percentages as students in face-to-face courses. To test this hypothesis the following model was created: $Y = b_0 + b_1(\text{online}) + b_2(\text{woman}) + b_4(\text{age})$.

Results showed that course modality had no effect on final grade percentages (b = -2.192, $p > .05$), after controlling for gender and age. Therefore, hypothesis 1 was supported.

Hypothesis 2 stated that women would score lower than men. There was no difference in final grade percentages between men and women (b = -.997, $p > .05$), after controlling for age and modality. This hypothesis was not supported.

Hypothesis 4 stated that as students' ages increase, final grade percentage would also increase. Age had no relationship with final grade percentage (b = 0.239, p > .05), after controlling for modality and gender. This hypothesis was not supported.

A summary of parameter estimates for Model 1 can be found in Table 6.

Table 6. Multiple Regression Output for Models 1, 2, and 3

	Model 1					Model 2					Model 3				
Variable	*B*	*SE B*	*β*	*t*	*p*	*B*	*SE B*	*β*	*t*	*p*	*B*	*SE B*	*β*	*t*	*p*
Modality	-2.19	3.45	-0.08	-0.64	0.53	8.90	5.86	0.33	1.52	0.13	-16.72	14.20	-0.62	-1.18	0.24
Gender	-1.00	3.49	-0.04	-0.29	0.78	5.54	4.42	0.19	1.25	0.21	-0.49	3.53	-0.02	-0.14	0.89
Age	0.24	0.28	0.11	0.85	0.40	0.21	0.28	0.09	0.75	0.46	-0.30	0.59	-0.14	-0.52	0.61
Modality x Gender						-15.88	6.88	-0.58	-2.31	0.02					
Modality x Age											0.77	0.67	0.67	1.06	0.30
R^2			0.01					0.08					0.03		
Adjusted R^2			-0.03					0.03					-0.03		
F for change in R^2			0.32					1.59					0.52		

Modality: 0-face-to-face. 1-online; Gender: 0-man, 1-woman

Findings for Hypothesis 3

Hypothesis 3 stated the following: For women, online learning is associated with higher grades, but for men, online learning is associated with lower grades. To test this hypothesis, a second model was created that included an interaction term for women in online classes. Model 2 was: $Y = b_0 + b_1(\text{online}) + b_2(\text{female}) + b_3(\text{online x female}) + b_4(\text{age})$.

Women scored over 15 points lower than men when taking online courses (b = -15.88, p = 0.02 95% CI [-29.60, -2.16]. See Figure 8 for an illustration of this effect. Although a significant interaction was found, hypothesis 3 was not supported because the direction of the interaction was opposite of that hypothesized.

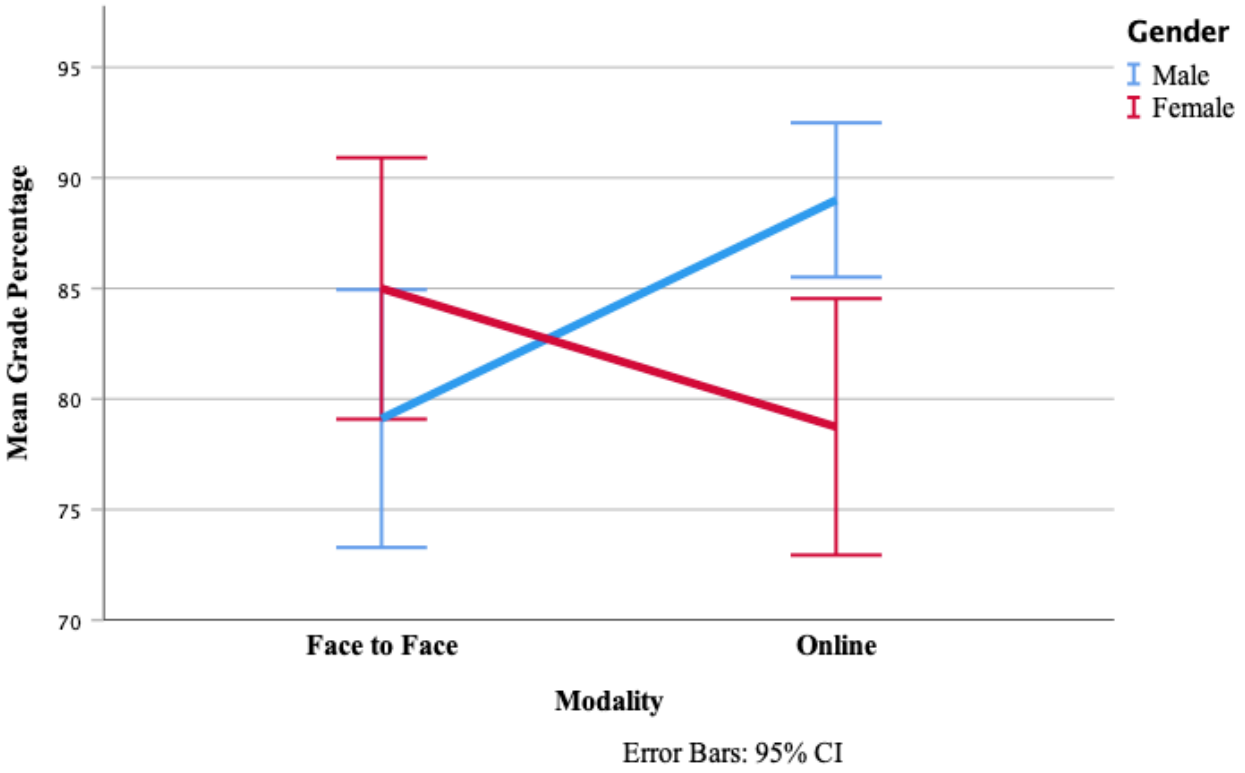

Figure 8. Interaction Between Gender and Modality.

Findings for Hypothesis 5

Hypothesis 5 stated the following: For younger students, online learning is associated with lower grades, but for older students, online learning is associated with higher grades. To test this hypothesis, a third model was created that included an interaction term for age and online modality: $Y = b_0 + b_1(\text{online}) + b_2(\text{female}) + b_4(\text{age}) + b_5(\text{online x age})$. No interaction was found ($b = 0.706$, $p > .05$) and Hypothesis 5 is rejected.

Summary and Conclusion

This study only found evidence to support one of its five hypotheses. Learners who took online courses scored the same as students in face-to-face courses after controlling for age and gender, so course modality appears to have no relationship with course outcomes. There were no significant differences in final grade percentages between men and women. There was also no

relationship between a student's age and final grade percentage. Additionally, there was no evidence showing that online learning affected grades for younger or older students. The hypotheses that women would score higher than men in online classes was not supported. A significant interaction term, however, revealed that women scored lower than men in online courses. Men in online courses also appeared to score higher than men in in-person courses.

The following chapter will discuss and interpret these findings and offer recommendations for further research.

Chapter 5

Summary, Conclusions, Limitations, Discussion, & Recommendations

Summary of the Study

The purpose of this study was to examine the relationship between course modality and final grade percentages for students taking college algebra at a rural community college in Arkansas. As colleges and universities lean into online education to reach more students, it is important to determine whether online courses are as effective as traditional courses in college algebra. To date there has been only a small amount of research that addresses this issue.

Research Questions

The research questions were investigated through the lens of Moore's Theory of Transactional Distance, with distance being a psychological construct rather than a physical one. To account for transactional distance, the study used one instructor using similar materials for both the online and face-to-face sections. The idea was that an instructor teaching both online and face-to-face sections would make the course as similar as possible regardless of modality. The instructor for this study made an effort to make both modalities as similar as possible by using the same curriculum, course materials, assignments, assessments, and instructional videos.

Five research questions were crafted to dive deeper into the relationship between course modality and final grade percentages.

1. After accounting for instructor and course materials, what is the relationship between course modality and final grade percentage for students taking college algebra at a rural community college in Arkansas?

The results showed no relationship between course modality and final grade percentages (b = -2.192, p > .05) after accounting for instructor and course materials.

2. Do Final grade percentages in college algebra differ by gender, after accounting for course delivery method?

   There was no significant difference in final grade percentages between men and women after accounting for course delivery method (b = -2.192, p > .05).

3. Does a student's gender influence the relationship between course modality and course grades?

   While there was no significant difference between final grades between men and women taking College Algebra, when the course was taken online, women scored significantly lower than men (b = -15.88, p = 0.02 95% CI [-29.60, -2.16].

4. What is the relationship between a student's age and the final grade percentage earned in a college algebra course, after controlling for course delivery method?

   There was no significant relationship between age and final grade percentage (b = 0.239, p > .05), after accounting for the course delivery method.

5. Does a student's age influence the relationship between course modality and course grades?

   Age did not influence the relationship between course modality and final grade percentages (b = 0.706, p > .05).

Literature Review

As mentioned earlier, studies comparing the relationship between course modality and grade outcomes proved inconclusive (Amro et al., 2015; Francis et al., 2019). Some researchers

found face-to-face college algebra courses more effective (Amro, 2014; Amro et al., 2015) while others determined online courses more effective (Burch & Kuo, 2010, Graham & Lazari, 2019). Other research reported no difference in outcomes based on modality (Huang, 2012; Araeipour, 2013; 2016; Arviso, 2019).

A closer examination of the research revealed that studies that accounted for instructor and course materials found no significant difference in course outcomes (Huang, 2012; Araeipour, 2013; 2016; Arviso, 2019). This was the most enlightening finding of the literature review. It changed how the hypotheses for the research questions were formed. It also signified the study was on the right track using the same instructor and course materials to account for transactional distance. Using the same instructor and course materials as a way of accounting for Transactional Distance should not be construed as a measurement of Transactional Distance. It assumes an instructor uses similar materials and strategies to teach a course no matter the modality. The instructor in this study made every effort to make both modalities as similar as possible, using the same materials, curriculum, assignments, and exams. A reasonable inference can be made that instructors who teach both modalities attempt to make their courses as equivalent as possible, even if it is to only simplify their workflow. In this way, every instructor would have arbitrary Transactional Distance built into the course curriculum. Using one instructor also eliminated potential confounding variables such as instructor experience, course curriculum, instructor engagement, and personal characteristics.

Methodology

A causal-comparative design was used to answer the five research questions. Data was requested and received from the participating community college. Student records were taken from MAT-1223, College Algebra, taught by one instructor who taught both online and face-to-

face courses over a single school year. The records collected contained modality information (online or F2F), as well as student information: gender, age, and final grade percentage. Multiple linear regression were used to test the five hypotheses.

Findings

Only one of the five hypotheses was supported by the data. Of the three main-effects hypotheses, there were no significant differences between online and F2F learners. This was the hypothesis of Research Question 1. Additionally, there were no significant differences between men and women, and there was no significant relationship between a student's age and final grade percentage.

There was no significant interaction between an online student's age and final grade percentage. There was, however, an interaction between online students and gender. Women scored significantly lower than men in online courses ($b = 15.88$, $p = 0.02$ 95% CI [2.16, 29.60].

Conclusions

Several conclusions can be made from this study.

Conclusion 1. The study found no difference between modality and final grade percentages. This is supported by other research that also accounted for instructor and course materials (Huang, 2012; Araeipour, 2013; 2016; Arviso, 2019). From these findings, as they pertain to community colleges, one can conclude there is no relationship between course modality and final grade percentages if the instructor and course materials are accounted for. Average final grades were similar for face-to-face (M = 82.3, SD = 2.014) and online students (M = 79.60, SD = 2.968). This suggests instructors teaching both modalities consciously try to organize the sections and interact with students as similar as possible.

Conclusion 2. The study found no difference in the final grade percentages of men and women ($B = 6.722$, $p > .05$). From these findings, the following conclusion was drawn: Community college men and women who take college algebra score about the same, whether the course is taken online or face-to-face. This corresponds with findings from Araeipour (2013) but contradicts Amro (2014) who found women outperformed men.

Conclusion 3. The study found no significant relationship between a student's age and performance in college algebra ($B = -0.503$, $p > .05$). Based on these findings, the conclusion is that there is no relationship between a student's age and final grade percentage in college algebra when taken at a community college. This suggests that once students meet the qualifications to take college algebra by completing prerequisite courses or by having acceptable placement test scores, age won't be a factor in course outcomes. This is consistent with Hollis-Sawyer's (2011) study that found no significant differences in math test performance.

Conclusion 4. Although there were no differences between men and women taking college algebra at a rural community college, when the course was taken online, men scored higher than women. There was a statistically significant difference in this case with women scoring close to 16 points lower than men ($b = -15.88$, $p = 0.02$). An independent samples t-test was run to compare the scores of men in face-to-face courses versus men in online courses. The 8 men who took the online course ($M = 89$, $SD = 4.18$) compared to the 17 men who took the face-to-face course ($M = 79.12$, $SD = 11.34$) scored significantly higher on their final grade percentages, $t(23) = -3.17$, $p < .05$. There was no significant effect for modality, $t(49) = 1.49$, $p = .143$, even though the 31 women taking online courses ($M = 78.74$, $SD = 15.8$) scored lower than the 20 women in face-to-face courses ($M = 85$, $SD = 12.62$). None of the literature pointed to this conclusion as a possibility. Araeipour (2013) found no significant interaction between

modality and gender, and Amro (2015) concluded gender did not predict online achievement. Other studies comparing outcomes in online and F2F college algebra courses did not look at interactions between gender and modality.

This interaction is interesting because some literature suggests women are more engaged than men in online courses, which would lead to higher success rates (Chyung, 2007). Other studies comparing men and women in online courses found women did outperform men (Alstete & Beutell, 2004; Chyung, 2007; Xu & Jaggars, 2013), although when looking specifically at college algebra, Araeipour (2013) and Wagner (2011) found no significant differences. There was also no literature indicating men would improve their scores in college algebra by switching to an online modality.

One possible reason for the interaction could be the small number of men who took the online course (9) versus the number of women (31). All 9 men scored between 83 and 97 percent (M = 89). For the women, 6 failed the course completely, scoring between 41 and 56 percent (M = 78.7). It's possible the men that opted to take college algebra online did so because they were confident in their math skills. There was no way to view placement scores or high school GPA for any of the participants, so one possible conclusion is men are more confident in their math skills and are more likely to self-enroll into an online class. This is purely speculative and did not emerge from the literature.

Another consideration could be the number of students who withdrew from online college algebra during the term. Withdrawal rates for online college algebra courses are traditionally higher than in other disciplines (Warren, 2018) though Graham and Lazari (2018) found no statistical evidence that either modality had a higher retention rate. Of the 19 men who enrolled into an online section, 10 withdrew from the course at some point during the semester—

about 53%. The withdrawal rate for women was about 31%. The total withdrawal rate for both men and women in College Algebra for this study was 25.5%. This percentage is higher than findings by McKinney et al. (2019) who found the withdrawal rate for College Algebra students at a community college was 15.7% but supports their finding that withdrawal rates for men were higher than women. Perhaps men are more likely to withdraw from an online class if they start poorly while women are more likely to stick it out, even if it means a lower grade.

Limitations

The study's conclusions should be interpreted with careful consideration of the study's limitations. There were six principal limitations to consider. First, this study's sample was drawn from a rural community college in north Arkansas and is not representative of the community college population of the United States. The student demographics do not have the same socioeconomic makeup of the rest of the country. There are also concerns about reliable internet access for students in remote areas. The state of Arkansas developed the Arkansas Rural Connect (ARC) program in August 2019 to increase broadband internet access in underserved communities (Arkansas Department of Commerce Broadband Office, n.d.). The service area of the school in this study was awarded nearly $3 million in ARC funding to alleviate the problem (KAIT8, 2020). Since the study took place prior to the expanded internet access, online students in this study could have potentially had unreliable internet access.

Second, this study looked at results from one instructor teaching both online and face-to-face sections of college algebra over the course of a year. Ideally, a study using a multi-level methodology to examine instructor characteristics and practices would include over thirty instructors teaching college algebra to both online and face-to-face sections in both urban and rural environments throughout the U.S. using similar course materials. A study of this magnitude

would have been too costly and time consuming for the purposes of a dissertation but could be an interesting project to tackle later in my career.

Third, the study accounted for transactional distance by using one instructor teaching online and face-to-face sections using similar materials. There's an assumption that the instructor managed classroom interactions the same way in both modalities. The instructor for this study maintained the course was identical no matter what section a student enrolled in. It is possible that other instructors teaching both modalities would approach interactions differently, providing different experiences for online and face-to-face students, and thus changing the transactional distance. Until a definitive transactional distance measurement tool is agreed upon, a limitation of this nature will exist in future studies as well.

Fourth, the sample size was lower than needed to find a medium effect size while maintaining a customary type-2 error rate. The number of participants required for the study was 92, and after removing outliers, only 76 records were used. Because there were less data available, a post-hoc power analysis was calculated using G*Power to determine the actual power of the study. The result was 70.4%, meaning there was about a 30% chance of a false-negative occurring. This is slightly higher than the 20% customary rate used in educational research.

Fifth, the study couldn't account for a variety of environmental factors encountered by the participants throughout the school year. Things such as job and familial obligations were not collected by the college or instructor. Neither were things like the students' attitude toward math, IQ, high school GPA, college placement scores, or effort. Any of these things could affect outcomes.

Finally, students self-enrolled in the modality of their choice. This is a possible selection bias and could be a threat to internal validity. Students could have enrolled into a particular modality based on their own perceived math skills. A way to control this would have been to use the math placement scores, but I did not have access to them. Students enrolled into College Algebra would have completed the required prerequisites or achieved a minimum score the placement exam, but there was no way of knowing how well students scored above the minimum threshold.

Discussion

This study's findings and conclusions align with research that illustrated no relationship between modality and final grade percentages in College Algebra when accounting for instructor and course materials (Huang, 2012; Araeipour, 2013; Arviso, 2019).

It is important to note this study does contradict the claim that online education can be superior to other modalities when teaching college algebra. Research from Burch and Kuo (2010) and Graham and Lazari (2018) suggested online education was more effective than face-to-face courses. Burch and Kuo (2010) found online students using computer-based homework assignments scored higher on exams than students in face-to-face sections who completed paper homework. An important difference between this study and Burch and Kuo's is this study kept course materials constant while Burch and Kuo's participants completed different assignments depending on the course modality. Graham and Lazari (2018) found online students scored 7-10 points higher on the final exam than face-to-face students. A notable difference between Graham and Lazari's study and this study is Graham and Lazari looked at all college algebra scores within the department and used data from all sections taught by multiple instructors.

This study also conflicts with the idea that face-to-face instruction is more effective than online instruction. Amro (2014) an Amro et al. (2015) found face-to-face students scored higher than online students taking college algebra. An important difference between this study and Amro's studies is that Amro looked at data from all sections of college algebra taught by multiple instructors.

The four conclusions of this study support previous findings that used a similar methodology. The key point in comparing online and face-to-face outcomes is to account for Transactional Distance. Again, Transactional Distance is a psychological construct, rather than physical, that focuses on the interactions between the learner and instructor, other learners, materials, and interface. Transactional Distance was used as a reference point for a specific instructor attempting to create similar learning environments for each modality by using consistent materials, lesson plans, homework assignments, and exams. Analyzing differences between modalities and not controlling for Transactional Distance by accounting for instructor and materials could highlight differences not related to modality like instructor characteristics, course expectations, class interactions, etc. Framing the study in this way eliminated a large confounding variable missing from other studies, the instructor.

Moore's Theory of Transactional Distance focuses on the interactions between the student and the instructor, materials, other learners, and interface. Instructors that make a concerted effort to lessen Transactional Distance have student outcomes that are similar no matter the modality. In College Algebra this can be accomplished by presenting material in a consistent manner. The courses in this study used instructor-created videos of the instructor explaining concepts and completing examples. Homework and quiz examples were graded in a timely manner and the student materials were accessed online with adaptive learning features

that helped students work through and master concepts at their own pace. Traditional classroom discussions and questions were replicated by online discussions accessed through the learning management system (LMS).

There is evidence that there is no relationship between course modality and final grade percentages across disciplines. Arviso's (2019) study looked at three disciplines and found no significant differences in student outcomes. I went back to my own macroeconomics courses and ran the same regression models I used for this study. I found the same results.

In the 2020-2021 school year, I taught 103 macroeconomics students. Of those, 43 took a face-to-face course and 60 took the online version. On the question of whether there was a relationship between modality and final grade percentage, there was no significant difference (b = .824, p = .810). For gender, there was no significant difference (b = 4.501, p = .202). There was also no significant relationship between age and final grade percentage (b = .184, p = .388). I also checked to see if there was any significance in outcomes when women took online courses. In this case, there was none (b = -9.766, p = .157).

Recommendations

Recommendations for Teaching & Practice

This study's findings indicate there is no relationship between course modality and final grade percentages when the instructor and materials are accounted for. This prompts a visit to the question posed in the opening paragraph of Chapter 1, "Is online education as good as in a classroom?" The answer is yes! Perhaps research has been asking the wrong questions.

When I began this study, I would have wagered online students would outperform face-to-face students. I based this on anecdotal evidence from my own experience—which was wrong anyway based on the analysis of my own classes. I even asked multiple college algebra

instructors from the participating school which modality they thought would have the best performance. Every instructor thought face-to-face students would perform better. This is possibly because face-to-face instruction is more enjoyable for teachers. A study by Galanek and Gierdowski (2020) found that faculty in both two-year and four-year schools preferred face-to-face instruction over online instruction but chalk it up to a lack of training and technical support for online courses. Every instructor learned primarily through traditional face-to-face instruction. Online coursework (and now live videoconferencing) wasn't even a viable option until a few years ago. When things are new, there's a learning curve involved. It appears higher education has caught up with the curve when it comes to online education.

If educators or administrators notice differences between online and face-to-face outcomes, the focus shouldn't be on which modality is better. The focus should be on minimalizing Transactional Distance and identifying the strategies successful faculty use to make their course modalities similar. Differences in modality outcomes likely point to training issues more than anything else. A literature review by Maguire (2005) suggested a lack of institutional support in regards to training, standards, release time, and technology was the largest factor for faculty preferring face-to-face courses to online courses. A greater emphasis on reducing Transaction Distance across all modalities would help outcomes for all students. This will be increasingly important as more hybrid courses are offered through video conferencing software such as Zoom.

Educators should be careful about comparing outcomes in online and face-to-face courses. Engagement is likely the most important factor in learning new material. Academic researchers have all had good instructors and poor instructors, and most have been able to learn the material because effort is generally a given for academics. Researchers and students who

have taken both online and F2F courses may prefer one modality over another, but those reasons are likely related to the interactions with instructors and other students, not grade outcomes.

Recommendations for Further Study

What follows are three recommendations for future research. The first is to expand this study to algebra instructors in multiple colleges and universities while accounting for similar course materials. A random sample of thirty to fifty randomly selected instructors from around the U.S. would be adequate. Ideally, each instructor would have multiple sections of both online and face-to-face courses with a total of at least 100 students who completed the courses. In addition to answering questions posed in this study, selecting instructors randomly from around the U.S. would also allow researchers to test for relationships between factors based on the zip code of the institution. This could potentially uncover a confounding variable such as location (i.e., urban vs. rural), technology, socioeconomic status, or internet access undetected in earlier research. Once the relationship between modality and course outcomes is clear, researchers could hone in on the differences between effective and ineffective course designs through the lens of Transactional Distance. Evaluating courses in terms of Transactional Distance would help researchers understand student success better than looking at differences between modalities. This segues into the next recommendation.

Second, develop a measurement tool to evaluate Transactional Distance applicable to any modality. Moore's Theory of Transactional Distance has historically been used to evaluate online courses. Many instructors who teach F2F courses attempt to replicate their lesson plans for the online environment. Mehall (2020) advocated for a Purposeful Interpersonal Interaction (PII) rubric to evaluate online courses' ability to have purposeful instructional, social, and supportive interactions. It built on an earlier rubric developed by Roblyer & Wiencke (2003) that

rated online course design on five elements: Social/Rapport Building, Instructional Design for Interaction, Interactivity of Technology Resources, Evidence of Learner Engagement, and Evidence of Instructor Engagement. Even Quality Matters (Quality Matters, n.d.), an educational company designed to measure and improve the quality of courses, started out as a group of colleagues trying to evaluate the quality of an online course. Identifying shared characteristics of successful courses taught by instructors in multiple modalities could help improve the quality of any type of course. One approach to accomplish this would be to develop a *similarity checklist* for courses taught by one instructor teaching the same course over multiple modalities. This checklist could outline and measure the four interactions described in Moore's Theory of Transactional Distance (Learer-Instructor, Learner-Learner, Learner-Content, and Learner-Interface). By looking at the relationships between student outcomes and the four interactions, researchers could better understand the relationship between course design and student success.

Finally, expand the study to include disciplines outside college algebra. Arviso (2019) found no relationship between modality and outcomes in algebra, psychology, and history, but the study focused on a specific population of Navajo students in New Mexico and is not representative of the U.S. population. Studies addressing the relationship between modality and student outcomes (in any discipline) have garnered mixed conclusions because none have accounted for instructor and course materials (see Table 1 in Chapter 2). A study that did account for instructor and materials would be a huge undertaking and require multiple researchers. It would be interesting to see if differences emerged based on subject matter.

Instructors at all levels need to look for ways to increase student interaction, no matter if the courses are delivered face-to-face, asynchronously online, through synchronous video conferences, or hybrids. The focus should be to reduce Transactional Distance. Outcomes and

final grade percentages should be part of the formula, but not the quintessential element. If careful attention is paid to increase the learner-instructor, learner-learner, learner-interface, and learner-content interactions, there's a chance College Algebra could lose its stigma as a gateway course.

As Clark opined in 1983 at the dawn of distance education, only content matters. The truck that delivers food to the grocery store isn't responsible for whether the food is healthy or unhealthy. The same holds true for education. The modality doesn't determine student outcomes. Student engagement does, and engagement increases when the Transactional Distance is reduced.

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Appendix A: Comparison of Findings in College Algebra 2010-Present

Year	Author(s)	Modality Findings	Control for Instructor?	Control for Materials?	Miscellaneous
2010	Burch & Kuo	Online	No	No	Studied homework grades in college algebra.
2011	Wagner et al.	No Difference	Yes	No	No difference between males and females, but females performed worse in Online courses - gender effect.
2012	Huang	No Difference	Yes	Yes	Studied unit concepts in college algebra. Not the entire course.
2013	Araeipour	No Difference	Yes	Yes	CC in urban setting
2014	Amro	Traditional	No	No	Age not a predictor. Females outperformed males.
2015	Amro et al.	Traditional	No	No	Hispanic student population
2016	Harrington et al.	No Difference	Yes	Yes	
2018	Graham & Lazari	Online	No	No	Studied final exam results. Online course was 8-weeks long.
2019	Arviso	No Difference	No	Yes	Studied college algebra, history, and psychology. No difference in any of the subjects.

Appendix B: IRB Expedited Review - Review Not Required

UNIVERSITY OF ARKANSAS

To:	Christopher Michael LaFata
From:	Chair, Douglas J Adams Chair, Justin R Chimka IRB Expedited Review
Date:	04/04/2022
Action:	**Review Not Required**
Action Date:	04/04/2022
Protocol #:	2201384153
Study Title:	A Comparison of Student Final Grades in College Algebra Based on Face-to-Face and Online Course Modalities

Please keep this form for your records. Investigators are required to notify the IRB if any changes are made to the referenced study that may change the status of this determination. Please contact your IRB Administrator if you have any questions regarding this determination or future changes to this determination.

cc: Kevin M Roessger, Investigator

Appendix C: Copy of Course Syllabus

North Arkansas College
Student Course Syllabus

COURSE:	College Algebra / MAT 1223 / 3 credit hours
INSTRUCTOR:	Sherry Jennings, Division of Mathematics
OFFICE:	M 134 D
OFFICE HOURS:	Posted on Portal under Course Info
PHONE:	391-3264 (I have voice mail so please leave a message. Email is better.)
EMAIL:	sjennings@northark.edu • Please allow at least 24 hours response time
COURSE ADDRESSES:	Portal – This is the main part of the course. Descriptions of the links are discussed later in the syllabus. https://portal.northark.edu/ics/ MyMathLab – This is where you access the homework problems. http://www.mymathlab.com
LOGIN FOR MyMath Lab:	To gain access you must first go through the registration process. You will need an email address, the course ID, and your access code. You will create a login name and password which you will use to login to access the homework assignments. For log in instruction, please go to the Syllabus Page on Portal under Important Documents
COURSE ID:	Instructions for Logging in to MyMath Lab and the Course ID are located on Portal under the Syllabus Page under Important Documents
ACCESS CODE:	Each student has a different code which is located inside the MyMathLab packet. The MyMathLab packet can either be purchased from the Northark bookstore or online at www.mymathlab.com.
COURSE DESCRIPTION:	This is a course designed for all students who show by their background on the mathematics placement examination that they are ready for college level mathematics. Usually students who enroll in this course will have had the equivalent of two years of high school algebra. Topics included in this course are sets, relations and functions, the real number system, complex numbers, polynomials, and systems of equations.

Online Course: This course is a web based course, which means that the instruction is through the web. Material covered is the same as what is covered in the course taught on campus. However, Exams will be proctored.

RATIONALE: By studying and developing an ability to apply the mathematical principles of College Algebra, the student will be prepared to study higher mathematics courses.

AUDIENCE: The intended audience for College Algebra is the student who needs a background in College Algebra to help prepare him/her for the calculus courses, or for other quantitative courses, such as statistics or mathematics for elementary teachers.

COURSE PREREQUISITES: Either CP 0933 or MAT 1123 with grade of "C" or better OR Algebra II and satisfactory score on the placement test.

NORTHARK GENERAL LEARNING OUTCOMES: The learning outcomes of general education will be common to all students regardless of major. When students have completed the general education component of their studies, they should be able to:
1. Apply critical thinking and problem solving skills across disciplines.
2. Apply life skills in areas such as teamwork, interpersonal relationships, ethics, and study habits.
3. Communicate clearly in written or oral formats.
4. Use technology appropriate for learning.
5. Discuss issues of a diverse global society.
6. Demonstrate math and/or statistical skills.

This course also satisfies the following Arkansas Department of Higher Education - Arkansas Course Transfer Systems (ACTS) learning outcomes:
The student will demonstrate:
· The ability to perform and solve basic function operations and algebraic problems using appropriate vocabulary
· Critical thinking to formulate decisions and problem solving based on reasoning and analysis
· The appropriate use of technology to supplement and enhance conceptual understanding, visualization, and inquiry
· The ability to synthesize information from a variety of sources to solve problems and interpret results
The student will demonstrate a basic understanding of functions including:
· Absolute values
· Quadratic
· Polynomial
· Rational
· Logarithmic

· Exponential
· Graphing of inequalities and quadratic inequalities

The student will demonstrate an understanding of the application of the following topics:
· Systems of equations
· Matrices

COURSE OBJECTIVES:

1. The student will be able to perform the algebraic operations on polynomials, radicals, complex numbers, and exponential, logarithmic and rational expressions and to simplify the results.
2. The student will be able to solve algebraic equations and inequalitites. This includes 1st, 2nd, and 3rd degree equations, exponential and logarithmic equations, and equations involving rational expressions and radicals.
3. The student will be able to identify a function, find its domain and range, find the inverse function for those functions that are one-to-one and to sketch the graph of both the function and its inverse.
4. The student will be able to use the remainder and factor theorems to find the real zeros of a polynomial.
5. The student will be able to solve a system of equations in two and three variables using algebraic and matrix methods.

RESOURCES NEEDED:

1. Textbook:
   College Algebra Graphs & Models, 6th edition, Bittinger, Beecher, Ellenbogen, Penna
2. MyMathLab access code
   An access code is needed for the homework assignments. It will come bundled with the ebook . The packet contains information and codes for accessing the homework assignments. The packet can either be purchased in the Northark bookstore or online at www.mymathlab.com.
3. Paper Supplies:
   Notebook or Loose Leaf Paper – For homework assignments.
4. Calculators:
   You will need a graphing calculator. I will use the TI-84 Plus in class. Calculators may be checked out at the North Arkansas College Library. **No TI-89 calculators are allowed or any other calculator with algebraic capabilities. Cell phones are not allowed in the classroom therefore they are not to be used as calculators.**
5. Lecture Guide:
   Lecture Guide are to be purchased at the Northark Bookstore.
6. Personal computer:
   The student is expected to have access to a computer with these system requirements. If you have any problems with your computer, ie, computer crashes, internet goes down, or etc., it is your responsibility to have a backup plan.
7. Email Account:

A Northark email account was issued to you automatically when you enrolled in your classes. To access your email, navigate to Northark's Portal site at portal.northark.edu. On the eLearning tab, there is a link located under Bookmarks. You may also access your email from https://northark.okta.com. Your email address will be your username@my.northark.edu

RESOURCES AVAILABLE:

1. Graphing Calculators – Calculators are available to check out in the Northark library.

2. MyMathLab – Instructions for access will be given in class and are located on the Syllabus Page under Important Documents on Portal.

3. Instructor – See office hours in Portal or email.

4. Northark Student Resource Center.

ADDITIONAL ASSISTANCE:

If you are having any issues in your online course, the first person you should contact is your instructor by email. If you need technical assistance for logon issues, contact Brenda Freitas *(Northark IT department)* at *bfreitas@northark.edu* or *870.391.3275.*

PARTICIPATION:

The Participation Grade comes from completing your Lecture Guide and showing all work for your Homework, Quizzes, and Tests. Lecture Guides are to be purchased at the Northark Bookstore. To complete the Lecture Guide, you will do so while watching the videos which are located on Portal under the corresponding Chapter Tabs. To receive full credit you will complete all sections, examples, and your turns. Basically, if I write it in the video, you need to include it in the Lecture Guide. You are more than welcomed to take additional notes or highlight any part of the Lecture Guide. Be certain to complete the Lecture Guide notes before beginning the Homework.
Your Homework, Quizzes, and Tests are located on MyMath Lab and work shown can be completed in either a spiral notebook, 3 ring binder, or inserted in your Lecture Guide after each section. This just depends on your personal preference. Whichever you choose, it must contain College Algebra and only College Algebra, no other class work should be in there. To receive full credit for each assignment you must complete it in order beginning each new section on a new page, you must label each assignment, number and show work for each problem, and include the grade earned at the top of the page. Even if the question is multiple choice, you must show work. For example, this can be done with an illustration of a graph and explanation of why you choose that answer. Any work placed in the pocket of the Lecture Guide will not be graded. In order for your Lecture Guide to be graded, it must be in a 3 ring binder.

HOMEWORK: Homework is located on MyMath Lab. The MyMath Lab link in located on the login page on Portal. You will need to purchase an access code online or at the Northark Bookstore. The Instructions for enrolling in to MyMath Lab are located in Portal on the Syllabus Page. There is a homework assignment for each section. For each problem you have 3 attempts plus 2 additional Similar Exercises with 3 attempts each, unless it is a multiple choice problem, to get the problem correct. This is a total of 9 tries for each problem. Be certain to label each section, number and show work for each problem, and record your score for each section in a spiral notebook, 3 ring binder, or include it in your Lecture Guide for it is part of you Participation Grade. There is a 10% per day penalty for late homework assignments. All homework assignments for each chapter will close at the due time of the chapter test. No late homework will be accepted after the due date of the corresponding chapter test.

QUIZZES: Quizzes are timed with no help features on MyMath Lab. There is a quiz after every 2 sections plus the last section of each chapter. You will be given 3 attempts for each quiz and the highest grade will be recorded. Be certain to label each quiz, number and show work for each problem, and record your score for the quiz in with your Homework for it is part of your Participation Grade. You will not be able to review the quiz until after the due date. No late Quizzes will be accepted

TESTS: Tests are timed with no help features on MyMath Lab. There is a test after each chapter. You will be given 3 attempts for each Practice Test, but only one attempt at the Chapter Test. Be certain to label each test, number and show work for each problem, and record your score for the test in your Homework for it is part of your Participation Grade. You will not be able to review the test until after the due date. No late Tests will be accepted.

One Make-Up Test will be allowed to replace or improve one Test Grade. The Make-Up Test will be at the end of the semester and comprehensive.

EXAMS: There will be 4 exams during the semester, three chapter exams and a comprehensive final exam. Exams are proctored. They are paper/pencil. There will be 3 exams, one after every 2 chapters. Thus Exam 1 will cover Chapters 1 & 2, Exam 2 will cover Chapters 3 & 4, and Exam 3 will cover Chapters 5 & 6. If you score 70% or higher on each of the homework sections for both chapters covered in the exam, you may use a 3 inch by 5 inch notecard on the chapter exam. If your overall homework average is 70% or higher, you may use a 5 inch by 7 inch notecard on the Final Exam.

Exam 1	Chapters 1 and 2
Exam 2	Chapters 3 and 4
Exam 3	Chapters 5 and 6
Final	All previous material

GRADE	PERCENT

GRADING:				
	Participation	10%	A	90- 100
	Homework	10%	B	80-89
	Quizzes	15%	C	70-79
	Tests	20%	D	60-69
	Exams	35%	F	0 – 59
	Final Exam	10%		
		100%		

MAKE-UPS: No make-up exams. The Final Exam can be used to replace your lowest exam or test grade.

One Make-Up Test will be allowed to replace or improve one Test Grade. The Make-Up Test will be at the end of the semester and comprehensive.

ACADEMIC DISHONESTY: Academic fraud and dishonesty are defined as follows:

Cheating: Intentionally using or attempting to use unauthorized materials, information, or study aids in any academic exercise.

Facilitating academic dishonesty: Intentionally or knowingly helping or attempting to help another commit an act of academic dishonesty.

Test tampering: Intentionally gaining access to restricted test booklets, banks, questions, or answers before a test is given; or tampering with questions or answers after a test is taken.

Plagiarism: Intentionally or knowingly representing the words and ideas of another as one's own in any academic exercise.

Academic dishonesty will not be permitted. It shall be at the instructor's discretion to fail the student for that assignment, remove the student from the class, reduce the student's grade, or petition to have the student suspended from the college.

ATTENDANCE: You are expected to be present for all class sessions. If you are absent for any reason you are expected to keep up with the lessons.

Excused absences include:
1. Northark activities such as PBL and ballgames with advanced notice.
2. Illness with a doctor's excuse.
3. Required presence in court.

The instructor must be notified by the student about an excused absence.

Online:
- Students in online courses must take four proctored exams. If you are unable to be on Northark's campus for the proctored exams then it is your responsibility to find your own test proctor and complete the

Proctor Nomination form which can be obtained from your instructor. Arrangements must be approved by your instructor at least 2 weeks before the exam.

- Attendance is required four times during the semester for taking the exams. The exams are given in the testing center on the south campus.

STUDENT RESPONSIBILITES:

- Read the college catalog and all materials you receive during registration. These materials tell you what the college expects of you.
- Read the syllabus for each class. The syllabus tells you what the instructor expects from you.
- Attend all class meetings. Something important to learning happens during every class period. If you must miss a class meeting, talk to the instructor in advance about what you should do.
- Be on time. If you come in after class has started, you disrupt the entire class.
- Never interrupt another class to talk to the instructor or a student in that class.
- Be prepared for class. Complete reading assignments and other homework before class so that you can understand the lecture and participate in discussion. Always have pen/pencil, paper, and other specific tools for class.
- Learn to take good notes. Write down ideas rather than word-for-word statements by the instructor.
- Allow time to use all the resources available to you at the college. Visit your instructor during office hours for help with material or assignments you do not understand; use the library; use the free tutors, tapes, computers, and other resources in the Learning Assistance Center.
- Treat others with respect. Part of the college experience is being exposed to people with ideas, values, and backgrounds different from yours. Listen to others and evaluate ideas on their own merit.

http://tutorial.math.lamar.edu/Extras/StudyMath/HowToStudyMath.aspx

SPECIAL NEEDS: North Arkansas College complies with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990. Students with disabilities who need special accommodations should make their requests in the following way: (1) talk to the instructor after class or during office hours about their disability or special need related to classroom work; and/or (2) contact Student Support Services in Room to M154H (Inside the Learning Commons) or call 870-391-3338 and ask to speak to Kim Brecklein.

NOTES:

1. If the syllabus needs to changed for any reason there will be notification of the changes as an announcement on the Portal.