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Success Rates of Second Semester Anatomy Students in Online and On-Ground Classes at a Community College in East Tennessee

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Success Rates of Second Semester Anatomy Students in Online and On-Ground Classes at a Community College in East Tennessee

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by

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ABSTRACT

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Educators expect the number of institutions offering online courses and the number of students enrolling in these courses to increase as many students, particularly nontraditional students, discover the advantages of online content delivery. Online courses require new methods of communication between students and faculty as well as discovering new ways to build relationships, earn student trust, conduct appropriate assessment, and deliver useful course content. Many institutions—public, private, and for-profit—offer a wide variety of online coursework but faculty, employers, and the public have expressed concerns about the quality of online course content. In particular, online delivery of coursework in the natural and physical sciences, courses previously offered only in an on-ground format because of their laboratory components, has raised questions about efficacy.

The current study was designed to investigate whether there were significant differences in student success between online and on-ground second semester anatomy courses at a community college in East Tennessee during a 5-year period. Statistical analyses were conducted on the following variables: lecture final examination grade, final lecture course grade, final laboratory course grade, sex, age, and content delivery for students enrolled in online and on-ground Anatomy 2 courses at the participating community college. The results of this study indicated that the most successful students in Anatomy 2 lecture and laboratory classes were older (nontraditional-aged) male and female students who attended on-ground classes. Older students

in on-ground classes were more likely to earn an A in both lecture and laboratory classes than younger (traditional-aged) students. On-ground male and female students also gained admission into the nursing program at a greater rate than did male and female students from online sections. While age apparently made no difference in the admission rate for female students, older male students from on-ground sections had a greater admission rate than younger male students.

DEDICATION

This study is dedicated to my wife Angela for her unconditional love, support, and patience as we went through this process together and to our great sons, Michael and Zachary, who were always there when we needed them.

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TABLE OF CONTENTS

Page

ABSTRACT....2

LIST OF TABLES....8

Chapter

1. INTRODUCTION....11

Background....11

Natural Science Courses....13

Online Anatomy Coursework....13

Statement of the Problem....15

Research Questions....17

Significance of the Study....18

Definition of Terms....19

Limitations and Delimitations....21

Overview of the Study....22

2. REVIEW OF LITERATURE....23

The History of Online Education....24

Efficacy of Online Courses....30

Perceptions of Efficacy....33

The Cost of Online Classes....35

Efficacy of Online Science Education....37

The Hybrid Option....49

Student Success in Online Classes....51

Summary....53

3. RESEARCH METHOD....54
Research Questions and Null Hypotheses....54
Instrumentation....59
Population....59
Data Collection....61
Data Analysis....62
4. FINDINGS....63
Demographics of Population....63
Analysis of Research Questions....64
Summary....108
5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS....109
Summary of Findings....111
Conclusions....134
Implications for Practice....137
Recommendations for Further Research....138
REFERENCES....140
VITA....150

LIST OF TABLES

Table Page

1. Sections and Course Enrollment for Anatomy 2 Lecture Courses Offered 2009-2015 64

2. Results of Pairwise Comparisons of Final Examination Grades Using Holm's Sequential Bonferroni Method 66

3. Results for Pairwise Comparisons of Final Lecture Grades Using Holm's Sequential Bonferroni Method....68

4. Results for Pairwise Comparisons of Final Laboratory Grades Using Holm's Sequential Bonferroni Method....70

5. Results for Pairwise Comparisons of Final Lecture Grades for Male Students Using Holm's Sequential Bonferroni Method 72

6. Results for Pairwise Comparisons of Final Laboratory Grades for Male Students Using Holm's Sequential Bonferroni Method 74

7. Results for Pairwise Comparisons of Final Lecture Grades for Female Students Using Holm's Sequential Bonferroni Method 76

8. Results for Pairwise Comparisons of Final Laboratory Grades for Female Students Using Holm's Sequential Bonferroni Method 78

9. Results for Pairwise Comparisons of Final Lecture Grades for Traditional Students Using Holm's Sequential Bonferroni Method 80

10. Results for Pairwise Comparisons of Traditional Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method....82

11. Results for Pairwise Comparisons of Final Lecture Grades for Nontraditional Students Using Holm's Sequential Bonferroni Method 84

12. Results for Pairwise Comparisons of Nontraditional Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method....86

13. Results for Pairwise Comparisons of Traditional Male Student Final Lecture Grades Using Holm's Sequential Bonferroni Method....88

14. Results for Pairwise Comparisons of Traditional Male Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method 90

15. Results for Pairwise Comparisons of Nontraditional Male Student Final Lecture Grades Using Holm's Sequential Bonferroni Method 92

16. Results for Pairwise Comparisons of Nontraditional Male Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method 94

17. Results for Pairwise Comparisons of Final Lecture Grades for Traditional Female Students Grades Using Holm's Sequential Bonferroni Method 96

18. Results for Pairwise Comparisons of Traditional Female Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method 98

19. Results for Pairwise Comparisons of Final Lecture Grades for Nontraditional Female Students Grades Using Holm's Sequential Bonferroni Method 100

20. Results for Pairwise Comparisons of Nontraditional Female Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method 102

21. Admission to a Participating Community College Nursing Program by Delivery Format 103

22. Female Student Admission to a Participating Community College Nursing Program by Delivery Format 104

23. Male Student Admission to a Participating Community College Nursing Program by Delivery Format 105

24. Female Student Admission to a Participating Community College Nursing Program by Age Category and Delivery Format 106

25. On-ground Male Student Admission to a Participating Community College Nursing Program by Age Category 108

26. Anatomy 2 Lecture Final Examination Grades by Delivery Format 113

27. Anatomy 2 Lecture Final Lecture Grades by Delivery Format 114

28. Anatomy 2 Final Laboratory Course Grade by Delivery Format 115

29. Anatomy 2 Final Lecture Course Grade for Male Students by Delivery Format 117

30. Anatomy 2 Final Laboratory Course Grade for Male Students by Delivery Format 118

31. Anatomy 2 Final Lecture Course Grade for Female Students by Delivery Format 119

32. Anatomy 2 Final Laboratory Course Grade for Female Students by Delivery Format 120

33. Anatomy 2 Final Lecture Course Grade for On-Ground Students by Age Category 122

34. Anatomy 2 Final Laboratory Course Grade for On-Ground Students by Age Category 123

35. Anatomy 2 Final Lecture Course Grade for Online Students by Age Category 124

36. Anatomy 2 Final Laboratory Course Grade for Online Students by Age Category 125

37. Admission to a Participating Community College Nursing Program by Delivery Format 130

38. Female Student Admission to a Participating Community College Nursing Program by Delivery Format 131

39. Male Student Admission to a Participating Community College Nursing Program by Delivery Format 132

39. Female Student Admission to a Participating Community College Nursing Program by Age Category and Delivery Format 133

41. On-Ground Male Student Admission to a Participating Community College Nursing Program by Age Category 134

CHAPTER 1

INTRODUCTION

Background

The National Center for Educational Statistics (NCES) defined a nontraditional student as one with any of the following characteristics; a) delaying enrollment into a postsecondary college or university: b) attending college on a part-time basis only; c) working full time and not dependent on parents for financial aid; d) having dependents of their own, including single parents; or e) holding either no high school diploma or only a GED (Choy, 2002). The number of institutions offering online courses and the number of students enrolling in these courses continues to increase as many students, particularly nontraditional students, discover the advantages of online content delivery (NCES, 2011).

Many nontraditional students have significant time constraints that preclude access to typical on-ground higher education opportunities (Choy, 2002; Kadlubowski, 2000; Pelletier, 2010), and online course delivery provides an opportunity to enroll in courses at convenient times. On the other hand, online courses require new methods of communication between students and faculty, including new ways to build relationships, earn student trust, conduct appropriate assessment, and deliver content. Because many institutions—public, private, and for-profit—offer a wide variety of online coursework, there are ongoing concerns about the quality of online course content.

Consequently, researchers have continuing discussions in the literature concerning the efficacy of online coursework as compared to on-ground classes, attempting to determine whether online content delivery is as effective as face-to-face delivery in on-ground classes. While numerous studies demonstrated conclusively that online classes were less effective in

content delivery and in creating student success rates (Garman, 2012; Hara & Kling, 2000; Hughes, 2008; Xu & Jaggars, 2010, 2013), others found online classes to be as effective, if not more effective, in content delivery and student success as was on-ground coursework (Arle, 2010; Bata-Jones & Avery, 2004; Bird, 2010; Peat & Taylor, 2005; Riggins, 2014: Young, 2012). Consequently, researchers advocated for hybrid combinations of online and on-ground course content, insisting this approach was the most effective method of content delivery (Jaschik, 2012; McClure & Cook, 2012; Riffell &Merrill, 2005). An even bolder assertion made by Jaschik (2012) posited no difference in the efficacy of online or on-ground course delivery but that differences resulted from the student's amount of time spent on coursework. In other words, online students may have more success than their counterparts in on-ground classes simply because they spend more time on their coursework. Consequently, the key to the success in online learning may be nothing more than enhanced student engagement.

The numbers and types of courses from a variety of disciplines, including literature, history, foreign languages, and sciences, adapted for online delivery have increased significantly since 2000. Allen and Seaman (2013) reported that more than 62% of all institutions offering education degrees had programs delivered completely online. Further, the number of students enrolled in one or more online classes has increased significantly since 2002. In the fall semester of 2002 approximately 1,600,000 students, which represented 9.6% of all students enrolled in postsecondary institutions, enrolled in some type of online course (Allen & Seaman, 2013). By 2011 the number of students taking at least one course online rose to over 7,000,000, or 32% of all students (NCES, 2016). However, by the fall semester of 2014, the total number of online students in the United States had declined to 5,750,000 or 28.5% of all students (NCES, 2016).

Natural Science Courses

The online delivery of coursework in the natural sciences (biology, chemistry, and physics) courses traditionally offered as on-ground classes with separate hands-on laboratory components has been instrumental in raising concerns about the quality and efficacy of online science classes. Many, but perhaps not a majority, of science faculty remain skeptical about the effective delivery of course content in an online format (Lacey, 2013).

Studies conducted in several states supported this skepticism (Xu & Jaggars, 2010, 2013). A study conducted in 2012 comparing online and on-ground first semester biology, chemistry, and physics classes found that online science students were not as successful as were their on-ground counterparts (Colorado Department of Higher Education, 2012). Conversely, however, this study also demonstrated that online science students had higher grade point averages (GPAs) and more earned credit hours than did on-ground students. This could suggest that some online science students enjoyed greater success because they had more experience and more academic focus than on-ground science students did (Colorado Department of Higher Education, 2012).

Online Anatomy Coursework

Students intending to enter the nursing field must successfully complete prerequisite anatomy and physiology courses before applying for admission to a nursing program (Page, 2013). These gateway courses usually determine whether students have the qualifications to enter nursing or other healthcare professions. Anatomy and physiology courses outline the structures and functions of the body and provide the foundation for individuals involved in any form of healthcare (Page, 2013). Thus, the focus of the current study was whether particular online courses were as effective in delivering content as were their on-ground counterparts. Specifically, would students taking Anatomy and Physiology 2 (Anatomy 2) online be as

successful as were students in on-ground classes. A previous study by Garman (2012) found that online Anatomy and Physiology 1 (Anatomy 1) students were not as successful as were on-ground students. Additional studies at other institutions supported this position (Colorado Department of Higher Education, 2012; Hughes, 2008; Mentzer, Cryan, & Teclehaimanot, 2007). On the contrary, other studies found that online science students were just as successful in their coursework as were on-ground students (Arle, 2010; Bata-Jones & Avery, 2004; Bird, 2007; McClure & Cook, 2012; Young, 2012).

The 2012 Garman study, conducted at a community college in East Tennessee, found that Anatomy 1 students in on-ground classes had greater success than did online students, showing on-ground students had consistently higher average grades on the final examination (69% vs. 64%), final lecture grades (66% vs. 59%), and final laboratory grades (68% vs 61%), than did the online students. Garman suggested that, while on-ground students had consistently higher average grades, one reason the average grades for both online and on-ground students overall were very low might reveal more difficulty in course content than in course delivery. However, at this particular community college, Anatomy 1 was open to all students regardless of ability, science background, or grade point average (GPA) as long as there were no learning support holds. Students with learning support restrictions could not enroll in Anatomy 1until removing those restrictions. Admission into Anatomy 2 at this community college was even more restrictive. For students to enroll in Anatomy 2, they must have a grade of C or better in Anatomy 1. This restriction automatically selected students who demonstrated a certain level of success and should allow a more equitable comparison between online and on-ground Anatomy 2 students. As such, a direct comparison of online and on-ground Anatomy 2 student outcomes could be more indicative of the efficacy of online instruction at this particular community

college. For that particular study both the online and on-ground course at the participating community college in East Tennessee shared a common comprehensive final examination. Thus, a comparison of the final examination scores could assess whether there were differences in outcomes.

Statement of the Problem

In 2009 the expansion of the nursing program of the participating community college in the current study required additional sections of Anatomy 1 and Anatomy 2, gateway courses used to determine admission into healthcare programs. In response, the Natural Science Division of the participating community college increased the number of sections of on-ground classes and developed online versions of Anatomy 1 and Anatomy 2 lecture and laboratory courses that included all of the course content found in the on-ground courses. In addition to identical course content, both the online and on-ground lecture classes shared a common comprehensive final examination. Successful completion of Anatomy 1 and Anatomy 2 were prerequisites for admission into the nursing, the radiography, the physical therapy, and other allied health programs across the state of Tennessee and throughout the southeast United States. Because course content was the same, students who completed the online versions of Anatomy 1 and Anatomy 2 should be as successful as on-ground students and should gain admission to the nursing program at similar rates. However, the Garman (2012) study indicated that online Anatomy 1 students were not as successful as were on-ground students, but that study did not consider that Anatomy 1 had no prerequisites or restrictions. As a result, many students who begin Anatomy 1 are often ill prepared for the challenges of the course and fail or withdraw from class regardless of the course delivery. For a student to register for Anatomy 2, they must have

completed Anatomy 1 with a demonstrated level of success (a letter grade of C or better) regardless of the delivery method.

Students successful in Anatomy 1 should be successful in Anatomy 2 regardless of content delivery, but little conclusive evidence supported this belief. The problem investigated in the current study was to determine whether there were significant differences in student success between on-ground and online Anatomy 2 courses by evaluating student variables including final lecture examination grades, final lecture course grades, final laboratory grades, sex, and whether traditional-aged or nontraditional-aged. The purpose of this comparative study was to determine the value of course content delivery (online or on-ground) to final grades with regard to age (traditional-aged or nontraditional-aged) and sex for Anatomy 2 students, including a comparison of admission rates between online and on-ground students into the nursing program at a participating community college in East Tennessee.

The participating community college is a 2-year public institution in East Tennessee, governed under the Tennessee Board of Regents (TBR) system of community colleges and technology centers. This institution awards the Associate of Applied Science (AAS), Associate of Arts (AA), Associate of Science (AS), and Associate of Science in Teaching (AST) degrees in 88 different disciplines in addition to awarding Technical Certificates in 19 fields. Prior to 2008 student enrollment remained relatively constant with approximately 5,900 students registering each year. In 2009 enrollment increased to 6,854 students and to 6,960 students in 2010. The head count for the 2009 and the 2010 academic school years represented the largest enrollment in the history of the college (THEC, 2014). Since the peak enrollment in 2010 the headcount at the college has declined to the fall semester 2016 level of 6,004 students (THEC, 2017).

Research Questions

The study analyzed demographic data such as age and sex and academic data such as final examination grades, final lecture grade, and final laboratory grade, of students enrolled in online and on-ground Anatomy 2 courses at a community college in East Tennessee during a 5-year period. The following research questions guided the study.

Research Question 1

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture examination grade, the final lecture course grade, and the final laboratory course grade between online and on-ground course delivery?

Research Question 2

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 lecture final examination grade, the final lecture course grade, and the final laboratory course grade between online and on-ground course delivery when categorized by sex?

Research Question 3

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 lecture final examination grade, the final lecture course grade, and the final laboratory course grade between online and on-ground course delivery when categorized by traditional-aged and nontraditional-aged?

Research Question 4

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 lecture final examination grade, the final lecture course grade, and

the final laboratory course grade between online and on-ground course delivery when categorized by traditional-aged and nontraditional-aged and sex?

Research Question 5

Is there a significant difference in the proportion of students admitted into the participating community college nursing program between online and on-ground course delivery?

Research Question 6

Is there a significant difference in the proportion of students admitted into the participating community college nursing program between online and on-ground course delivery for traditional-aged females and nontraditional-aged females?

Research Question 7

Is there a significant difference in the proportion of students admitted into the participating community college nursing program between online and on-ground course delivery for traditional-aged males and nontraditional-aged males?

Significance of the Study

A direct comparison of online and on-ground student outcomes for Anatomy 2 may be more indicative of the efficacy of online instruction than is a comparison of the online and on-ground student outcomes for Anatomy 1 alone. Further, the results of this study may allow the Natural Science division of this participating community college to assess the effectiveness and quality of online instruction for Anatomy 2. Additionally, because the goal of many Anatomy 2 students is admission into a nursing program, the results of this study could assess whether online Anatomy 2 students gain admission into a nursing program at a proportional rate to on-ground students.

At the community college used for the current study Anatomy 1 classes are open to all students regardless of ability or GPA as long as there are no learning support holds. Learning support restrictions prevent students from enrolling in Anatomy 1 until removal of those restrictions. However, only those students who have earned a C or better in Anatomy 1 can register for Anatomy 2. This restriction automatically selects students who have demonstrated a specific level of success: consequently, the course will allow a more equitable comparison of online and on-ground students. By restricting the current study to Anatomy 2 students, a more valid analysis can evaluate the efficacy of online delivery at this participating community college.

The college's primary requirements for admission into the nursing program are successful completion of Anatomy 1 and 2 with a grade no lower than C. Students who repeat Anatomy 1 or Anatomy 2 due to a grade lower than C or a withdrawal do not receive credit for repeating the course unless they earn a higher grade. Students usually complete their general education requirements before admission as well.

Definition of Terms

Numerous terms describe online and on-ground course content, methods used to deliver content, and student descriptors. For the purposes of this study the following definitions will apply for clarity:

Asynchronous instruction. Asynchronous instruction is instruction offered via Web technology that is available at all times and does not require to students to be on campus (Haslem, 2014).

Distance education. Distance education courses include live, interactive audio or videoconferencing; prerecorded instructional videos, webcasts, CD-ROMs or DVDs, or

computer-based systems accessed over the Internet but does not include correspondence courses (National Center for Education Statistics [NCES], 2014).

Final examination grade. For this study the final examination grade was the letter grade earned by online and on-ground students on the comprehensive Anatomy 2 final exam offered at the participating community college (R. Wilson, personal communication, June 2, 2016).

Final laboratory course grade. For this study the final laboratory course grade was the final letter grade earned by online and on-ground students for the Anatomy 2 laboratory course offered at the participating community college (R. Wilson, personal communication, June 2, 2016).

Final lecture course grade. For this study the final lecture course grade was the final letter grade earned by online and on-ground students for the Anatomy 2 lecture course offered at the participating community college (R. Wilson, personal communication, June 2, 2016).

Sex. For the purposes of this study the definition of sex was male or female per the self-reporting requirements of the participating community college (R. Wilson, personal communication, June 2, 2016).

Hybrid with asynchronous component. A hybrid class that uses both classroom and online instructional modes and meets 25%-75% of the course contact hours as described in the syllabus (CPP, 2011).

Massive open online courses (MOOCs). MOOCs enable an unlimited number of students to take courses from faculty members who design and lead the course (Hill, 2012).

Nontraditional-aged student. For the purposes of this study nontraditional-aged students included students over the age of 24 (NCES, 2014).

On-ground class. For this study on-ground classes were courses that met in a face-to-face format, often called traditional format, but might use Web-based technology to facilitate the class through a course management system or Web pages to post syllabi, additional content, and assignments (Allen & Seaman, 2014).

Online class. For this study online courses were those in which at least 80% of the course content delivery was online (Allen & Seaman, 2014).

Synchronous instruction. Synchronous instruction requires the simultaneous participation of all students and instructors and considered *real-time* instruction involving chat rooms, Web-conferencing, and virtual worlds (Technology Source, 2016).

Traditional-aged student. For this study traditional-aged students included those 24 years of age or younger (NCES, 2014).

Limitations and Delimitations

This study was delimited to students who registered for the Anatomy 2 course at a participating community college in East Tennessee in either an online or an on-ground format and may not be generalizable to other courses. One assumption of the study is that the methodology adequately addresses the research questions and that the statistical tests are appropriate and possesses the necessary power to detect differences in the variables if present.

This study was delimited to students who achieved a grade of C or better in Anatomy 1 on their first or second attempt and registered for the Anatomy 2 course at a participating community college in East Tennessee. The study was also delimited to analysis of final examination grades, final lecture grades, and final laboratory grades for Anatomy 2 students in online and on-ground classes. The selected theoretical framework for this study derived from

previous research in similar studies. The results of this study may not be generalizable to other groups of students or to other school environments.

Overview of the Study

Chapter 1 presented the introduction, statement of the problem, research questions, significance of the study, definition of terms, and limitations of the study. Chapter 2 contains the review of related literature and research related to the problem under investigation. The methodology and study design are in Chapter 3. The results of the findings are in Chapter 4, while Chapter 5 contains a summary of the study and findings, conclusions drawn from the findings, a discussion, and recommendations for further study.

CHAPTER 2

REVIEW OF LITERATURE

There has been continuing discussion in the literature over the efficacy of online delivery compared to traditional on-ground classes. This discussion attempted to determine whether online classes and course content delivery were as effective in enhancing student learning as traditional on-ground classes were. Numerous studies (Garman, 2012; Hara & Kling 2000; Hughes, 2008; Xu & Jaggars, 2010, 2013) demonstrated that online classes were less effective than on-ground classes, while other researchers claimed that online classes were just as, or more, effective in student success than was on-ground coursework (Arle, 2010; Bata-Jones & Avery, 2004; Bird, 2010; Peat & Taylor, 2005). Other researchers (Jaschik, 2012; McClure & Cook, 2012; Riffell &Merrill, 2005) noted the most effective delivery method for course content might be a hybrid combination of online and on-ground instruction. An even bolder assertion by Jaschik (2012) posited no difference in the efficacy of online or on-ground course delivery but that differences resulted from the student's amount of time spent on coursework. In other words, online students may have more success than their counterparts in on-ground classes do simply because they spend more time on their coursework. Consequently, the key to the success in online learning may be nothing more than enhanced student engagement.

Courses from a variety of disciplines including literature, history, foreign languages, and traditional science classes have adapted to online delivery. However, the online delivery of content in biology, chemistry, and physics courses, traditionally taught in on-ground format with an accompanying laboratory section, raises concerns about the efficacy of content delivery and course outcomes compared to traditional on-ground science classes. Many, but perhaps not a majority, of science faculty are skeptical that delivery of an in-depth major science course can be

successful in an online format (Lacey, 2013). On the other hand, some studies indicated that science students seemed to enjoy greater success in traditional on-ground courses as opposed to online classes (Xu & Jaggars, 2010, 2013), while others demonstrated that online science students had higher grade point averages (GPAs) and more earned credit hours than traditional students did (Colorado Department of Higher Education, 2012). This could suggest that some online science students enjoy greater success simply because they had more experience and more academic focus (Colorado Department of Higher Education, 2012).

Garman (2012), in a previously mentioned study, found that Anatomy 1 students in online classes at a community college in East Tennessee were less successful than were on-ground Anatomy 1 students. Anatomy 1 at this particular institution was open to all students regardless of ability or grade point average (GPA) as long as there were no developmental holds. Students with developmental restrictions may not enroll in Anatomy 1 until removal of those restrictions. Admission into Anatomy 2 is more strenuous; thus, research into the success of those particular students might offer greater insight.

The History of Online Education

Distance education has numerous definitions. For example, Greenberg (1998) defined distance education as "a planned teaching/learning experience that uses a wide spectrum of technologies to reach learners at a distance and is designed to encourage learner interaction and certification of learning" (p. 36). Teaster and Blieszner (1999) stated that in distance education "the teacher and the learner are separate in space and possibly time" (p. 741), while Keegan (1995) defined the term as a process that eliminated the need for students to travel to "a fixed place, at a fixed time, to meet a fixed person, in order to be trained" (p. 7). In an attempt to develop a comprehensive definition, the National Center for Educational Statistics (NCES)

(2011) defined distance education as "primarily delivered using live, interactive audio or videoconferencing, pre-recorded instructional videos, webcasts, CD-ROM, or DVD, or computer-based systems delivered over the Internet. Distance education does not include correspondence courses" (p. 19).

One of the earliest examples of distance education—a forerunner of contemporary online education—might trace to the letters of St. Paul sent to the 1st century Christian churches to provide instruction on faith and worship. A more recent example of distance education occurred in 1728 when Caleb Phillips advertised in the *Boston Gazette*, offering instruction in shorthand through a correspondence course (Thompson, 2016). In 1840 Sir Isaac Pitman taught shorthand in England through correspondence courses and, in 1852 his brother Benjamin offered shorthand by correspondence in the United States (Pappas, 2013). As early as 1892 the term distance education appeared in an educational pamphlet published by the University of Wisconsin (Stanard, 2014).

In 1883 distance education achieved a level of academic legitimacy when the Chautauqua College of New York received authorization to grant degrees to students who completed correspondence work during the academic year in conjunction with participation in the college's summer institutes (Nasseh, 1997). During the same year a private school, the Colliery Engineer School of Mines, established a correspondence program to teach mine safety. Based on the success of that program, the school added other correspondence courses and the school renamed the International Correspondence Schools in 1891 (Moore & Kearsley, 2011). Between 1890 and 1930 the success of the International Correspondence Schools program led to the development of over 200 similar programs addressing a wide range of vocational topics (Moore & Kearsley, 2012).

By the early part of the 20th century numerous universities discovered the benefits of correspondence courses in reaching a broader student base (White, 1982). By 1938 the first International Conference for Correspondence Education addressed issues on instruction, accreditation, and course content (Lee, 2009). In the United States broadcasters adapted the use of radio and television for distance education. In fact, the University of Louisville, in conjunction with the National Broadcasting Corporation (NBC), developed a distance education program for local residents where they could register for classes, receive their course materials through the mail, and listen to lectures over the radio (Cox & Morison, 1999).

By the 1960s a multimedia approach of distance education applied television, audio and video tapes, residential short courses, and limited computer applications usually accessed through some type of mainframe system hardwired to a terminal (Sumner, 2000). Most of the course content delivery was in a one-way format with little interaction between the students and the instructor or among their classmates. Fortunately, the development of the Internet provided an opportunity for students to interact with instructors in real time and discuss course content with other students. In 1997 Western Governors University was founded when 19 western state governors came together following a proposal by the Governor of Utah to create a multi-state online university (Thompson, 2016). Western Governors University has experienced significant student demand and has since expanded into Indiana in 2010 and Tennessee in 2013 (WGU, 2014). At the beginning of the 21st century student enrollment in online courses began to significantly increase and many traditional institutions made online courses a regular part of their curricula.

According to Clinefelter and Aslanian (2015) online students at the undergraduate level were more than 70% female and at the graduate level the percentage of female students increased

to 72%. These values reflected the overall majority of female students found in all undergraduate and graduate courses. In the *Condition of Education 2015* the authors of the study reported that 56% of all undergraduate students and 59% of all graduate students were female (Kena et al., 2015). In addition, Clinefelter and Aslanian (2015) reported that 34% of all online undergraduate students were under 24 years old or considered traditional students, an increase from 25% in 2012 while only 19% of all online graduate students were under 24. The authors suggested an upward trend in the numbers of traditional students enrolling in undergraduate online classes, while the mean age of the typical online undergraduate student was 32.3 years and the mean online graduate student age was 35 years.

Americans continue to seek access to higher education. Hebel (2010) stated that according to the Georgetown University Center on Education 60% of all positions in the United States work force required some type of postsecondary degree. At the time of this study, however, only 38% of the American work force held some form of college degree. Of interest, Hebel found that the state with the lowest degree attainment was West Virginia at 25%, while Massachusetts had the highest percentage of the workforce with a degree at slightly less than 50%. In addition to these low levels of degree attainment, Hebel reported that 22 % (37 million workers) of the working population attended some form of college but did not complete a degree program. Many of these former students, the very type of nontraditional students who could take advantage of online programs, stopped attending for a variety of reasons, including cost, family commitments, time requirements, employment issues, or lack of convenient meeting time for classes.

From 2000 to 2008 the number of undergraduate students enrolled in at least one online class increased from 8% to 20%, and students enrolled in a completely online degree program

rose from 2% to 4% (NCES, 2011). Kirtman (2009) reported that in the 2000-2001 academic year approximately three million students enrolled in some type of online course and that number increased to over four million by the 2007 academic year. Further, according to Kirtman more than 30% of all institutions offering education degrees offered program delivery completely online.

By 2011 the number of students taking at least one course online had risen to 6.7 million, an increase of 570,000 students from the previous year (Allen & Seaman, 2013). Ironically, at the same time overall enrollment in colleges and universities in the United States dropped for the first time in 15 years (Lederman, 2013). Student enrollment continued to decline through 2015 with a reported 18.6 million students enrolled in higher education nationwide, a 2% drop from 2014 (Clinefelter & Aslanian, 2015). Even though overall enrollment decreased, the numbers of students in online courses continued to climb. During the fall semester of 2013 the National Center for Education Statistics (2015) reported that 27% of all undergraduate and graduate students in the United States enrolled in some form of online course work at Title IV institutions. By 2015 the number of undergraduate students enrolled in full-time online classes had risen to 5.5 million with an annual increase of about 1% (Clinefelter & Aslanian, 2015). By 2016, the number of undergraduate students in online classes had risen to 5.8 million (Online Learning Consortium, 2017).

Community colleges benefitted from this increase in online registration. Two-year institutions educate 45% of all undergraduates in the United States and 27% of those students take some or most of their courses online (Barshay, 2015). Because of the apparent interest, community colleges expanded their online course offerings, and experienced an increase of 4.7% in online registrations from 2013 to 2014, despite an overall decrease in enrollment of 3.5% for

the same time (Smith, 2016). In spite of the increased offerings and apparent student interest, the question remained whether online content delivery was an efficacious method of instructing students in community colleges, and researchers continued to dispute positive findings. For example, Johnson and Mejia (2015) found that California community college students enrolled in online coursework had a 40% failure rate for the course, compared to the 30% failure rate reported for students in comparable on-ground classes.

Christensen and Horn (2011) described the rapid expansion of online content delivery in higher education as either a disruptive innovation or a process that could transform higher education by making content delivery more convenient and affordable. The authors compared the response to online education from traditional brick-and-mortar institutions as similar to the response of ocean-going sailing ships when steam-powered ships became practical. As with educators, the owners of sailing ships initially downplayed the impact of steam-powered ships but attempted a hybrid combination of steam and sail that was ultimately impractical. Consequently, by the early part of the 20th century all transoceanic sailing ship companies had gone out of business. Christensen and Horn (2011) stated that traditional institutions acted much like the owners of 19th century sailing ship companies because many were late to embrace online education, and when they finally realized the impact, they leaned toward some form of hybrid content.

Christensen and Horn (2013) found that universities offering course content and degree programs completely online were true examples of disruptive innovation. Online institutions began with the goal of making higher education convenient for those students who did not have the time or availability to attend a brick-and-mortar institution, in other words, the nontraditional student. Christensen and Horn (2013) noted that for-profit institutions such as the University of

Phoenix embraced the use of online course delivery in the 1990s and achieved great success in targeting an underserved market.

When institutions offer online courses, they generally limit the number available and continue to charge the same, or in some cases more, tuition and fees as they do for on-ground courses. Despite the convenience of online courses, students are neither saving time nor money because they are often limited to the number of courses they can take each semester due to the costs involved. However, the authors state that thanks to federally funded financial aid, colleges and universities could continue to charge the same for online or on-ground courses instead of reducing costs for online courses. Christensen and Horn (2013) predicted that students will become much more selective in their educational choices when faced with increasing tuition costs. In fact, Clinefelter and Aslanian found in their comprehensive 2015 study of online students that 45% selected an institution based on cost alone.

Efficacy of Online Courses

Allen and Seaman (2010) reported that reviews on the efficacy of online classes were mixed when compared to traditional coursework. In a 2003 study they reported 57% of college administrators rated the learning outcomes for online courses as equivalent to or better than outcomes in on-ground classes, and by 2010 that number rose to 66% (Allen & Seaman, 2010). Conversely, that also meant that slightly over one third of administrators considered online classes inferior to on-ground delivery. When evaluated by the type of institution—public, private, or for-profit—the number of academic administrators that deemed online courses equivalent was greatest at public colleges (75%), lowest at private schools (55%), and in the midrange (67%) at for-profit schools (Allen & Seaman, 2010). Further, almost one third of the

academic leaders of the 2,800 colleges surveyed stated they would have no concerns about the quality of online learning over the next 5 years.

The results of Allen and Seaman's (2010) study supported the position that at many institutions, though not all, online course delivery was an equivalent way to deliver content and enable more students, both traditional and nontraditional, to access higher education. Many academic institutions also posited that online courses were more cost-effective because they did not require dedicated classroom space. For example, at a community college in East Tennessee, the college's cost for an online or Web-based class was $4,927, while a comparable on-ground course cost $6,356 (M. Hunter, personal communication, September 16, 2015). The view that online courses were less expensive to maintain resulting in a cost-savings to the institution presumed that the use of new technology could enable greater efficiency in content delivery (Kirshstein & Wellman, 2012). However, not all institutions embraced online course delivery typically because of a reluctance to use of technology in the classroom with the associated costs or because of perceptions held by faculty and administrators that online courses were not as rigorous as were their on-ground counterparts. There could also be a continued perception that online students learned passively with no interaction with faculty or other students in their classes (Hara & Kling, 2000). Regardless, online courses provide flexibility for students without the available time to enroll in traditional on-ground classes because of work, family, or other commitments (NCES, 2011).

This pattern of flexibility and convenience in scheduling is particular attractive to students enrolled in graduate programs. Willging and Johnson (2009) found that graduate students, particularly nontraditional students, typically enrolled in online courses because of the

convenience and the flexibility in scheduling. Further, the authors found that graduate students considered online classes as effective as traditional on-ground classes.

Online learning became the new paradigm in education according to Allen and Seaman (2010). They reported an increase in the number of college administrators—from 59% in 2009 to 63% in 2010—who considered online education part of their long-term plans and goals. However, those values could be somewhat skewed because the authors noted the greatest increase in online students came from for-profit institutions which depended on online courses and distance education to attract and retain high numbers of students (Allen & Seaman, 2010). By 2013 the number of colleges and universities offering online programs rose to 2,250, a 23% increase from the previous year (Clinefelter & Aslanian, 2015).

According to Lacey (2013) while the number of students taking at least one online class continued to increase, there was significant disagreement between administrators and faculty on the value of online learning. Based on the *2012 Survey of Online Learning*, Lacey reported that 77% of academic administrators opined that online education was at least equivalent or superior to traditional on-ground courses. However, only 30% of faculty members at the surveyed institutions viewed online courses as legitimate. Allen and Seaman (2014) added that 69% of those academic administrators, an increase from the 63% they reported in 2010, noted that online education was part of their institutions' long-term strategies and that faculty needed to adapt to change. In a follow-up study the authors found the number of colleges that positioned online content delivery as part of their future plans increased to 91% (Allen & Seaman, 2014). Lacey asserted that this divergent opinion resulted from administrators viewing educational outcomes from a global perspective, while faculty focused on course quality and learning outcomes. Lacey

added that administrators appeared to focus on nontraditional students, attempting to provide more services and allowing them to attend classes at their convenience.

Student retention in online classes may often negate the benefits of convenience. Ali and Leeds (2009) found that retention rates for online classes were typically 20% lower than they were for the same on-ground class. Heyman (2010) also observed that online courses had higher attrition rates and lower retention rates than did traditional on-ground courses. Allen and Seaman (2013) reported that academic administrators noted the lower student retention rates as one of the reasons more institutions had not adopted online content delivery. Student retention is typically one factor that affects funding. In many states the basis of funding at the state level was not on the number of students enrolled but on the number of students retained from one year to the next. For example, in Tennessee the NCHEMS Information Center for Higher Education Policymaking and Analysis related that the average 3-year graduation rate for an associate's degree in 2010 was 26.2 %, while the average graduation rate for the United States was 29.2% (NCHEMS, 2013). One of the consequences of this relatively poor performance in graduation rates was the passage of the Complete College Tennessee Act in 2010. The purpose of this legislation was to increase Tennessee's graduation rates to at least the national average by 2025. To accomplish this the method of distributing state funding in higher education changed from an enrollment-based formula to an outcome-based formula. Thus, funding depended on several factors including the students' completion of 12, 24, and 36 hours of study as well as the number of degrees and certificates awarded. Student transfers, awards for full-time equivalents (FTE), job placement, and success in remedial and developmental studies also affected fund dispersal (Tennessee Higher Education Commission, 2010).

Perceptions of Efficacy

Not everyone perceives online coursework as equivalent to on-ground courses. Parker, Lenhart, and Moore (2011) reported on a Pew Research Center study that presented a distinct difference of opinion of the value of online education. According to the authors 89% of 4-year public colleges in the United States offered some form of online coursework as opposed to 60% of private 4-year colleges. Further, 51% of all public college presidents surveyed replied that their online courses were equivalent to on-ground courses, but this value dropped to 36% among private 4-year college presidents. When considering 2-year community colleges, the authors found that 91% of community colleges offered online courses and 66% of all community college presidents posited online education equivalent to on-ground courses. A survey of for-profit colleges and universities found 71% of those institutions offered online classes and 54% of their presidents reported online classes had the same value as on-ground classes. Interestingly, those values were higher than the perception of online courses by the American public. Parker et al. (2011) revealed that only 29% of American adults considered online coursework equivalent to on-ground courses.

The perception by the American public that online courses are less challenging than on-ground courses was also evident in a 2013 Gallup poll of 1,028 adults. According to Saad, Busteed, and Ogisi (2013) in this Gallup poll survey of perceptions of online and on-ground coursework, most Americans perceived online coursework as less demanding than on-ground courses, the faculty as less qualified, and online degrees as less credible for employment. Further, the survey found that only 34% of Americans rated online education as excellent or good compared to 68% for on-ground 4-year education and 64% for community colleges. While most Americans expressed that online education was easier than on-ground coursework, Saad et

al. discovered that half of all the Americans surveyed felt that obtaining knowledge and skills were more important than obtaining a degree. The authors suggested that online course content tailored to specific knowledge and skill sets might be what ultimately changes perceptions of online course delivery in higher education. A follow-up Gallup survey in 2015 of 1,527 adults found that the number of Americans who perceived online education as excellent or good had only risen from 34% in 2013 to 36% in 2015 (McCarthy, 2015).

The Cost of Online Classes

With continuing increases in tuition rates as well as student debt load, students may become more selective in their choice of institutions and content delivery. Smith (2013) argued that the rapid development of online course content and delivery not only changed the way students took courses but also changed the traditional approach of higher education funding. Smith compared the traditional approach for funding higher education to an economic model for marketing goods and services based on supply and demand, wherein students were the consumers and institutions were the product suppliers. However, Smith noted this was an imperfect model because the government manipulated the market by subsidizing the costs of the goods and services. The author stated that since the mid-1800s with the establishment of land grant institutions and later with the development of Pell grants and loan programs taxpayers continued to subsidize higher education. Instead of seeing education costs decrease as competition increased with more college choices, the cost of higher education continued to rise. Smith affirmed that approximately 66% of all colleges and universities offer online classes and over 33% of all current students have taken at least one class online. Smith added that because cost for online courses was significantly lower than traditional coursework, students should

realize a savings in tuition and fee costs for online classes. However, more than 90% of institutions charged the same or more for online classes than they did for on-ground classes.

Evidence of this cost disparity has been observed at numerous colleges and universities in the United States. A 2013 of survey of 300 public state institutions conducted by U.S. News & World Report and the American Association of State Colleges and Universities found that it was more expensive for a student to register for an online course than for its on-ground counterpart (Haynie, 2013). The survey found that the average in-state cost for an online bachelor's program was $277 per credit hour but only $243 per credit hour for the same class in an on-ground format. In 2014 a survey of 18 state universities in Texas found that 16 of the schools had tuition rates for online courses as much as 20% higher than comparable on-ground classes (Barnett, 2014). However, other institutions that have the same per hour tuition cost for online and on-ground classes believe that because the operational costs are identical, tuition costs should be identical (Cillay, 2014).

In Tennessee, for example, courses offered under TN eCampus (formerly the Regents Online Degree Program or RODP) cost approximately one third more than their on-ground counterparts (TN eCampus, 2017). According to Smith (2013) because the cost of online courses was the same or greater than were on-ground courses, colleges and universities often used the additional revenue to subsidize traditional classes. For example, at one community college in East Tennessee the tuition cost whether online or on-ground was $152 per credit hour (Walters State, 2017). However, the same course taken online through TN eCampus increased to $213 per credit hour (TN eCampus, 2017).

Efficacy of Online Science Education

Faculty and administrators must address ways in which to make the transition from delivering course content in a traditional setting to delivering the same type of content in an online format. Arle (2010) developed a systems approach at Rio Salado College to deliver an online anatomy course using four distinct content sections including an introduction, student instruction, self-assessment, and student learning. Arle began each new content section with an overview of new material and how it related to previous material. Additional instruction followed that included a list of learning objectives for the student to master using the resources provided. Self-assessment and student learning allowed individual assessment designed to stimulate critical thinking and graded assessment to determine student retention. The reported efficacy of the content delivery indicated students in online classes scored consistently higher than the national average (63% compared to 51%) on a standardized anatomy and physiology examination (Arle, 2010). The author did not describe how the institution transitioned from traditional to online courses, nor was the reasoning behind the switch in format explained.

Bird (2010) described an online science course that addressed a method of instructing first-year biology students in using a microscope, an essential skill needed by both undergraduate and graduate students in biology, particularly those involved in preprofessional and professional programs like medicine. Bird instructed first-year biology students in microscope skills in a traditional classroom setting in 2008 while first-year biology students in 2009 received instruction using an online microscopy package. To assess skill levels and compare the effectiveness of the two instruction methods, student assessment included a practical examination and a written examination at the conclusion of the course. The author compared the assessment results from the traditional instruction group to the assessment results of the online

instruction group. The results indicated that the learning outcomes of the online students were equivalent to or, in some cases, better than traditional methods.

However, Bird (2010) did not compare online and traditional students in either cohort and it was unfortunate that the study was not longitudinal before reporting these results. Because of the limited number of students, the author failed to demonstrate that online instruction for microscope skills was as effective as traditional instruction. Further, the author did not explain the way in which online instruction improved or enhanced microscope skills acquisition (Bird, 2010).

Hughes (2008) conducted a quantitative study on online course development, describing the successful conversion of an on-ground course into an online course. The course used in the study was Applied Microbiology, a biology course designed for hospitality and culinary students that had both a lecture and lab component (Hughes, 2008). The author converted the traditional course content from 27 lectures to 17 online lessons. Course content and lesson areas corresponded to one of the four lecture examinations given during the course (Hughes, 2008). Measurement of student learning involved an electronic drop box for homework assignments, required responses to a discussion board on a weekly basis, and a proctored examination to maintain academic integrity.

Hughes's approach was consistent with online course delivery at other institutions and similar to the format used by TN eCampus for online science classes. For example, in the TN eCampus online Anatomy 1 courses students submit assignments to a drop box, respond to discussion boards, and have their midterm and final examinations proctored (Garman, 2012). Because TN eCampus students come from all parts of Tennessee, these students may go to a

testing center at any Tennessee Board of Regents (TBR) institution close to their homes and take their proctored examinations at that location.

After developing the online course, Hughes (2008) found that over a 3-year period, on-ground students had a 97% completion rate for the course as opposed to a 95% completion rate for online students. The author noted that the success rate for on-ground students—based on at least a passing grade—was 96% compared to 82% for online students (Hughes, 2008). The author observed that the majority of on-ground students achieved a grade of B, while the online students had a mixture of B and C grades. While Hughes described successful development of online course delivery for a science course similar to models employed at other institutions, the course content did not have a required laboratory component, and the author did not address delivery of online laboratory content. From an anecdotal perspective, the grade distribution in the study described by Hughes was similar to the average grade distribution reported in online anatomy courses at the TN eCampus level (Garman, 2012).

Mentzer, Cryan, and Teclehaimanot (2007) reported similar results in a study comparing 36 undergraduate students randomly assigned to either an online or on-ground section of the same course with the same instructor and identical course content. The researchers reported mid-term and final examination scores as similar regardless of the delivery method employed. However, final course grades were significantly higher in the on-ground section because many online students failed to submit the required course assignments. Based on the quality of online students' course assignments compared to on-ground students' assignments, there were no significant differences in grades. Mentzer, Cryan, and Teclehaimanot suggested that a lack of direct interaction with faculty might have been a factor in the poor performance of online students on required course assignments.

Peat and Taylor (2005) offered methods to deliver hands-on science content in an online environment. The authors noted the advantages of replicating hands-on activities online provided students with realistic, three-dimensional examples of living organisms and structures without the cost and maintenance of using real specimens. This problem was similar to those experienced by students and faculty at various TBR institutions across Tennessee. For example, most community colleges in Tennessee no longer offer cadaver dissection for anatomy students because of the high cost associated with maintaining and preserving the cadavers. Another problem concerned the various ethical, cultural, and safety considerations in hands-on classes (Peat & Taylor, 2005). Again, TBR schools experienced the same problems. For example, when dealing with preserved specimens, pregnant students were cautioned to limit exposure to the preservative because of potential teratogenic risk. Some students had concerns about working with cadavers, and others might have cultural or religious prohibitions that prevented them from handing certain materials.

Peat and Taylor (2005) demonstrated that virtual biology was more cost effective than hands-on biology and could be used in any setting or environment. However, the use of virtual biology materials was not a new approach to teaching biology. Many schools in the TBR system used some type of virtual content to supplement and occasionally replace the hands-on content (Garman, 2012). While online implementation allowed content anywhere and eliminated safety or cultural issues, laboratory classes persisted in using the actual materials in on-ground classes. Peat and Taylor noted that virtual biology was, at best, a good supplement to hands-on science but was not the only way to deliver content.

Poster, Mancini, and Ganji (2013) described a successful online program developed for registered nurses transitioning from an RN to BSN degree at the University of Texas-Arlington

College of Nursing. The significance of the program was not that it was online but that it offered flexible scheduling and competitive pricing in a public and private partnership, resulting in a significant tuition savings for students. According to the authors approximately 18% of all registered nurses with an associate degree entered a bachelor's program and only 50% of all registered nurses held a bachelor's degree. Because the Institute of Medicine of the National Academy of Science recommended that at least 80% of all registered nurses have a baccalaureate degree by 2020 (Poster et al., 2013), the Arlington College of Nursing developed an online program for traditional and nontraditional students that attempted to preserve high quality and academic integrity while also being convenient, affordable, and flexible enough to take advantage of massive open online courses (MOOCs). Most MOOCs allow students to take coursework at no charge to determine if they are interested in returning to school. A private organization that specialized in converting traditional content to online content developed the course in a joint venture with the university. This partnership offered all prerequisite courses online and allowed students to start their program of study at eight different start dates during the year. Poster et al. stated that the cost savings of the online program resulted in a lower online program tuition of $8,995, which was 6.8 % lower than the tuition cost for the traditional program and much less than the $22,000 at comparable for-profit online programs. In 2013 admission into their program exceeded 10,000 students with 3,593 students graduated and approximately 350 to 550 new students starting every 8 weeks. By 2015 the number admitted to the program had risen to 17,000 with the number of start dates revised from every 8 weeks to five times per year with the first start date in May and the last start date in November (University of Texas, 2015).

However, the number of institutions that use MOOCs is small (2.6%), and the opinion on the effectiveness of MOOCs is divided. Approximately one half of the chief academic officers in institutions held no opinion on MOOCs, while the other half was evenly divided for and against MOOCs (Lederman, 2013). The greatest concern held by many academic administrators was whether MOOCs represented a viable and sustainable methodology for course content delivery (Allen & Seaman, 2013).

Bata-Jones and Avery (2004) offered additional support for online content delivery in a study that evaluated the effectiveness of online and traditional delivery methods of pharmacology instruction for graduate nursing students. The authors reported that in a three-credit graduate pharmacology course there were no significant differences in the examination scores between the online course and the on-ground course. To reduce variability in the study the students had no prior knowledge of whether they enrolled for an online or on-ground course; the same instructor taught both courses, and students took the same examinations. While this study reinforced the prevailing view among many instructors that online instruction was equivalent to on-ground, it also demonstrated that graduate education might provide a better format for online instruction (Bata-Jones & Avery, 2004).

McClure and Cook (2012) reported similar results from a study comparing lecture and laboratory examination scores for online and on-ground anatomy students. The authors discovered that the examination scores of online anatomy students were significantly higher than those of the on-ground anatomy students. They suggested that online learning was more effective but posited that a hybrid approach would offer better content delivery and student success (McClure & Cook, 2012).

Riggins (2014) conveyed that community college students enrolled in online or on-ground General Biology 1 lecture and laboratory course demonstrated no significant difference in overall test scores. Further, the author noted that when these students took qualifying examinations as a requirement prior to entry into the next level of biology courses, there was no significant difference in test scores between online and on-ground students. Riggins also observed that online students had a 25 % greater attrition rate in General Biology 1. The author did not consider the effect of age, sex, or previous science education on student success and did not offer any suggested reasons for the greater attrition rate among online students.

Another hybrid approach involved an online e-learning technology program to supplement course content for on-ground Anatomy 1 students. Young (2012) recounted that students registered for Anatomy 1 had to complete scheduled assignments consisting of quizzes, homework assignments, videos, and virtual experiments that represented 12.5% of their final grade in the online technology program that corresponded to their course textbook. In comparing the final grades of students completing Anatomy 1 the previous year, the overall final grade average for students increased from 72% to 78%. More significantly, the number of students earning a letter grade of A increased from 0% to 6% and from 11% to 20% for a letter grade of B. While this hybrid approach demonstrated a successful combination of online and on-ground content delivery, the overall increase in final grade average could simply be the result of the weight assigned to the technology program homework assignments. In addition, students worked together on homework, which may have artificially inflated scores. Further, the overall final grade average did not improve beyond that of C despite the use of the technology program (Young, 2012).

In 2010 Xu and Jaggars evaluated online versus on-ground course outcomes across the Virginia community college system to determine if online courses were equivalent to on-ground courses. The authors evaluated student outcomes for the 2004 through 2008 student cohort, considered the type, kind, and frequency of online courses taken, and compared the educational outcomes of prepared and unprepared student retention and performance. The authors found that while the more academically prepared students were likely to enroll in online courses, online students had a higher failure or dropout rate than did students in traditional courses. Further, they found that students who took most of their courses online were less likely to transfer to a 4-year college or university (Xu & Jaggars, 2010).

In 2013 Xu and Jaggars examined online versus on-ground course outcomes across the Washington State Community College system. The authors reported that the average persistence rate for on-ground courses was 94.5% compared to 91.2% for online courses in all discipline areas evaluated. Further, Xu and Jaggars discovered that the average GPA for students in on-ground courses was 2.98, while students in online classes had an average GPA of 2.77. This finding contradicted the generally accepted view of many educators that online courses were equivalent to on-ground courses and reinforced the results of the researchers' previous study of the Virginia Community College system. While these results might have been an anomaly when compared to national data, the authors reported that over 500,000 students were in the Washington State Community College system with more than 10,000 enrolled in online courses (Xu & Jaggars, 2013). However, the evaluation of Washington students was based on a narrow range of criteria that did not conclusively demonstrate online course efficacy. While the number of students considered in the Xu and Jaggars study was significantly larger than any other study

conducted to that date, the authors' primary criterion for evaluating students depended only on the distance the students had to travel to reach a campus (Xu & Jaggars, 2013).

Brown (2011) noted the same group of Washington students enrolled in online classes had completion rates 8% lower than students enrolled in similar on-ground classes. In a study that tracked 51,000 students from 2004 through 2009 the author observed that students registered for online classes in their first and second years were more likely to drop out of college than were students registered only for on-ground classes. Further, the more online credits a student accumulated, the more likely they were not to graduate or transfer to a 4-year school. In the period of the study 33% of the students observed enrolled in at least one online course, and online students had an 82% completion rate compared to a 90% completion rate for students enrolled in on-ground classes. The differences in completion rates were even greater in remedial courses. Students enrolled in online remedial classes had a completion rate of 74% compared to an 85% completion rate for on-ground remedial classes (Brown, 2011).

The enrollment pattern seen in Washington State reflected the overall growth trends in online classes previously reported by Allen and Seaman in 2009. The authors found that online enrollment had a growth rate of 21% compared to the overall higher education growth rate of a modest 2%, with over 5.6 million students taking at least one online course, an increase of one million students since 2008 (Allen & Seaman, 2009). The number of institutions offering online courses and the number of students enrolling in these courses also increased as many students, particularly nontraditional students, discovered the advantages of online content delivery (NCES, 2011). By the fall semester of 2014 registration statistics revealed that 5.8 million students were in at least one online class, an increase of 3.9% from the fall semester of 2013 (Friedman, 2016). Of these, 2.8 million students registered exclusively for online classes (NCES, 2015).

Wojciechowski and Palmer (2005) revealed that online courses also had a higher withdrawal rate than their on-ground counterparts. They cited the national average online withdrawal rate of 50%, which was 10 to 20 percentage points higher than the withdrawal rate for on-ground classes. This was consistent with overall completion rates for undergraduates in community colleges nationally. The average community college has a 6-year student completion rate of 39% (Fain, 2015) in contrast to the 6-year student completion rate at 4-year degree granting institutions of 60% (NCES, 2017).

A study conducted by staff members of the Colorado Department of Higher Education (CDHE) (2012) evaluated student success in online and on-ground courses for students in the Colorado Community College System. The Colorado study compared the academic performance of online students to the performance of on-ground students to determine the level of preparation necessary to succeed in upper level science courses at 4-year schools. The CDHE study concluded that online students were not as successful in online science class as were students in on-ground classes. The study evaluated 4,500 students in on-ground and online first semester biology, chemistry, and physics classes and considered three variables: cumulative GPA, cumulative credit hours, and grades in the online or on-ground courses. The study found that students in on-ground biology and chemistry courses had higher course grades than online students but grades for physics students showed no appreciable differences. However, the study also demonstrated that collectively, online students had higher GPAs and more earned credit hours than on-ground students. This could suggest that online students enjoy greater overall academic success because they are more experienced and more focused academically (Colorado Department of Higher Education, 2012).

The Colorado Community College System also evaluated student performance in upper level science classes by following the academic achievements of over 400 science students at 4-year institutions. This follow-up study found that there was no significant difference in science course GPAs between online students and on-ground students and suggested that, at least in Colorado, online science students are as academically prepared for upper level courses as are on-ground students (Colorado Department of Higher Education, 2012).

Garman (2012) demonstrated that in certain cases online science courses might not be as effective in delivering course content as on-ground courses. To determine whether specific online courses were equivalent to on-ground courses, Garman conducted a quantitative study to compare student success in online and on-ground first semester science courses at a community college in the Tennessee Board of Regents system. The author compared lecture grades, lab grades, final course grades, student attrition, and student age from 170 on-ground and 127 online sections of Anatomy 1 from the fall semester of 2008 through the spring semester of 2011 to evaluate equivalency (Garman, 2012).

Garman found significant differences between online and on-ground average lecture, lab, and final grades with on-ground students consistently achieving higher grades than did online students. The author also uncovered a higher attrition rate for online students than for on-ground students. When compared by age, Garman noted no statistical difference between traditional students (those 24 years of age or less) and nontraditional students (those greater than age 24) in on-ground courses. The author reported that nontraditional students had statistically significant lower online success rates compared to traditional students. Student success in anatomy courses can often be predictors of success in later nursing programs (Herrera & Blair, 2015). In a study comparing final grades in undergraduate anatomy Herrera and Blair showed a direct correlation

between successful completion of undergraduate anatomy and later success in upper level nursing courses.

In contrast to the Garman study, Amro, Mundy, and Kupczynski (2015) disclosed that age was not a significant factor in student success. In a quantitative study using archival data they evaluated the impact of age and sex on success rates for students in online and on-ground college algebra classes at a Texas college and discovered that on-ground students consistently earned higher grades than did online students. The study addressed the academic years 2010-2013 and used a sample size of over 8,000 students with 7,800 students enrolled in on-ground college algebra classes. Of the students enrolled in on-ground classes 41% or 3,200 were male and 59% or 4,600 were female. There were 440 students enrolled in online classes with 31% or 135 students male and 69% or 308 were female (Amro et al., 2015). The authors noted that the mean age for on-ground students was 25 and the mean age for online students was 27. Analysis of student grades revealed that the overall average grade for on-ground students was higher than the overall average grade for online students (2.98 for on-ground; 2.20 for online). Grades for both male and female on-ground students for college algebra were consistently higher than were grades for online students. On-ground female students also had higher average grades than did on-ground male students, with an average grade of 3.05 for female students compared to 2.88 for male students. Online students had an average grade of 2.20 with online female students earning a final grade of 2.21 and online male students earning a final grade of 2.16. When evaluating students by age and sex, the authors found no significant difference in grades between online and on-ground students (Amro et al., 2015).

The results of the Amro et al. study in respect to age, however, were inconsistent with the findings of Jackson-Smith in 2017. In a comprehensive study using archival data involving

23,000 developmental mathematics students from a Central Florida state college, Jackson-Smith found differences in student success rates (pass/fail) between traditional and nontraditional students and between male and female students. When categorized by age nontraditional students had success rates of 59% compared to 58.6% among traditional students. When categorized by sex female students had a success rate of 61.1% compared to 57.3% among male students.

The Hybrid Option

A 2012 meta-analysis conducted by the Department of Education (DOE) validated the opinion held by the majority of college administrators on the positive effect of online education but did not express that online learning was superior to traditional on-ground classes (Jaschik, 2012). According to the DOE study students enrolled in hybrid classes—part on-ground and part online—fared significantly better than did students in either completely online or completely on-ground formats. The DOE meta-analysis suggested that online students did better than students taking the same course through on-ground delivery (Jaschik, 2012). The DOE meta-analysis evaluated over 1,000 studies conducted from 1996 to 2006 but ultimately considered only 50 studies as conclusive. Studies considered conclusive had to demonstrate a valid research design that adequately measured student learning outcomes (Jaschik, 2012).

Conclusions drawn from the meta-analysis did not support the position that online learning was superior to traditional on-ground classes. In fact, one of the most significant conclusions drawn in the study was that student success in online learning was not a result of the application of technology in content delivery but rather a result of the amount of time spent by the student working on online content and assignments. Students may have been more

successful in online classes simply because they spent more time on their coursework than did students enrolled in traditional classes (Jaschik, 2012).

Riffell and Merrill (2005) evaluated student performance in hybrid classes comparing first semester preprofessional biology students enrolled in either a traditional laboratory session or a hybrid laboratory session. The study involved 28 laboratory sessions with identical content, consisting of approximately 700 students with 14 sessions taught in a traditional format and 14 sessions taught in a hybrid format, substituting 1 hour of in-class content for 1 hour of on-line content (Riffell & Merrill, 2005). To avoid bias in student selection students did not know which laboratory session (hybrid or traditional) they would attend until the first class. The authors evaluated the overall laboratory scores and results on common laboratory final examination questions and found no difference between student outcomes in the hybrid or traditional laboratory sections.

Rubin (2013) supported the use of a hybrid approach and argued that online education might be most effective when combined with face-to-face participation in an application of blended learning. The author reported a demonstration project conducted by edX, a partnership between Harvard and MIT, designed to address the most significant problem with MOOCs—most students who registered for MOOCs failed to complete the class because they received no feedback and were not taught to think critically (Rubin, 2013). Rubin reported that a blended or hybrid approach could help overcome this problem and enhance critical thinking skills at nominal cost.

Student Success in Online Classes

Online courses typically require more self-discipline from students and the reported lower scores in many online courses may reflect student application rather than content. Young

and Duncan (2014) reported that when asked to compare the two delivery methods college students rated communication, faculty/student interaction, grading, instructional methods, and course outcomes for on-ground classes significantly higher than they did for online courses. However, student effort rated significantly higher in online courses compared to on-ground classes. Clinefelter and Aslanian (2015) revealed that 43% of online students reported spending 6-10 hours per week on coursework for each online course enrolled.

Wojciechowski and Palmer (2005) investigated student success and failure rates by following students in the same community college online business course over a 3-year period. The basis of their study was to determine the relationship, if any, between various student characteristics and student success, i.e., could any of these characteristics be a predictor of success. The characteristics that the authors examined included the overall GPA of each student, attendance at class orientation sessions, previous online course experiences and withdrawals, standardized test reading and English scores, and the age of the student. According to the authors while all of the characteristics examined had significant positive relationships with student success, regression analysis indicated that two characteristics, orientation attendance and GPA, were the most effective predictors (Wojciechowski & Palmer, 2005).

The authors argued that the predictors found in their study enabled faculty to recommend on-ground or online classes to students at risk. However, one of the two most effective predictors found by the study was student GPA, indicating students with higher GPAs tended to do better in online classes. While there was significant correlation reported for this predictor, this is generally true for all students in all classes. Students with high GPAs are generally more successful because they know how to study, tend to be more disciplined, and are more focused on their coursework. The authors noted that nontraditional students consistently had higher

grades than traditional students and also found that the younger the student enrolled in online classes, the lower the grade earned.

Wilson and Allen (2011) observed the role of student GPA in their study, comparing success rates of online and on-ground students in a 1-semester management course at a Historically Black College or University (HBCU). Their study considered the success rates of approximately 100 students in two different business management courses, one section taught as a traditional on-ground course and the other taught as an online course. The authors found three differences between online and on-ground students: online students were predominately female, nontraditional (i.e., age greater than 24 years), and completed more semester hours than on-ground students (Wilson & Allen, 2011). When compared by completion, withdrawal, and failure rates, the authors found no significant difference between online and on-ground students. However, they also recounted that online students, completing their respective courses, had more earned semester hours of credit and higher GPAs than did their on-ground counterparts. The authors concluded that cumulative student GPA appeared to be the determining factor for student success, i.e., students with higher GPAs had greater success in both online and on-ground classes (Wilson & Allen, 2011).

Brau et al. (2010) compared on-ground, online, and hybrid student success and retention rates at a community college in Oregon and discovered that while online and hybrid classes were often the same size as on-ground classes, there was a significant difference in grade distribution between on-ground, online, and hybrid classes. The authors defined completion rate as the percentage of students who remained enrolled at the end of the course and success rate as the percentage of students who earned a grade of A, B, C, or P, for passing in a Pass/Fail class (Brau et al., 2010). Study findings indicated that online hybrid classes had fewer letter grades of A,

fewer incompletes, and more letter grades of C, D, or F than did their on-ground counterparts. Brau et al. also noted that on-ground classes had a slightly higher average completion rate (92%) compared to both online classes (88%) and hybrid classes (91%). Average success rates reported by the authors ranged from 82% for on-ground classes, 78% for online classes, and 80% for hybrid classes. Brau et al. observed an uneven distribution of online and hybrid classes at the study site with most online and hybrid classes offered in only a few departments including Business, Health Professions, Language, Literature and Communications, and the Social Sciences.

Young and Duncan (2014) found online students needed more discipline and more focus to succeed. The authors reported that when community college students rated and compared online and on-ground courses concerning communication, faculty to student interaction, grading, instructional methods, and course outcomes, on-ground courses rated significantly higher than did online courses. However, student effort rated significantly higher in online courses.

Summary

The results of studies comparing on-ground, online, and hybrid delivery methods offered mixed findings. Previous studies indicated that age, self-discipline, and grade point average may be important to success in online courses. Others, however, indicated that student effort was a factor in outcomes.

CHAPTER 3

RESEARCH METHOD

This chapter introduces the methodology providing the quantitative research framework for the study and including the proposed research questions and null hypotheses, instrumentation, population, data collection, and data analysis. This was a nonexperimental design study involving secondary data analysis that described what occurred previously, explored comparisons among groups, and examined trends within the data (McMillan & Schumacher, 2010).

Research Questions and Null Hypotheses

The study analyzed demographic data such as age and sex and academic data such as final examination grades, final lecture grades, and final laboratory grades on students enrolled in online and on-ground Anatomy 2 courses at a community college in East Tennessee during a 5-year period. The following research questions guided the study.

Research Question 1

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 lecture final examination grade, the final lecture course grade, and the final laboratory course grade between online and on-ground Anatomy 2 course delivery?

$Ho1_1$: There is no significant difference in the proportion of students receiving grades of A, B, C, D, or F for the Anatomy 2 lecture final examination grade between online and on-ground Anatomy 2 course delivery.

$Ho1_2$: There is no significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade between online and on-ground Anatomy 2 course delivery.

$Ho1_3$: There is no significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final laboratory course grade between online and on-ground Anatomy 2 course delivery.

Research Question 2

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade and the final laboratory course grade between online and on-ground Anatomy 2 course delivery when categorized by sex?

$Ho2_1$: There is no significant difference in the proportion of male students receiving grades of A, B, C, D, F, or W for the lecture final course grade between online and on-ground Anatomy 2 course delivery.

$Ho2_2$: There is no significant difference in the proportion of male students receiving grades of A, B, C, D, F, or W for the laboratory final course grade between online and on-ground Anatomy 2 course delivery.

$Ho2_3$: There is no significant difference in the proportion of female students receiving grades of A, B, C, D, F, or W for the lecture final course grade between online and on-ground Anatomy 2 course delivery.

$Ho2_4$: There is no significant difference in the proportion of female students receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

Research Question 3

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the final lecture course grade and the final laboratory course grade between online

and on-ground Anatomy 2 course delivery when categorized by traditional-aged and nontraditional-aged?

$Ho3_1$: There is no significant difference in the proportion of traditional students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade between online and on-ground Anatomy 2 course delivery.

$Ho3_2$: There is no significant difference in the proportion of traditional students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

$Ho3_3$: There is no significant difference in the proportion of nontraditional-aged students (over 24 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade between online and on-ground Anatomy 2 course delivery.

$Ho3_4$: There is no significant difference in the proportion of nontraditional students (over 24 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the Anatomy 2 final laboratory course grade between online and on-ground Anatomy 2 course delivery.

Research Question 4

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade and the final laboratory course grade between online and on-ground Anatomy 2 course delivery when categorized by traditional-aged and nontraditional-aged and sex?

$Ho4_1$: There is no significant difference in the proportion of traditional-aged male students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final lecture course grade between online and on-ground Anatomy 2 course delivery.

$Ho4_2$: There is no significant difference in the proportion of traditional-aged male students receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

$Ho4_3$: There is no significant difference in the proportion of nontraditional-aged male students (over 24 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final lecture course grade between online and on-ground Anatomy 2 course delivery.

$Ho4_4$: There is no significant difference in the proportion of nontraditional-aged male students receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

$Ho4_5$: There is no significant difference in the proportion of traditional-aged female students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final lecture course grade between online and on-ground Anatomy 2 course delivery.

$Ho4_6$: There is no significant difference in the proportion of traditional female students receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

$Ho4_7$: There is no significant difference in the proportion of nontraditional-aged female students (over 24 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final lecture course grade between online and on-ground Anatomy 2 course delivery.

$Ho4_8$: There is no significant difference in the proportion of nontraditional female students (over 24 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

Research Question 5

Is there a significant difference in the proportion of students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery?

$Ho5_1$: There is no significant difference in the proportion of students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

$Ho5_2$: There is no significant difference in the proportion of female students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

$Ho5_3$: There is no significant difference in the proportion of male students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

Research Question 6

Is there a significant difference in the proportion of traditional-aged female and nontraditional-aged female students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery?

$Ho6_1$: There is no significant difference in the proportion of traditional-aged female students and nontraditional-aged female students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

Research Question 7

Is there a significant difference in the proportion of students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery for traditional-aged males and nontraditional-aged males?

$Ho7_1$: There is no significant difference in the proportion of traditional-aged male students and nontraditional-aged male students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

Instrumentation

The participating institution's student and course database systems provided the secondary data used in this nonexperimental design study. The academic division deans had access to student records for those taking courses within their respective divisions. For this study the Dean of Natural Sciences provided data on individual course outcomes at the division level data and the community college's Office of Planning, Research, and Assessment provided registration data. Using this system the researcher generated data on student demographics, including age and sex, course registration, and final grades in Anatomy 2 lecture and laboratory sections as well as admission rates from the participating institution's nursing program.

Population

The participating community college is a 2-year public institution in East Tennessee governed under the Tennessee Board of Regents (TBR) system of community colleges and technical centers. The institution awards the Associate of Applied Science (AAS), Associate of Arts (AA), Associate of Science (AS), and Associate of Science in Teaching (AST) degrees in 88 different disciplines in addition to awarding Technical Certificates in 19 fields. Prior to 2008 student enrollment remained relatively constant, with approximately 5,900 students registering

each year. In 2009 enrollment increased to 6,854 students and increased to 6,960 students in 2010. The head count for the 2009 and the 2010 academic school years represented the largest enrollment in the history of the college (THEC, 2014). Since the peak enrollment in 2010, the headcount at the college has declined to the fall semester 2016 level of 6,004 students (THEC, 2017).

The numbers of anatomy courses offered by the Natural Science Division at this institution increased since 2009 because of higher enrollment numbers in the division and the expansion of the nursing program. Prior to 2009 students admitted to the nursing program took classes on the main campus only and commenced their coursework at the beginning of the fall semester. If successful, they graduated 2 years later after 4 academic semesters and be awarded an AAS in Nursing. With the demand for registered nurses in the state of Tennessee and the southeast United States significantly increased, the institution expanded its nursing program to include programs offered at two satellite campuses in addition to the main campus. Nursing programs offered at the satellite campuses, designed to be off-cycle from the program at the main campus, started at the beginning of the spring semester each year and ended in the fall semester of the following year. Following the success of the off-cycle programs on the satellite campuses, the main campus also initiated an off-cycle class each year, beginning every spring semester.

To meet the demand for required anatomy courses the Natural Science faculty at this community college developed online versions of Anatomy 1 and Anatomy 2 lecture and laboratory courses that included all of the course content found in the on-ground courses. In addition to containing identical content, both the online and on-ground lecture courses shared a common comprehensive final examination. The TBR TN eCampus program also incorporated the college's online course content for Anatomy 1 and 2 with statewide offerings. Students who

passed Anatomy 1 in the TN eCampus system with a grade as low as a D were free to register for Anatomy 2; however, at the community college in this study students could not enroll for Anatomy 2 unless they earned a C or better in Anatomy 1. This restriction automatically selected students who demonstrated a higher level of success than did students in the TN eCampus Anatomy 1 course had. The population for the current quantitative study of 3,444 students included all students enrolled in either the online or on-ground Anatomy 2 lecture and laboratory classes at this community college from spring 2009 (the first semester that online anatomy classes were available) through fall 2015. This represented the entire population of Anatomy 2 students from 2009 through 2015 and was adequate for a comparative study (McMillan & Schumacher, 2010).

Two subgroups within the population included those students who registered for on-ground Anatomy 2 and those students who registered for online Anatomy 2. The number of students in the population (all Anatomy 2 students from spring 2009 through fall 2015) was 3,444, with 2,812 female students and 632 male students. According to the Argos and StarNet data management system used by the community college, 3,100 students registered for on-ground Anatomy 2 in 143 sections and 344 students registered for online Anatomy 2 in 21 sections between 2009 and 2015. Within the total population of on-ground students, 2,526 were female and 574 were male. The breakdown for online students included 286 female students and 58 male students.

Data Collection

The researcher analyzed secondary data collected from the community college's student data-management system as well as data from individual course outcomes collected at the division level from the Dean of Natural Sciences. The participating community college's Office

of Planning, Research, and Assessment provided student registration data. The Institutional Review Board (IRB) of East Tennessee State University and the President and the Dean of Natural Sciences of the participating institution granted permission to conduct the study. To maintain confidentially those supplying the data removed all unique student identifiers from the data before access and analysis. Reports from the student and course database system provided data on student demographics including age and sex, course registration, and final grades in Anatomy 2, as well as nursing admission rates into the community college nursing program.

Data Analysis

IBM-SPSS 24 was used for data analysis. The independent variables in the study were content delivery of Anatomy 2, whether online or on-ground, traditional-aged or nontraditional-aged, or sex. The dependent variables were the final examination grades, the final lecture grades, and the final laboratory grades for online and on-ground Anatomy 2 classes. Chi-square crosstabs analyses evaluated the hypotheses for Research Questions 1 through 7 with a .05 level of significance. The statistical procedures used and results for the data analyses are in Chapter 4.

CHAPTER 4

FINDINGS

The purpose of this comparative study was to determine if there were significant differences in student success rates in second semester anatomy courses (Anatomy 2) based on course content delivery (on-ground or online) at a participating community college in East Tennessee. Student variables evaluated included final lecture examination grades, final lecture course grades, final laboratory grades, sex, age classification (traditional or nontraditional), and admission into the participating community college's nursing program. The population for this study consisted of 3,100 students enrolled in on-ground lecture classes, 3,035 students enrolled in on-ground laboratory classes, 344 students enrolled in online (web-based) lecture classes, and 359 students enrolled in online laboratory classes during the fall and spring semesters beginning spring 2009 through fall 2015. The population of students enrolled in either on-ground or online lecture classes from spring 2009 through fall 2015 was 3,444. From this population 667 students gained admission to the participating college's nursing program.

Chapter 4 presents a demographic overview of the population followed by statistical analysis of the research questions and associated hypotheses. An alpha level of 0.05 was used for the analyses. The findings of the study are presented in this chapter.

Demographics of Population

The Office of Planning, Research, and Assessment and the Dean of Natural Sciences of the participating community college provided data from the college course database system. Student and course data were collected for students enrolled in on-ground or online classes of Anatomy 2 lecture and laboratory sections for the spring and fall semesters from spring 2009 through fall 2015. Students who had successfully gained admission into the participating

community college's nursing program were determined by enrollment in Nursing 1160 (NURS 1160), the first course in the first semester of the program. Only students admitted into the nursing program may register for this course.

The characteristics of the total enrollment indicated that the majority of students were female (81.6%), enrolled in on-ground classes (91.3%), and considered nontraditional students (57.5% were over 24 years of age). Table 1 shows the number of on on-ground and online lecture sections taught during the period 2009 through 2015 and their respective total enrollments.

Table 1

Sections and Course Enrollment for Anatomy 2 Lecture Courses Offered 2009-2015

Format	Number of Sections	Enrollment
On-ground	143	3,100
Online	21	344
Total	164	3,444

Analysis of Research Questions

Analysis consisted of evaluating background data (age, sex) and academic data (final examination grades, final lecture grade, and final laboratory grades) from students enrolled in on-ground and online sections of Anatomy 2 courses at a community college in East Tennessee during a 5-year period. The focus of this study was based on the following research questions and associated hypotheses.

Research Question 1

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, or F for the Anatomy 2 lecture final examination grade, the final lecture course grade, and the final laboratory course grade between online and on-ground Anatomy 2 course delivery?

$Ho1_1$: There is no significant difference in the proportion of students receiving grades of A, B, C, D, or F for the Anatomy 2 lecture final examination grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in student grades for the Anatomy 2 final examination between online and on-ground content delivery. The two variables were student final grades received for the Anatomy 2 final examination and the delivery format, either online or on-ground content delivery. Final examination grades and format were found to be significantly related (Pearson $\chi^2(4, N = 2957) = 240.68$, $p < .001$), Cramer's $V = .29$. Therefore, the null hypothesis was rejected. The proportion of students who received a grade of A, B, or C was .12, .18, and .22 for on-ground students compared to .007, .04, and .11 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 2 presents the results of these analyses. Significant pairwise differences were found for all grade comparisons except A to B. The proportion of on-ground students who received a final examination grade of A, B, or C was more than 3 times greater than the proportion of A, B, or C grades received by online students. On-ground students also earned a letter grade of A at a rate 16 times greater than online students. Further, online

students were almost 2.6 times more likely to receive a failing grade for the Anatomy 2 final examination as on-ground students were.

Table 2

Results for Pairwise Comparisons of Final Examination Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	3.06	.080	(.025)	.06
A to C	12.75	< .001*	(.005)	.12
A to D	18.04	< .001*	(.006)	.14
A to F	78.32	< .001*	(.006)	.25
B to C	7.03	<.008*	(.017)	.08
B to D	13.30	<.001*	(.007)	.11
B to F	99.68	< .001*	(.008)	.27
C to D	1.37	.242	(.050)	.03
C to F	80.69	< .001*	(.010)	.23
D to F	65.43	< .001*	(.013)	.21

**p* value ≤ alpha

Ho1$_2$: There is no significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in student final grades for Anatomy 2 lecture courses between online and on-ground content delivery. The two variables were student final grades received for the Anatomy 2 lecture

course and the delivery format, either online or on-ground content delivery. Final examination grades and format were found to be significantly related (Pearson $\chi^2(4, N = 3444) = 17.42$, p =.004), Cramer's V = .07. Therefore, the null hypothesis was rejected. The proportion of students who received a grade of A, B, or C was .25, .31, and .22 for on-ground students compared to .016, .37, and .23 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 3 presents the results of these analyses. Significant pairwise differences were found for the following grade comparisons: A to B and A to F. The proportion of on-ground students who received a final lecture grade of A was 1.5 times greater than online students. Further, online students were 1.5 times more likely to fail than on-ground students.

Table 3

Results for Pairwise Comparisons of Final Lecture Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	13.57	< .001*	(.003)	.08
A to C	6.42	.011	(.004)	.06
A to D	4.50	.034	(.004)	.06
A to F	11.46	.001*	(.004)	.10
A to W	.71	.401	(.008)	.03
B to C	.98	.321	(.009)	.02
B to D	.04	.950	(.050)	.04
B to F	.55	.458	(.017)	.02
B to W	1.90	.168	(.006)	.04
C to D	.01	.914	(.025)	.01
C to F	1.90	.163	(.005)	.04
C to W	.62	.432	(.010)	.03
D to F	1.18	.278	(.063)	.05
D to W	.61	.436	(.013)	.03
F to W	2.86	.091	(.005)	.08

**p* value $\leq$ alpha

Ho1_3: There is no significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final laboratory course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in final student grades for Anatomy 2 laboratory sections between online and on-ground content delivery. The two variables were final student grades received for Anatomy 2 laboratory sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 1774) = 26.71$, $p < .001$), Cramer's $V = .12$. Therefore, the null hypothesis was rejected. The proportion of students who received a grade of A, B, or C was .39, .29, and .16, for on-ground students compared to .28, .27, and .22 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 4 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to C, A to F, B to F, C to W, D to F, and D to W. The proportion of on-ground students who received a final lecture grade of A, B or C was 1.1 times greater than the proportion of A, B, or C grades received by online students. Further, on-ground students were 1.4 times more likely to earn an A than online students, while online students were also 2.4 times more likely to receive a failing grade for the Anatomy 2 laboratory course as on-ground students.

Table 4

Results for Pairwise Comparisons of Final Laboratory Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	13.57	.176	(.013)	.08
A to C	10.76	.001*	(.004)	.11
A to D	4.50	.009	(.063)	.06
A to F	19.97	.001*	(.003)	.16
A to W	.71	.295	(.017)	.03
B to C	.98	.049	(.008)	.02
B to D	.04	.084	(.010)	.04
B to F	11.71	.001*	(.004)	.14
B to W	1.90	.865	(.050)	.04
C to D	.01	.683	(.025)	.01
C to F	4.91	.007	(.006)	.08
C to W	28.28	.003*	(.005)	.02
D to F	7.15	.003*	(.005)	.08
D to W	9.35	.001*	(.004)	.10
F to W	2.86	.018	(.007)	.08

*p value $\leq$ alpha

Research Question 2

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade, and the final laboratory course grade between online and on-ground Anatomy 2 course delivery when categorized by sex?

$Ho2_1$: There is no significant difference in the proportion of male students receiving grades of A, B, C, D, F, or W for the lecture final course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in the Anatomy 2 final lecture course grades for male students based on on-ground or online content delivery. The two variables were male student final Anatomy 2 lecture course grades and the delivery format, either online or on-ground content delivery. Final lecture course grades and format were found to be significantly related (Pearson χ^2 (5, N = 632) = 12.44, p = .029), Cramer's V = .14. Therefore, the null hypothesis was rejected. The proportion of students who received a grade of A, B, or C was .26, .30, and .21 for on-ground students compared to .17, .40, and .17 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 5 presents the results of these analyses. No significant pairwise differences were found for comparisons between grades. The proportion of online students who received a final lecture grade of A, B, or C was almost identical to the proportion of on-ground students who received an A, B, or C. However, on-ground male students were 1.5 times more likely to receive a lecture grade of A than online students, while online students had a failure rate 3.5 times greater than on-ground students.

Table 5

Results for Pairwise Comparisons of Final Lecture Grades for Male Students Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	3.26	.071	(.005)	.10
A to C	.20	.655	(.025)	.03
A to D	1.57	.210	(.006)	.09
A to F	4.41	.036	(.004)	.15
A to W	1.02	.313	(.008)	.07
B to C	1.58	.209	(.006)	.07
B to D	.04	.950	(.050)	.04
B to F	.54	.464	(.013)	.05
B to W	5.52	.019	(.004)	.15
C to D	.74	.390	(.010)	.06
C to F	3.38	.066	(.005)	.14
C to W	1.52	.218	(.007)	.09
D to F	.377	.539	(.017)	.06
D to W	5.18	.023	(.004)	.24
F to W	8.04	.005	(.003)	.29

**p* value $\leq$ alpha

Ho2$_2$: There is no significant difference in the proportion of male students receiving grades of A, B, C, D, F, or W for the laboratory final course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in the Anatomy 2 final laboratory course grades for male students based on on-ground or online content delivery. The two variables were male student final Anatomy 2 laboratory course grades and the delivery format, either online or on-ground content delivery. Final laboratory course grades for male students and format were found to be significantly related (Pearson χ^2 (5, N = 620) = 12.71, p = .026), Cramer's V = .14. Therefore, the null hypothesis was rejected. The proportion of students who received a laboratory final grade of A, B, or C was .36, .27, and .19 for on-ground students compared to .28, .28, and .19 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 6 presents the results of these analyses. Significant pairwise differences were found only for comparisons between A to F, B to F, and F to W. The proportion of online students who received a final laboratory grade of A, B, or C was essentially identical to the proportion of on-ground students who received an A, B, or C. On-ground male students were 1.2 times more likely to receive a laboratory grade of A than online students, while online students had an overall failure rate 3.3 times greater than on-ground students.

Table 6

Results for Pairwise Comparisons of Final Laboratory Grades for Male Students Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	.53	.467	(.010)	.10
A to C	.32	.570	(.025)	.03
A to D	1.10	.294	(.007)	.09
A to F	9.87	.002*	(.003)	.15
A to W	.85	.357	(.008)	.07
B to C	.01	.931	(.050)	.07
B to D	.34	.558	(.017)	.04
B to F	6.62	.010*	(.014)	.05
B to W	1.68	.195	(.005)	.15
C to D	0.38	.535	(.013)	.06
C to F	5.79	.016	(.004)	.14
C to W	1.47	.225	(.006)	.09
D to F	1.49	.222	(.006)	.06
D to W	2.38	.123	(.005)	.24
F to W	8.45	.004*	(.004)	.29

*p value $\leq$ alpha

Ho2$_3$: There is no significant difference in the proportion of female students receiving grades of A, B, C, D, F, or W for the lecture final course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in the Anatomy 2 final lecture course grades for female students based on on-ground or online content delivery. The two variables were female student final Anatomy 2 lecture course grades and the delivery format, either online or on-ground content delivery. Final lecture course grades and format were found to be significantly related (Pearson $\chi^2(5, N = 2812) = 12.21$, $p = .032$), Cramer's $V = .07$. Therefore, the null hypothesis was rejected. The proportion of female students who received a grade of A, B, or C was .24, .31, and .22 for on-ground students compared to .16, .12, and .24 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 7 presents the results of these analyses. No significant pairwise differences were found for comparisons between grades. The proportion of online students who received a final lecture grade of A, B, or C was essentially identical to the proportion of on-ground students who received an A, B, or C. On-ground female students were 1.5 times more likely to receive a lecture grade of A than online students while online female students had a failure rate 1.3 times greater than on-ground students.

Table 7

Results for Pairwise Comparisons of Final Lecture Grades for Female Students Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	10.36	.001*	(.003)	.08
A to C	6.41	.011	(.004)	.07
A to D	3.10	.078	(.004)	.06
A to F	7.45	.006	(.004)	.09
A to W	1.92	.165	(.005)	.05
B to C	.29	.592	(.010)	.01
B to D	.42	.519	(.008)	.02
B to F	.21	.648	(.013)	.01
B to W	.37	.543	(.007)	.02
C to D	.06	.808	(.025)	.00
C to F	.63	.426	(.006)	.03
C to W	.08	.776	(.017)	.01
D to F	.76	.363	(.005)	.04
D to W	.06	.940	(.050)	.00
F to W	.69	.406	(.006)	.04

*p value $\leq$ alpha

Ho2$_4$: There is no significant difference in the proportion of female students receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in female student final grades for Anatomy 2 laboratory sections between online and on-ground content delivery. The two variables were female student final grades received for Anatomy 2 laboratory sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 2774) = 29.96, p < .001$), Cramer's $V = .13$. Therefore, the null hypothesis was rejected. The proportion of students who received a grade of A, B, or C was .33, .32, and .17, for on-ground students compared to .23, .28, and .23 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 8 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to C, A to D, A to F, and B to F. The proportion of on-ground female students who received a final laboratory grade of A, B, or C was essentially identical to the proportion of online students who received an A, B, or C. Further, on-ground female students were 1.5 times more likely to earn an A than online students, while online female students were 1.8 times more likely to receive a failing grade for the Anatomy 2 laboratory course than on-ground students.

Table 8

Results for Pairwise Comparisons of Final Laboratory Grades for Female Students Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	2.47	.116	(.007)	.04
A to C	13.22	<.001*	(.004)	.10
A to D	12.99	<.001*	(.004)	.11
A to F	17.33	<.001*	(.003)	.13
A to W	7.18	.008	(.005)	.08
B to C	4.93	.026	(.006)	.06
B to D	6.25	.012	(.005)	.08
B to F	9.35	.002*	(.004)	.10
B to W	2.54	.111	(.006)	.05
C to D	.67	.413	(.013)	.03
C to F	1.83	.176	(.008)	.05
C to W	.00	.989	(.050)	.00
D to F	.20	.652	(.025)	.03
D to W	.48	.490	(.017)	.04
F to W	1.29	.256	(.010)	.06

*p value $\leq$ alpha

Research Question 3

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the final lecture course grade and the final laboratory course grade between online

and on-ground Anatomy 2 course delivery when categorized by age (traditional-aged and nontraditional-aged)?

$Ho3_1$: There is no significant difference in the proportion of traditional students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in the Anatomy 2 final lecture course grades for traditional students based on on-ground or online content delivery. The two variables were traditional student final Anatomy 2 lecture course grades and the delivery format, either online or on-ground content delivery. Final lecture course grades and format were not found to be significantly related (Pearson $\chi^2(5, N = 1979) = 9.28$, $p = .098$), Cramer's $V = .07$. Therefore, the null hypothesis was retained. The proportion of traditional students who received a grade of A, B, or C was .19, .30, and .26, for on-ground students compared to .13, .39, and .23 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 9 presents the results of these analyses. No significant pairwise differences were found for comparisons between grades. The proportion of online students who received a final lecture grade of A, B, or C was identical to the proportion of on-ground students who received an A, B, or C. On-ground students were 1.4 times more likely to earn an A than online students while online students were 1.4 times more likely to fail than on-ground students.

Table 9

Results for Pairwise Comparisons of Final Lecture Grades for Traditional Students Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	5.96	.015	(.003)	.08
A to C	.67	.413	(.007)	.03
A to D	.08	.773	(.017)	.01
A to F	3.28	.070	(.004)	.08
A to W	1.58	.208	(.006)	.06
B to C	3.43	.064	(.002)	.06
B to D	3.21	.073	(.004)	.06
B to F	.01	.917	(.050)	.00
B to W	.13	.718	(.013)	.01
C to D	.17	.681	(.010)	.02
C to F	.51	.218	(.006)	.05
C to W	.52	.469	(.008)	.02
D to F	1.91	.168	(.005)	.07
D to W	.89	.346	(.006)	.05
F to W	.06	.810	(.025)	.01

**p* value $\leq$ alpha

$Ho3_2$: There is no significant difference in the proportion of traditional students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in final grades for Anatomy 2 laboratory sections for traditional students between online and on-ground content delivery. The two variables were traditional student final grades received for Anatomy 2 laboratory sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 1951) = 18.08$, $p = .003$), Cramer's $V = .10$. Therefore, the null hypothesis was rejected. The proportion of traditional students who received a grade of A, B, or C was .28, .38, and .21 for on-ground students compared to .18, .29, and .23 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 10 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to F and A to D. The proportion of on-ground traditional students who received a final laboratory grade of A, B, or C was 1.2 times greater than grades received by online traditional students. Further, on-ground traditional students were 1.5 times more likely to earn an A than online students, while online students were 1.9 times more likely to fail than on-ground students.

Table 10

Results for Pairwise Comparisons of Traditional Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	1.94	.164	(.006)	.04
A to C	4.55	.033	(.004)	.07
A to D	10.87	<.001*	(.004)	.13
A to F	12.53	<.001*	(.003)	.14
A to W	2.46	.008	(.007)	.06
B to C	.80	.373	(.013)	.03
B to D	3.21	.073	(.005)	.06
B to F	6.53	.011	(.004)	.10
B to W	.39	.533	(.017)	.02
C to D	1.81	.178	(.08)	.14
C to F	3.11	.078	(.005)	.08
C to W	.00	.996	(.005)	.00
D to F	.06	.802	(.025)	.02
D to W	1.36	.243	(.010)	.07
F to W	1.91	.167	(.007)	.09

*p value $\leq$ alpha

$Ho3_3$: There is no significant difference in the proportion of nontraditional-aged students, (over 24 years) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in nontraditional student final grades for Anatomy 2 lecture sections between online and on-ground content delivery. The two variables were nontraditional student final grades received for Anatomy 2 lecture sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 1465) = 27.97$, $p < .001$), Cramer's $V = .14$. Therefore, the null hypothesis was rejected. The proportion of nontraditional students who received a lecture grade of A, B, or C was .34, .33, and .17 for on-ground students compared to .19, .36, and .23 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 11 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to B, A to C, A to D, and A to F. The proportion of on-ground nontraditional students who received a final lecture grade of A, B, or C was 1.3 times greater than the proportion of grades received by online students. Further, on-ground nontraditional students were 1.8 times more likely to earn an A than online students while online students were 1.9 times more likely to fail than on-ground students.

Table 11

Results for Pairwise Comparisons of Final Lecture Grades for Nontraditional Students Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	8.82	.003*	(.004)	.10
A to C	13.42	<.001*	(.004)	.14
A to D	16.54	<.001*	(.003)	.17
A to F	13.92	<.001*	(.004)	.16
A to W	1.58	.208	(.010)	.06
B to C	1.12	.290	(.017)	.04
B to D	3.98	.046	(.006)	.08
B to F	2.98	.084	(.007)	.07
B to W	2.59	.108	(.008)	.07
C to D	1.29	.256	(.013)	.06
C to F	.85	.355	(.025)	.05
C to W	4.51	.034	(.006)	.11
D to F	.02	.886	(.050)	.01
D to W	7.49	.006	(.005)	.20
F to W	.56	.010	(.005)	.19

**p* value $\leq$ alpha

$Ho3_4$: There is no significant difference in the proportion of nontraditional students (over 24 years) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the Anatomy 2 final laboratory course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in student final grades for Anatomy 2 laboratory sections for nontraditional students between online and on-ground content delivery. The two variables were nontraditional student final grades received for Anatomy 2 laboratory sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 1443) = 29.35$, $p < .001$), Cramer's $V = .14$. Therefore, the null hypothesis was rejected. The proportion of nontraditional students in laboratory sections that received a grade of A, B, or C was .42, .29, and .14 for on-ground students compared to .28, .27, and .22 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 12 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to C, A to F, and B to F. The proportion of on-ground nontraditional students who received a final laboratory grade of A, B, or C was 1.6 times greater than grades received by online nontraditional students. Further, on-ground nontraditional laboratory students were 1.5 times more likely to earn an A than online students, while online students were 2.6 times more likely to fail than on-ground students.

Table 12

Results for Pairwise Comparisons of Nontraditional Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	2.61	.106	(.006)	.05
A to C	14.74	.001*	(.004)	.14
A to D	6.87	.009	(.004)	.10
A to F	20.27	<.001*	(.003)	.18
A to W	2.52	.121	(.006)	.06
B to C	5.15	.023	(.005)	.09
B to D	3.97	.046	(.005)	.08
B to F	10.79	.001*	(.004)	.15
B to W	.26	.607	(.025)	.02
C to D	.02	.884	(.050)	.01
C to F	2.36	.124	(.007)	.09
C to W	1.16	.282	(.010)	.06
D to F	1.14	.286	(.013)	.10
D to W	.91	.340	(.017)	.07
F to W	1.91	.167	(.008)	.09

*p value $\leq$ alpha

Research Question 4

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade and the final laboratory course grade

between online and on-ground Anatomy 2 course delivery when categorized by age (traditional-aged and nontraditional-aged) and sex?

$Ho4_1$: There is no significant difference in the proportion of male traditional-aged students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in final grades for Anatomy 2 lecture sections for traditional male students between online and on-ground content delivery. The two variables were traditional male student final grades received for Anatomy 2 lecture sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 334) = 41.44$, $p < .001$), Cramer's $V = .35$. Therefore, the null hypothesis was rejected. The proportion of traditional male students who received a grade of A, B, or C was .16, .28, and .28 for on-ground students compared to .15, .35, and .23 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 13 presents the results of these analyses. No significant pairwise differences were found for any comparisons between grades. The proportion of on-ground traditional male students who received a final lecture grade of A, B, or C was 1.4 times greater than grades received by online traditional students. While the proportion of on-ground students who received an A was essentially identical to the proportion of online students earning an A, online traditional male students were 5 times more likely to fail the class than on-ground students.

Table 13

Results for Pairwise Comparisons of Traditional Male Student Final Lecture Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	.01	.919	(.025)	.00
A to C	.33	.567	(.010)	.05
A to D	3.46	.063	(.004)	.20
A to F	1.74	.187	(.006)	.14
A to W	1.95	.163	(.006)	.16
B to C	.27	.593	(.013)	.04
B to D	3.30	.069	(.004)	.16
B to F	2.57	.109	(.005)	.14
B to W	.05	.819	(.006)	.00
C to D	2.46	.117	(.005)	.14
C to F	.86	.355	(.008)	.04
C to W	1.38	.240	(.007)	.11
D to F	7.32	.007	(.003)	.32
D to W	.00	.00	(.004)	.00
F to W	4.19	.041	(.004)	.27

**p* value $\leq$ alpha

Ho4$_2$: There is no significant difference in the proportion of traditional-aged male students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in final grades for Anatomy 2 laboratory sections for traditional male students between online and on-ground content delivery. The two variables were traditional male student final grades received for Anatomy 2 laboratory sections and the delivery format, either online or on-ground content delivery. Final laboratory grades for traditional male students and format were found to be significantly related (Pearson $\chi^2(5, N = 331) = 19.36$, $p = .002$), Cramer's $V = .24$. Therefore, the null hypothesis was rejected. The proportion of traditional students who received a grade of A, B, or C was .26, .29, and .24 for on-ground students compared to .24, .24, and .24 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 14 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to F and B to F. The proportion of on-ground traditional male students who received a final laboratory grade of A, B, or C was 1.1 times greater than grades received by online traditional male students. Further, the proportion on-ground traditional male students who earned an A were essentially identical to the proportion of online students who earned an A. However, online students were found to have a failure rate 4.4 times greater than on-ground students.

Table 14

Results for Pairwise Comparisons of Traditional Male Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	.04	.844	(.013)	.02
A to C	.02	.886	(.017)	.01
A to D	1.68	.195	(.007)	.13
A to F	8.07	.004*	(.004)	.27
A to W	2.37	.124	(.005)	.15
B to C	.12	.734	(.010)	.03
B to D	1.51	.219	(.008)	.12
B to F	9.50	.002*	(.003)	.28
B to W	2.13	.144	(.006)	.13
C to D	1.81	.178	(.006)	.17
C to F	7.12	.008	(.004)	.26
C to W	2.56	.109	(.005)	.16
D to F	6.82	.652	(.025)	.39
D to W	.00	.000	(.000)	.00
F to W	.00	.000	(.000)	.00

*p value $\leq$ alpha

$Ho4_3$: There is no significant difference in the proportion of nontraditional male students (over 24 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final lecture course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in student final grades for Anatomy 2 lecture sections for nontraditional male students between online and on-ground content delivery. The two variables were nontraditional male student final grades received for Anatomy 2 lecture sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 298) = 25.70$, $p < .001$), Cramer's $V = .29$. Therefore, the null hypothesis was rejected. The proportion of nontraditional male students who received a grade of A, B, or C was .38, .32, and .14 for on-ground students compared to .19, .44, and .13 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 15 presents the results of these analyses. No significant pairwise differences were found for any grade comparisons. The proportion of on-ground nontraditional male students who received a final lecture grade of A, B, or C was 1.1 times greater than the proportion of grades received by online nontraditional male students. Further, on-ground nontraditional male students were 2 times more likely to earn an A than online students, while online students were 5.6 times more likely to fail than on-ground students. Of note, on-ground students were also 2.7 times more likely to withdraw (W) than online students.

Table 15

Results for Pairwise Comparisons of Nontraditional Male Student Final Lecture Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	4.08	.043	(.004)	.14
A to C	.86	.355	(.008)	.08
A to D	5.02	.025	(.004)	.11
A to F	6.91	.009	(.003)	.24
A to W	.06	.801	(.025)	.02
B to C	.41	.523	(.017)	.05
B to D	.74	.389	(.010)	.08
B to F	1.27	.259	(.007)	.11
B to W	1.63	.202	(.006)	.12
C to D	1.46	.226	(.006)	.17
C to F	2.10	.147	(.005)	.19
C to W	.64	.424	(.013)	.10
D to F	.01	.904	(.050)	.01
D to W	3.00	.086	(.005)	.02
F to W	3.60	.058	(.004)	.30

**p* value $\leq$ alpha

$Ho4_4$: There is no significant difference in the proportion of nontraditional male students (over 24 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final laboratory grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in student final grades for Anatomy 2 laboratory sections for nontraditional male students between online and on-ground content delivery. The two variables were nontraditional male student final grades received for Anatomy 2 laboratory sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 291) = 24.14$, $p < .001$), Cramer's $V = .29$. Therefore, the null hypothesis was rejected. The proportion of nontraditional male students who received a grade of A, B, or C was .47, .25, and .14 for on-ground students compared to .32, .32, and .18 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 16 presents the results of these analyses. Significant pairwise differences were found for the following grade comparisons: A to F and F to W. The proportion of on-ground nontraditional male students who received a final laboratory grade of A was essentially identical to the proportion of online nontraditional male students who earned an A. However, online nontraditional male students had a failure rate 11 times greater than on-ground students.

Table 16

Results for Pairwise Comparisons of Nontraditional Male Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	10.42	.064	(.005)	.19
A to C	.37	.542	(.008)	.05
A to D	.23	.633	(.013)	.04
A to F	14.12	<.001*	(.003)	.32
A to W	.25	.620	(.010)	.04
B to C	.13	.714	(.017)	.03
B to D	.006	.938	(.050)	.01
B to F	3.80	.051	(.004)	.21
B to W	1.23	.268	(.006)	.11
C to D	.02	.902	(.025)	.02
C to F	6.61	.010	(.004)	.36
C to W	.67	.414	(.006)	.10
D to F	2.49	.114	(.050)	.37
D to W	.55	.457	(.007)	.13
F to W	8.26	.004*	(.004)	.50

*p value $\leq$ alpha

$Ho4_5$: There is no significant difference in the proportion of traditional-aged female students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final lecture course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in traditional female student final grades for Anatomy 2 lecture sections between online and on-ground content delivery. The two variables were traditional female student final grades received for Anatomy 2 lecture sections and the delivery format, either online or on-ground content delivery. Final grades and format were not found to be significantly related (Pearson $\chi^2(5, N = 1645) = 9.64$, $p = .086$), Cramer's $V = .08$. Therefore, the null hypothesis was retained. The proportion of traditional female students who received a lecture grade of A, B, or C was .19, 30, and .26 for on-ground students compared to .12, .39, and .23 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 17 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: C to D, D to F, and F to W. The proportion of on-ground traditional female students who received a final lecture grade of A, B, or C was essentially identical to the proportion of grades received by online students. However, on-ground traditional female students were 1.5 times more likely to earn an A than online students, while online students had a failure rate 1.2 times greater than on-ground students.

Table 17

Results for Pairwise Comparisons of Final Lecture Grades for Traditional Female Students Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	6.06	.014	(.004)	.09
A to C	.97	.325	(.013)	.04
A to D	.08	.779	(.017)	.13
A to F	2.76	.096	(.007)	.08
A to W	3.63	.057	(.005)	.96
B to C	2.79	.095	(.006)	.06
B to D	3.24	.072	(.006)	.07
B to F	.07	.799	(.025)	.01
B to W	.05	.819	(.050)	.01
C to D	304.61	<.001*	(.006)	.71
C to F	.86	.355	(.010)	.04
C to W	1.55	.213	(.008)	.06
D to F	351.64	<.001*	(.003)	.71
D to W	4.81	.028	(.005)	.18
F to W	247.15	<.001*	(.004)	.71

**p* value $\leq$ alpha

$Ho4_6$: There is no significant difference in the proportion of traditional female students (24 years of age or younger) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in student final grades for Anatomy 2 laboratory sections for traditional females between online and on-ground content delivery. The two variables were traditional female student's final grades received for Anatomy 2 laboratory sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 1620) = 16.69$, $p = .005$), Cramer's $V = .10$. Therefore, the null hypothesis was rejected. The proportion of traditional female students who received a grade of A, B, or C was .28, .32, and .20 for on-ground students compared to .17, .30, and .22 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 18 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to D and A to F. The proportion of on-ground traditional female students who received a final laboratory grade of A, B, or C was 1.2 times greater than the proportion of grades received by on-ground traditional female students. Further, on-ground traditional female students were 1.7 times more likely to earn an A than online students, while online traditional female students were 1.8 times more likely to fail than on-ground students.

Table 18

Results for Pairwise Comparisons of Traditional Female Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	6.06	.014	(.004)	.09
A to C	.86	.355	(.008)	.08
A to D	10.90	.001*	(.003)	.14
A to F	10.90	.001*	(.004)	.14
A to W	4.74	.030	(.005)	.09
B to C	.702	.402	(.010)	.03
B to D	4.40	.036	(.006)	.08
B to F	4.54	.033	(.005)	.09
B to W	1.08	.299	(.008)	.04
C to D	1.79	.191	(.007)	.06
C to F	1.96	.161	(.006)	.07
C to W	.17	.677	(.025)	.02
D to F	.01	.916	(.050)	.01
D to W	.48	.487	(.017)	.05
F to W	.60	.439	(.013)	.05

*p value $\leq$ alpha

$Ho4_7$: There is no significant difference in the proportion of nontraditional-aged female students (over 25 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final lecture course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in nontraditional female student final grades for Anatomy 2 lecture sections between online and on-ground content delivery. The two variables were nontraditional female student final grades received for Anatomy 2 lecture sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 1167) = 19.99$, $p = .001$), Cramer's $V = .131$. Therefore, the null hypothesis was rejected. The proportion of nontraditional female students who received a lecture grade of A, B, or C was .33, .33, and .18 for on-ground students compared to .19, .34, and .25 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 19 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to C, A to D, A to F, C to D, and F to W. The proportion of on-ground nontraditional female students who received a final lecture grade of A, B, or C was 1.2 times greater than the proportion of grades received by online students. Further, on-ground female students were 1.7 times more likely to earn an A than online students, while online nontraditional female students had a failure rate 1.7 times greater than on-ground students.

Table 19

Results for Pairwise Comparisons of Final Lecture Grades for Nontraditional Female Students Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	5.27	.022	(.005)	.08
A to C	11.71	.001*	(.004)	.14
A to D	11.70	.001*	(.004)	.17
A to F	8.21	.004*	(.005)	.14
A to W	.06	.903	(.050)	.01
B to C	1.95	.162	(.008)	.06
B to D	3.28	.070	(.010)	.09
B to F	1.84	.175	(.010)	.06
B to W	1.28	.257	(.013)	.05
C to D	304.61	<.001*	(.003)	.71
C to F	.16	.685	(.017)	.02
C to W	3.42	.064	(.006)	.11
D to F	.06	.800	(.025)	.02
D to W	4.81	.028	(.006)	.18
F to W	144.76	<.001*	(.004)	.72

*p value $\leq$ alpha

$Ho4_8$: There is no significant difference in the proportion of nontraditional female students (over 25 years of age) (NCES, 2012) receiving grades of A, B, C, D, F, or W for the final laboratory course grade between online and on-ground Anatomy 2 course delivery.

A two-way contingency table analysis was conducted to evaluate whether there was a difference in student final grades for Anatomy 2 laboratory sections for nontraditional females between online and on-ground content delivery. The two variables were nontraditional female student final grades received for Anatomy 2 laboratory sections and the delivery format, either online or on-ground content delivery. Final grades and format were found to be significantly related (Pearson $\chi^2(5, N = 1154) = 23.34$, $p < .001$), Cramer's $V = .142$. Therefore, the null hypothesis was rejected. The proportion of nontraditional female students who received a grade of A, B, or C was .41, .30 and .18 for on-ground students compared to .28, .26, and .23 for online students, respectively.

Follow-up pairwise comparisons were conducted to evaluate the differences among these proportions. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all comparisons. Table 20 presents the results of these analyses. Significant pairwise differences were found for comparisons between the following grades: A to C, A to D, C to D, and F to W. The proportion of on-ground nontraditional female students who received a final laboratory grade of A, B, or C was 1.1 times greater than the proportion of grades received by online nontraditional female students. On-ground nontraditional female students were 1.5 times more likely to earn an A than online students, while online students were 2 times more likely to fail than on-ground students.

Table 20

Results for Pairwise Comparisons of Nontraditional Female Student Final Laboratory Grades Using Holm's Sequential Bonferroni Method

Comparison	χ^2	*p*	alpha	Cramer's *V*
A to B	5.27	.022	(.005)	.08
A to C	11.71	.001*	(.004)	.14
A to D	11.70	.001*	(.004)	.16
A to F	8.21	.004	(.005)	.14
A to W	.02	.903	(.050)	.01
B to C	1.95	.162	(.008)	.06
B to D	3.28	.070	(.007)	.09
B to F	1.84	.175	(.010)	.06
B to W	1.28	.257	(.013)	.05
C to D	304.61	<.001*	(.003)	.71
C to F	.16	.685	(.017)	.02
C to W	3.42	.064	(.006)	.11
D to F	.06	.800	(.025)	.02
D to W	4.81	.028	(.006)	.18
F to W	144.76	<.001*	(.004)	.72

*p value $\leq$ alpha

Research Question 5

Is there a significant difference in the proportion of students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery?

$Ho5_1$: There is no significant difference in the proportion of students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

A chi square analysis was conducted to determine if there was a difference in the proportion of students admitted into the participating community college nursing program between online or on-ground content delivery. The variables were admission into the nursing program and the delivery format, either online or on-ground. Admission into the participating community college's nursing program and content delivery were significantly related (Pearson $\chi^2(1, N = 3444) = 9.67$, $p = .002$, Cramer's $V = .05$. Therefore, the null hypothesis was rejected. As shown in Table 21, the percentage of all on-ground students from the participating community college who were admitted into the nursing program was 20.1%, compared to 13.1% of all online students admitted. On-ground students are admitted to the nursing program at a rate 1.5 times greater than online students.

Table 21

Admission to a Participating Community College Nursing Program by Delivery Format

	On-ground		Online	
Nursing Program	*N*	%	*N*	%
Admission	622	20.1	45	13.1
Rejection	2,478	79.9	299	86.9
Total	3,100	100.0	344	100.0

$Ho5_2$: There is no significant difference in the proportion of female students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

A chi square analysis was conducted to determine if there was a difference in the proportion of female students admitted into the participating community college nursing program between online or on-ground content delivery. The variables were female student admission into the nursing program and the delivery format, either online or on-ground. Female student admission into the participating community college's nursing program and content delivery were significantly related (Pearson $\chi^2(1, N = 2812) = 9.19$, $p = .002$), Cramer's $V = .06$. Therefore, the null hypothesis was rejected. As shown in Table 22, 20.9% of all on-ground female students from the participating community college gained admittance into the nursing program, compared to 13.3% of all online female students admitted. On-ground female students had an admission rate into the nursing program 1.6 times greater than online female students.

Table 22

Female Student Admission to a Participating Community College Nursing Program by Delivery Format

	On-ground		Online	
Nursing Program	*N*	%	*N*	%
Admission	527	20.9	38	13.3
Rejection	1,999	79.1	248	86.7
Total	2,526	100.0	286	100.0

Ho5_3: There is no significant difference in the proportion of male students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

A chi square analysis was conducted to determine if there was a difference in the proportion of male students admitted into the participating community college nursing program

between online or on-ground content delivery. The variables were male student admission into the nursing program and the delivery format, either online or on-ground. Admission into the participating community college's nursing program and content delivery were not significantly related (Pearson $\chi^2(1, N = 632) = .78$, $p = .38$), Cramer's $V = .04$. Therefore, the null hypothesis was retained. As shown in Table 23, the admission rate of all male on-ground students from the participating community college into the nursing program was 16.6% compared to an admission rate of 12.1% for all male online students. On-ground male students gained admission to the nursing program at a rate 1.4 times greater than online male students.

Table 23

Male Student Admission to a Participating Community College Nursing Program by Delivery Format

	On-ground		Online	
Nursing Program	*N*	%	*N*	%
Admission	95	16.6	7	12.1
Rejection	479	83.4	51	87.9
Total	574	100.0	58	100.0

Research Question 6

Is there a significant difference in the proportion of traditional-aged female and nontraditional-aged female students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery?

$Ho6_1$: There is no significant difference in the proportion of traditional female students and nontraditional female students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

A chi square analysis was conducted to determine if there was a difference in the proportion of traditional and nontraditional-aged female students admitted into the participating community college nursing program between online or on-ground content delivery. The variables were age of female students admitted into the nursing program, either traditional-aged or nontraditional-aged, and the delivery format, either online or on-ground. Admission into the participating community college's nursing program by female student age and content delivery were not significantly related (Pearson $\chi^2(1, N = 565) = .14$, $p = .71$), Cramer's $V = .02$. Therefore, the null hypothesis was retained. As shown in Table 24, 53.1% of on-ground traditional-aged female students from the participating community college gained admission to the nursing program compared to 46.9% of on-ground nontraditional-aged female students. There was no difference in the percentage of online female students admitted when characterized by age group.

Table 24

Female Student Admission to a Participating Community College Nursing Program by Age Category and Delivery Format

	On-ground		Online	
Age Group	*N*	%	*N*	%
Traditional	280	53.1	19	50.0
Nontraditional	247	46.9	19	50.0
Total	527	100.0	38	100.0

Research Question 7

Is there a significant difference in the proportion of students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery for traditional males and nontraditional males?

$Ho7_1$: There is no significant difference in the proportion of traditional male students and nontraditional male students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery.

It was impossible to characterize any differences or similarities between online and on-ground format for traditional and nontraditional male students due to the extremely small sample size of online male students (seven students total). However, a chi square analysis was conducted to determine if there was a difference in the proportion of on-ground traditional and nontraditional male students admitted into the participating community college nursing program. The variables were the age of all on-ground male Anatomy 2 students, either traditional or nontraditional, and rejection or admission into the nursing program. Rejection or admission into the participating community college's nursing program by on-ground male student age were significantly related (Pearson $\chi^2(1, N = 574) = 7.27$, $p = .007$), Cramer's $V = .11$. Therefore, the null hypothesis was rejected. As shown in Table 25, 58.9% of on-ground nontraditional male students from the participating community college were admitted into the nursing program, compared to 41.1% of on-ground traditional male students.

Table 25

On-ground Male Student Admission to a Participating Community College Nursing Program by Age Category

	Admission		Rejection	
Age Group	*N*	%	*N*	%
Traditional	39	41.1	269	56.2
Nontraditional	56	58.9	210	43.8
Total	95	100.0	479	100.0

Summary

Chapter 4 presented the descriptive and comparative analyses for data collected from a community college's student and course databases for students enrolled in online and face-to-face sections of a biology course during the fall and spring semesters from spring 2009 through fall 2015. The data were analyzed using chi-square cross-tabulations. Chapter 5 presents the summary, conclusions, implications for practice, and recommendations for further study based on the findings of the research data.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Chapter 5 contains the findings, conclusions, implications for practice, and recommendations based on data collected for determining if significant differences existed in student success between online and on-ground sections of a second semester anatomy course. Statistical analyses were conducted on the following variables: lecture final examination grade, lecture final course grade, laboratory final course grade, sex, age, and format of content delivery. The population of students at the participating community college enrolled in either on-ground or online lecture classes from spring 2009 through fall 2015 totaled 3,444, including 3,100 students enrolled in on-ground lecture classes and 344 students enrolled in online classes. For laboratory sections, 3,035 students enrolled in on-ground classes while 359 students were enrolled in online classes. From this population, 667 students gained admission to the participating college's nursing program. Most of the students in this study were female (81.6%) and nontraditional-aged (57.5%). This is consistent with Wilson and Allen (2011) who reported that online students were predominately female and nontraditional-aged (age greater than 24 years) and had completed more semester hours than on-ground students. According to Friedman (2017), 95% of online students are returning students with some previous college experience, 84% are working adults with an average age of 32 years old, and 65% are female. Nationally, community college student populations in the United States are 56.8% female (Ginder, Kelly-Reid, Farrah, and Mann, 2016) and 67% traditional-aged (NCES, 2017).

The number of institutions offering online courses and the number of students enrolling in these courses have increased as many students, particularly nontraditional students, discover the advantages of online content delivery (NCES, 2011). By the fall semester of 2014, 5.8

million students had registered for at least one online class, an increase of 3.9% from the fall semester of 2013 (Friedman, 2016). Of these, 2.8 million students registered exclusively in online classes (NCES, 2015).

Community colleges have been the beneficiary of this increase in online registration. Two-year institutions educate 45% of all undergraduates in the United States and 27% of these students take some or most of their courses online (Barshay, 2015). Community colleges have expanded their online course offerings and have experienced a 4.7% increase in online registration from 2013 to 2014. Despite a 3.5% decrease in overall enrollment for the same time, the increase in online course offerings have been responsible for nearly all of the growth in student populations (Smith, 2016). The question to consider is whether online content delivery is an efficacious method for instructing students in community colleges. Johnson and Mejia (2015) found that California community college students enrolled in online coursework had a 40% failure rate for the course, compared to the 30% failure rate reported for students in comparable on-ground classes. While contributing to increased growth of student populations at community colleges, are online courses also contributing to low student completion rates? The average community college has a 6-year student completion rate of 39% (Fain, 2015) in contrast to the 6-year student completion rate at 4-year degree granting institutions of 60% (NCES, 2017).

The statistical analyses for the research questions and associated hypotheses introduced in Chapter 1, discussed in Chapter 3, and analyzed in Chapter 4 are summarized in this chapter. An alpha level of .05 was used for chi square crosstabs analyses for testing the research questions and hypotheses.

Research question 1 analyses included final lecture course grades, final laboratory course grades, and final examination grades for all students enrolled in either an online or on-ground

Anatomy 2 section. Research question 2 analyses considered final lecture course grades and final laboratory course grades for all students enrolled in either an online or on-ground section when categorized by sex. In research question 3 the focus of the analyses shifted from sex to age, comparing the final lecture course grade and the final laboratory course grade for all students enrolled in either an online or on-ground section, but now categorized by age, either traditional (24 years old and under) or nontraditional (over 24 years old). Research question 4 analyses considered final lecture course grades and final laboratory course grades for all students enrolled in either an online or an on-ground section when categorized by sex and age. Analyses addressed by research question 5 considered whether there were differences in the proportion of students admitted to the participating community college's nursing program between students enrolled in online or on-ground courses. Research question 6 analyses considered if there were differences in the proportion of traditional-aged and nontraditional-aged female students admitted into the participating community college's nursing program between students enrolled in online or on-ground courses. Research question 7 analyses considered if there were differences in the proportion of traditional-aged and nontraditional-aged male students admitted into the participating community college's nursing program between students enrolled in online or on-ground courses

Summary of Findings

The most successful students in Anatomy 2 lecture and laboratory classes were older (nontraditional-aged) male and female students who attended on-ground classes. Older students in on-ground classes were more likely to earn an A in both lecture and laboratory classes than younger (traditional-aged) students. On-ground male and female students from the participating community college also gained admission into the nursing program at a greater rate than did

male and female students from online sections. While age apparently made no difference in the admission rate for female students, older male students from on-ground sections had a greater admission rate than younger male students. Online male and female students, regardless of age, had generally higher failure rates for lecture and laboratory classes than on-ground students, but older male students in online classes had the highest failure rates of any group for both lecture and laboratory sections. Further, failure rates for students in online laboratory classes were significantly higher than on-ground laboratory sections and significantly higher than the online failure rates for lecture sections.

Research Question 1

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, or F for the Anatomy 2 lecture final examination grade, the final lecture course grade, and the final laboratory course grade between online and on-ground Anatomy 2 course delivery?

Anatomy 2 students in on-ground sections had significantly higher final examination grades, final course grades, and final laboratory course grades than students in online sections. As shown in Table 26, on the lecture course final examination on-ground students earned an A at a rate 16 times greater than did online students. Online students had a failure rate of 70% on the lecture course final examination, compared to 27% for students in on-ground sections, a rate almost 3 times greater than the on-ground failure rate.

Table 26

Anatomy 2 Lecture Final Examination Grades by Delivery Format

Final Grade	On-ground *N*	On-ground %	Online *N*	Online %
A	309	11.6	2	0.7
B	479	18.0	11	3.7
C	579	21.7	33	11.2
D	585	22.0	44	14.9
F	710	26.7	205	69.5
Total	2,662	100.0	295	100.0

For the final lecture grade almost 25% of all on-ground students earned an A for their final grade (1.5 times greater than for online students) compared to only 16% of online students who received an A. Further, as shown in Table 27, almost 20% of online students received a D or an F for their final lecture grade compared to 16% of on-ground students.

Table 27

Anatomy 2 Lecture Final Lecture Grades by Delivery Format

Final Grade	On-ground *N*	On-ground %	Online *N*	Online %
A	767	24.7	55	16.0
B	959	30.9	127	36.9
C	685	22.2	78	22.7
D	283	9.1	33	9.9
F	220	7.1	34	9.9
W	186	6.0	17	4.9
Total	3,100	100.0	344	100.0

In laboratory sections nearly 34% of on-ground students received an A for their final laboratory grade (1.5 times greater than for online students) compared to 23% for online students. Online students also failed the laboratory course at a rate twice that of on-ground students. As shown in Table 28, for the laboratory course final grade nearly 34% of on-ground students received an A compared to 23% for online students. Online students also failed the laboratory course at a rate twice that of on-ground students, at 10% and 5%, respectively. Final laboratory course grades do not have a direct impact on nursing program admission but contribute indirectly by affecting student grade point average (albeit slightly, because laboratory sections are only one credit hour courses

Table 28

Anatomy 2 Final Laboratory Course Grade by Delivery Format

Final Grade	On-ground		Online	
	N	%	*N*	%
A	1,025	33.8	84	23.4
B	933	30.7	100	27.9
C	539	17.8	79	22.0
D	172	5.7	32	8.9
F	151	5.0	36	10.0
W	215	7.1	28	7.8
Total	3,035	100.0	359	100.0

The results of this study were consistent with the findings of Garman (2012), Hara and Kling (2000), Hughes (2008), Wojciechowski and Palmer (2005), Xu and Jaggars (2010, 2013), and Amro et al. (2015) that found student success rates in on-ground classes to be consistently greater than those in online classes. However, the results of this study were in contrast with earlier studies (Arle, 2010; Bata-Jones & Avery, 2004; Biel & Brame, 2016; Bird, 2010; Peat & Taylor, 2005) that reported student success rates in online classes to be greater than or at least equal to success rates in on-ground classes. Additional studies seemed to support the position that there were no differences in student success between on-ground and online content delivery. Riggins (2014) noted no significant differences in overall test scores for community college students enrolled in either an online or an on-ground General Biology 1 course. In a survey of 13 studies that compared the effectiveness of either on-ground or online undergraduate biology

courses, Biel and Brame (2016) also found no significant differences in most of the studies surveyed. In studies conducted at five different community colleges, they found that in two of the studies, on-ground students did better than online students did but the remaining three studies showed no significant difference in effectiveness between on-ground and online format. The remaining eight studies, conducted at 4-year institutions, found no differences in student outcomes regardless of the content delivery format in six of the studies while two found that students in online sections did better than did students in on-ground sections (Biel and Brame, 2016).

Research Question 2

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade and the final laboratory course grade between online and on-ground Anatomy 2 course delivery when categorized by sex?

When categorized by sex male and female Anatomy 2 students in on-ground sections had significantly higher final lecture and laboratory course grades and lower failure rates than male and female students in online sections. On-ground male and female students were almost twice as likely to receive an A for their lecture grades as were online students. As shown in Table 29, the percentage of on-ground and online male students receiving a letter grade of A for their Anatomy 2 lecture courses were 26% and 17% respectively. Online students had a failure rate of almost twice that of on-ground students, at 16% and 8%, respectively.

Table 29

Anatomy 2 Final Lecture Course Grade for Male Students by Delivery Format

Final Grade	On-ground		Online	
	N	%	*N*	%
A	150	26.1	10	17.2
B	171	29.8	23	39.7
C	122	21.3	10	17.3
D	46	8.0	6	10.3
F	43	7.5	9	15.5
W	42	7.3	<5	0.0
Total	574	100.0	58	100.0

Failure rates for male and female students in online lecture and laboratory sections were also consistently higher than the failure rates for students in on-ground sections, in some cases more than four times greater than for on-ground students. In particular, online male students had the highest failure rates in both lecture and laboratory classes than any other category. Online male students had a failure rate twice as great for lecture and almost four times as great for laboratory sections as did on-ground male students.

For laboratory classes male and female students in on-ground sections were more likely to receive an A than online students. Table 30 presents the results of male students enrolled in on-ground or online laboratory courses. In laboratory sections the percentage of on-ground male students receiving an A was greater than online male students, at 35.5% and 28.1% respectively. Online male students in laboratory sections had a failure rate of almost four times greater than on-ground students, at 14% and 4 % respectively.

Table 30

Anatomy 2 Final Laboratory Course Grade for Male Students by Delivery Format

Final Grade	On-ground		Online	
	N	%	*N*	%
A	200	35.5	16	28.1
B	153	27.1	16	28.1
C	109	19.4	11	19.3
D	27	4.8	4	7.0
F	24	4.3	8	14.0
W	50	8.9	2	3.5
Total	563	100.0	57	100.0

Online female students had a failure rate for lecture classes slightly greater than on-ground students but almost twice that of on-ground laboratory sections. As shown in Table 31, the percentage of on-ground female students who received an A for their lecture course sections was 1.5 times greater than their online counterparts, at 24 % and 16% respectively. Failure rates for online students were also slightly higher than for on-ground students, at 9% and 7% respectively.

Table 31

Anatomy 2 Final Lecture Course Grade for Female Students by Delivery Format

Final Grade	On-ground		Online	
	N	%	*N*	%
A	617	24.4	45	15.7
B	788	31.2	104	36.4
C	563	22.3	68	23.8
D	237	9.4	27	9.4
F	177	7.0	26	9.1
W	144	5.7	16	5.6
Total	2,526	100.0	286	100.0

The percentage of on-ground female laboratory students who received an A was almost 1.5 times greater than online female students, at 33% and 23% respectively, as seen in Table 32. Online students had a failure rate almost twice as great as did students in on-ground sections, at 9% and 5% respectively.

Table 32

Anatomy 2 Final Laboratory Course Grade for Female Students by Delivery Format

Final Grade	On-ground *N*	On-ground %	Online *N*	Online %
A	825	33.4	68	22.5
B	780	31.6	84	27.8
C	430	17.4	68	22.5
D	145	5.9	28	9.3
F	127	5.1	28	9.3
W	165	6.7	26	8.6
Total	2,472	100.0	302	100.0

When other grades were considered, it was found that more online male and female students received a grade of F for the laboratory course than their on-ground male and female counterparts, with 14% to 4% for males and 9% to 5% for females respectively. However, on-ground male and female students had a greater withdrawal (W) rate than online male and female students, 6% to 1% for males and 9% to 4% for females respectively.

These findings are consistent with the results reported by Hughes (2008), Garman (2012), and Amro et al. (2015). Amro found that in a multiyear comprehensive study of 7,800 algebra students that grades for male and female on-ground algebra students were consistently greater than grades for male and female online algebra students. On-ground female students had a higher final average course grade than online female students. On-ground male students also had higher final average grades than did online students.

Research Question 3

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the final lecture course grade and the final laboratory course grade between on-ground and online Anatomy 2 course delivery when categorized by age (traditional-aged and nontraditional-aged)?

On-ground nontraditional-aged students did consistently better in all categories, with higher lecture and laboratory grades and lower failure rates than all other categories of format and age. These results contrast with the Garman (2012), Riggins (2014), Amro et al. (2015), and Biel and Brame (2016) studies that found no significance difference in student success between content delivery and student age.

When characterized by age, on-ground nontraditional-aged students (older students) exhibited more success in their coursework than any category of online or on-ground students. On-ground nontraditional-aged students were almost twice as likely to earn an A in their lecture classes as online students, at 34% to 19% respectively. In their laboratory sections, on-ground nontraditional-aged students were also 1.5 times more likely to earn an A than were online students, at 42% to 28% respectively. Nontraditional-aged online students had failure rates that were almost twice as great for lecture (9% to 5%, respectively) and almost three times as great for laboratory sections (9% to 3%, respectively) than students in on-ground sections.

Traditional-aged students in on-ground sections were also more likely to earn an A for their lecture and laboratory sections as were online students. Traditional-aged students in on-ground sections were 1.5 times more likely to earn an A for their final lecture grade than online students, at 19% to 13% respectively, and 1.6 times more likely to earn an A in their laboratory sections as were online students, at 28% to 18% respectively. Traditional-aged online students

also had failure rates more than twice as great for lecture (20% to 9%, respectively) and almost twice as great for laboratory sections (11% to 6%, respectively) than did students in on-ground sections.

Older, nontraditional-aged students in on-ground sections had a greater percentage of students earn an A for their final lecture and laboratory grade than did traditional-aged students. The percentage of on-ground nontraditional and traditional-aged students who earned an A in their lecture sections was 34% and 19%, respectively. The final lecture grades for traditional and nontraditional-aged students are presented in Table 33. Failure rates for on-ground nontraditional-aged students for lecture classes were consistently less than the failure rates for traditional students. Failure rates for on-ground lecture classes for nontraditional and traditional-aged students were 5% and 9%, respectively.

Table 33

Anatomy 2 Final Lecture Course Grade for On-Ground Students by Age Category

Final	Traditional		Nontraditional	
Grade	*N*	%	*N*	%
A	336	18.5	431	33.5
B	537	29.6	422	32.8
C	470	25.9	215	16.7
D	217	12.0	66	5.1
F	158	8.7	62	4.8
W	97	5.3	89	6.9
Total	1,815	100.0	1,285	100.0

The percentage of on-ground nontraditional and traditional-aged students who earned an A in their laboratory sections was 42% and 28%, respectively and are presented in Table 34. Failure rates for on-ground nontraditional-aged students for laboratory classes were consistently less than the failure rates for traditional students. Failure rates for on-ground laboratory sections for nontraditional and traditional-aged students were 3% and 6%, respectively.

Table 34

Anatomy 2 Final Laboratory Course Grade for On-Ground Students by Age Category

Final Grade	Traditional		Nontraditional	
Grade	*N*	%	*N*	%
A	494	27.7	531	42.4
B	566	31.7	367	29.3
C	366	20.5	173	13.8
D	124	7.0	48	3.8
F	108	6.1	43	3.4
W	125	7.0	90	7.2
Total	1,783	100.0	1,252	100.0

For online content delivery, nontraditional-aged students had a greater percentage of students earn an A for their final lecture and laboratory grade than did online traditional-aged students. As show in Table 35, for online final lecture grades, the percentage of nontraditional and traditional-aged students who earned an A was 19% and 13%, respectively. Further, failure rates for online lecture classes were greater for traditional-aged students than for nontraditional-aged students. Failure rates for online lecture classes for nontraditional and traditional-aged students were 9% for nontraditional-aged students and 11% for traditional-aged students.

Table 35

Anatomy 2 Final Lecture Course Grade for Online Students by Age Category

Final Grade	Traditional *N*	Traditional %	Nontraditional *N*	Nontraditional %
A	21	12.8	34	18.9
B	63	38.4	64	35.6
C	37	22.6	41	22.8
D	15	9.1	18	10.0
F	18	11.0	16	8.9
W	10	6.1	7	3.8
Total	164	100.0	180	100.0

The percentage of online nontraditional and traditional-aged students who earned an A for their final laboratory grade was 28% and 18%, respectively, as shown in Table 36. Further, failure rates for online lecture classes were greater for traditional-aged students than for nontraditional-aged students. Failure rates for online laboratory sections for nontraditional and traditional-aged students were 9% and 11%, respectively.

Table 36

Anatomy 2 Final Laboratory Course Grade for Online Students by Age Category

Final Grade	Traditional *N*	Traditional %	Nontraditional *N*	Nontraditional %
A	30	17.9	54	28.3
B	48	28.6	52	27.2
C	38	22.6	41	21.5
D	20	11.9	12	6.3
F	19	11.3	17	8.8
W	13	7.7	15	7.9
Total	168	100.0	191	100.0

Research Question 4

Is there a significant difference in the proportion of students receiving grades of A, B, C, D, F, or W for the Anatomy 2 final lecture course grade and the final laboratory course grade between online and on-ground Anatomy 2 course delivery when categorized by age (traditional-aged and nontraditional-aged) and sex?

When characterized by both age and sex, older (nontraditional-aged) male and female students demonstrated greater success in lecture and laboratory sections than did traditional-aged students. Further, on-ground male and female students generally had higher grades and lower failure rates than online male and female students in both lecture and laboratory sections. The percentage of on-ground older male and female students who earned an A for lecture was 38% for male students and 33% for female students compared to 16% and 19%, respectively, for younger (traditional-aged) students. The percentage of on-ground older male and female

students who earned an A for laboratory sections was 47% for male students and 41% for female students compared to 26% and 28% respectively, for younger (traditional-aged) students.

For traditional-aged male students the proportion of on-ground students who received an A was essentially identical to that of online students for both lecture and laboratory sections, at 16% to 15% respectively for lecture and 26% to 24% respectively for laboratory sections. However, nontraditional-aged male students in on-ground classes were twice as likely to earn an A for their final lecture grade and laboratory grade as were online students, with 38% of on-ground students receiving an A for lecture compared to 19% of online students. In laboratory sections the percentage of on-ground nontraditional-aged male students who received an A for their final laboratory grade was almost 47% compared to 32% for online students.

When considered by age nontraditional-aged male students also consistently earned higher grades in both lecture and laboratory classes than did traditional-aged male students. In on-ground lecture classes nontraditional-aged male students were more than twice as likely to receive an A for their final lecture grade when compared to traditional-aged male students, at 38% to 16% respectively. Further, nontraditional-aged male students also had greater success in online lecture classes than traditional-aged male students, with almost 19% of nontraditional-aged male students receiving an A compared to 15% of traditional-aged male students. In on-ground laboratory sections nontraditional-aged male students were almost twice as likely to receive an A for their final grade when compared to traditional-aged students at 47% to 26% respectively. Nontraditional-aged male students also did better in online laboratory sections than traditional-aged male students, with 32% of nontraditional-aged male students receiving an A compared to 24% of traditional-aged male students.

When failure rates were considered male students in online sections had failure rates for lecture and laboratory classes significantly greater than did male students in on-ground sections. Nontraditional-aged male students in online lecture and laboratory classes had the highest failure rates of all male students in lecture and laboratory classes, at 25% and 21% respectively. Traditional-aged male students in online sections had failure rates 1.5 times greater for lecture courses (at 15% and 10% respectively) and more than four times greater for laboratory courses (at 28% and 6% respectively) than did on-ground students. Nontraditional-aged male students in online sections had failure rates 5 times greater for lecture (at 25% and 5% respectively) and 11 times greater for laboratory sections (at 21% and 2% respectively) than did on-ground students.

When compared by age, on-ground nontraditional male lecture class failure rates were less than 5% compared to 10% for traditional males. However, online nontraditional-aged male students had a failure rate of 25% compared to 15% for online traditional-aged male students.

Older female students were more likely to be successful in lecture and laboratory sections than were younger students. Older female students had a greater percentage of students earning a letter grade of A for both lecture and laboratory sections than younger female students, regardless of content format. On-ground traditional and nontraditional-aged female students were almost twice as likely to earn an A in their lecture and laboratory sections as were students in online classes. The percentage of on-ground traditional-aged female students who received an A for lecture was 19%, compared to 12% for online students. The percentage of on-ground nontraditional-aged female students who received an A for lecture was 33% compared to almost 19% for online students. In laboratory sections, the percentage on-ground traditional-aged students who earned an A was 28% compared to 17% for online students, while the percentage

of on ground nontraditional-aged female students who received an A was 41% compared to 28% for online students.

When considered by age, older female students also consistently earned higher grades in both lecture and laboratory classes than did younger female students. In on-ground lecture classes, nontraditional-aged female students were more than twice as likely to receive an A for their final lecture grade when compared to traditional-aged female students, at 33% to 19%, respectively. Further, older female students also had greater success in online lecture classes than younger female students, with almost 19% of nontraditional-aged female students receiving an A compared to 12% of traditional-aged female students. In on-ground laboratory sections, nontraditional-aged female students were almost twice as likely to receive an A for their final grade when compared to traditional-aged students, at 41% to 28% respectively. Further, older female students also did better in online laboratory sections than younger female students, with 28% of nontraditional-aged female students receiving an A compared to 17% of traditional-aged female students

Online female students, regardless of age category, also had failure rates for lecture and laboratory classes greater than did female students in on-ground sections. Traditional-aged female students in online lecture sections had failure rates slightly greater than on-ground sections with failure rates of 10% and 8% respectively, and nearly twice as great for laboratory classes with failure rates of 11% and 6% respectively, than did on-ground students. Nontraditional-aged female students in online sections had failure rates almost twice as great for on-ground lecture and laboratory sections, with failure rates of 8% and 5% for lecture and 8% and 4% respectively, for laboratory sections.

The results of this analysis stand in contrast to the Amro et al. study (2015) that found no significant difference in grades between online and on-ground students. However, these results are similar to those reported by Jackson-Smith (2017) in a comprehensive study of 23,000 developmental mathematics students that found significant differences in student success rates (pass/fail) between age and sex. When categorized by sex, female students had a success rate of 61.1% in developmental mathematics compared to 57.3% among male students. When categorized by age, nontraditional students had success rates of 59% compared to 58.6% among traditional students (Jackson-Smith, 2017).

Research Question 5

Is there a significant difference in the proportion of students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery?

Of the 3,444 students in this study, over 19% or 667 students who had successfully completed Anatomy 2 at the participating community college, regardless of format, gained admission into the nursing program from 2009 through 2015. These students represented approximately 85% or more of all students admitted into the nursing program at the participating community college. Since 2015, the percentage of students admitted from the participating community college has approached 100% (D. McGaha, personal communication, February 21, 2018). When the percentage of students admitted to the nursing program were evaluated against course format, the rate of admission for on-ground students from the participating community college was consistently higher than for online students. Male and female students from on-ground sections had an admission rate 1.5 times greater than did students in online sections. The on-ground female student nursing program admission rate was 1.6 times greater than for online

female students. On-ground male students gained admission to the nursing program at a rate 1.4 times greater than did male online students.

As shown in Table 37, on-ground Anatomy 2 students from the participating community college had an admission rate of slightly more than 20% or 622 students compared to 13% or 45 online students.

Table 37

Admission to a Participating Community College Nursing Program by Delivery Format

Nursing Program	On-ground		Online	
	N	%	*N*	%
Admission	622	20.1	45	13.1
Rejection	2,478	79.9	299	86.9
Total	3,100	100.0	344	100.0

Out of the 3,444 Anatomy 2 students at the participating community college who registered for Anatomy 2 classes from 2009 through 2015, 2,812 or 82% of all students registered were female. Within all Anatomy 2 female students from the participating community college, 90% or 2,526 students registered for on-ground classes while 10% or 286 students registered for online classes. Out of the 2,812 female students, 20%, or 565 students gained admission into the community college nursing program. Within all female students admitted from the participating community college, more than 93% or 527 students were on-ground students compared to almost 7% or 38 online students. As shown in Table 38, on-ground female students had an admission rate of 21% compared to 13% for online female students.

Table 38

Female Student Admission to a Participating Community College Nursing Program by Delivery Format

Nursing Program	On-ground		Online	
	N	%	*N*	%
Admission	527	20.9	38	13.3
Rejection	1,999	79.1	248	86.7
Total	2,526	100.0	286	100.0

Out of the 3,444 Anatomy 2 students at the participating community college who registered for Anatomy 2 classes from 2009 through 2015, 632 or 18% of all students registered were male. There were 632 male students registered for Anatomy 2 classes from 2009 through 2015, which represented 18% of all Anatomy 2 students. Within all Anatomy 2 male students from the participating community college, 91% or 574 students registered for on-ground classes while 9% or 58 students registered for online classes. Out of the 632 male students, 16%, or 102 students from the participating community college, gained admission into the nursing program. Within all male students admitted, 93% or 95 students attended on-ground classes compared to almost 7% or 7 students who attended online classes. As shown in Table 39, on-ground male students had an admission rate of 17% compared to 12% rate for online male students.

Table 39

Male Student Admission to a Participating Community College Nursing Program by Delivery Format

Nursing Program	On-ground		Online	
	N	%	*N*	%
Admission	95	16.6	7	12.1
Rejection	479	83.4	51	87.9
Total	574	100.0	58	100.0

Research Question 6

Is there a significant difference in the proportion of traditional female students and nontraditional female students admitted into the participating community college's nursing program between online and on-ground Anatomy 2 course delivery?

Age apparently made no difference in the admission rate for Anatomy 2 female students from the participating community college. The percentage of traditional-aged and nontraditional-aged female students admitted into the nursing program was essentially identical for both on-ground and online students. As shown in Table 40, traditional-aged students had admission rates of 53% for on-ground students and 50% for online students. Nontraditional-aged students had admission rates of 47% for on-ground students and 50% for online students. Of note, for the 565 female students admitted 93% or 527 students attended on-ground classes compared to 7% or 38 students attended online classes.

Table 40

Female Student Admission to a Participating Community College Nursing Program by Age Category and Delivery Format

Age Group	On-ground		Online	
	N	%	*N*	%
Traditional	280	53.1	19	50.0
Nontraditional	247	46.9	19	50.0
Total	574	100.0	38	100.0

Research Question 7

Is there a significant difference in the proportion of male students admitted into the participating community college's nursing program between on-ground and online Anatomy 2 course delivery for traditional-aged males and nontraditional-aged males?

Due to the extremely small sample size of online Anatomy 2 male students from the participating community college admitted into the nursing program (seven students), regardless of age category, no reliable analysis comparing online and on-ground students was possible. However, when on-ground male students were evaluated by age, nontraditional-aged male students from the participating community college had an admission rate 1.4 times greater than did traditional-aged male students.

Of the 102 male Anatomy 2 students from the participating community college that were admitted into the nursing program, 61% or 62 students were nontraditional-aged males compared to almost 40% or 40 students of traditional-aged male students. As shown in Table 41, 59% of on-ground nontraditional-aged male students were admitted into the nursing program, compared to 41% of traditional-aged male students. On-ground students comprised the majority of male students admitted into the nursing program. Of the 102 male students admitted, 93% or 95

students were on-ground students and of these, more than 55% were nontraditional-aged students.

Table 41

On-ground Male Student Admission to a Participating Community College Nursing Program by Age Category

Age Group	Admission		Rejection	
	N	%	*N*	%
Traditional	39	41.1	269	56.2
Nontraditional	56	58.9	210	43.8
Total	95	100.0	479	100.0

Conclusions

Based on the data analyses and the findings of this study, the following conclusions can be drawn:

- The most successful students in Anatomy 2 lecture and laboratory classes were older (nontraditional-aged) male and female students who attended on-ground classes.
- Students in on-ground sections of Anatomy 2 had consistently higher final examination grades, final lecture course grades, and final laboratory course grades than did online students.
- Age and format may be factors in student success. Older students in on-ground classes were more likely to earn an A in both lecture and laboratory classes than younger students. The percentage of on-ground nontraditional and traditional-aged students who earned an A in their lecture and laboratory sections was 34% and 19% for lecture and 28% and 18% for laboratory sections, respectively.

- On-ground male and female students from the participating community college also gained admission into the nursing program at a greater rate than did male and female students from online sections. The percentage of all on-ground students from the participating community college admitted into the nursing program was 20%, compared to 13% of all online students admitted. The percentage of on-ground female students admitted into the nursing program was 21%, compared to 13% of online female students. The percentage of on-ground male students admitted into the nursing program was 17%, compared to 12% of online male students.
- Older (nontraditional-aged) male students from on-ground Anatomy 2 sections had a greater admission rate into the nursing program than younger (traditional-aged) male students, while age apparently made no difference in the admission rate for female students. The percentage of on-ground nontraditional-aged male students admitted into the nursing program was 59%, compared to 41% for on-ground traditional-aged male students.
- There was no difference in the nursing program admission rate for female students from the participating community college when characterized by age and format. The percentage of traditional-aged on-ground and online female students admitted was 53.1% and 50%, respectively. The percentage of nontraditional-aged on-ground and online female students admitted was 46.9% and 50%, respectively.
- Online male and female students, regardless of age, had generally higher failure rates for lecture and laboratory classes than on-ground students, but older male students in online classes had the highest failure rates of any group for both lecture and laboratory sections.

- Failure rates for students in online laboratory classes were significantly higher than on-ground laboratory sections, and significantly higher than the failure rates for online lecture sections.
- For the final examination, online students had a remarkably high failure rate of almost 70% compared to a 16% success rate. On-ground students were more successful than online students, with 51% of on-ground students earning a grade of A, B, or C, but also failing the final examination at a rate of 27%.
- For the final lecture grade, on-ground students earned an A at a rate of 25% compared to 16% for online students. On-ground students had a failure rate of 7.1% compared to 9.9% for online students.
- On-ground students also consistently did better in their laboratory courses than did online students, possibly due to the hands-on nature of the on-ground laboratory course. On-ground students earned an A at a rate of 34% compared to 23% for online students.
- When categorized by sex, on-ground male and female students consistently earned higher final grades in lecture and laboratory classes than did online male and female students. Sex did not appear to be as much of a factor in student success as did course content delivery.
- Older students did better than younger students, regardless of format. Nontraditional-aged students in on-ground sections had a greater percentage of students earn an A for their final lecture and laboratory grade than did traditional-aged students. The percentage of on-ground nontraditional and traditional-aged students who earned an A in their lecture sections was 34% and 19%, respectively. The percentage of on-ground

nontraditional and traditional-aged students who earned an A in their laboratory sections was 42% and 28%, respectively

- On-ground traditional-aged male students had higher grades than online traditional-aged male students in both lecture and laboratory classes. On-ground nontraditional-aged male students also had consistently higher final grades than did online nontraditional-aged male students for both lecture and laboratory courses.
- Regardless of age categories, on-ground female students had consistently higher final grades than online female students for both lecture and laboratory courses. On-ground nontraditional-aged female students also had consistently higher final grades than nontraditional online female students for both lecture and laboratory courses.

Implications for Practice

The researcher for this study investigated whether there were significant differences in on-ground and online content delivery for Anatomy 2 students measured by final examination grades, final lecture course grades, and final laboratory course grades when characterized by age and sex. The following recommendations derived from the findings of this study:

1. On-ground students had consistently higher lecture final examination grades, final lecture course grades, and final laboratory course grades than online students had. Online students had an extremely high final examination failure rate of 70%, compared to 27% for on-ground students. This failure rate may be due to little interaction with other students or the course instructor. Online students would likely benefit from a mandatory final examination review session, similar to the voluntary review session offered to the on-ground students. Online students should also have more opportunities for interaction

with the instructor and with other students. Both on-ground students and online students would also likely benefit from the use of drop box assignments and discussion boards.

2. Students who register for Anatomy 2 as an online class and have never taken an online course or an online science course should be required to complete an online orientation prior to enrollment.

Recommendations for Further Research

Ideally, the findings of this study could provide research-based information that could be used in the planning and assessment of science courses, particularly gateway courses, in on-ground and online formats at the community college level.

1. An area of interest for future research is to evaluate the potential impact of various demographic factors on online students. For example, what levels of success do online students achieve that have fulltime outside employment or are single parents? Do online students at other community colleges have similar success rates as did students at the participating community college in this study?
2. Because Anatomy 2 is the second of two gateway courses necessary for admission into a variety of healthcare programs of study, several quantitative studies might determine the success rates of online and on-ground students in these various programs. This study only considered admission into the participating college nursing program, but there are several types of follow-up studies that might be conducted. Are student success rates in Anatomy 2 dependent on success rates in Anatomy 1, i.e., will online students in Anatomy 1 do as well in Anatomy 2 as students who took Anatomy 1 in an on-ground format.

3. Is student success in the nursing program based on the type of either anatomy courses completed by the student, online or on-ground, that is, do students who took Anatomy 2 on-ground have greater success than online students.
4. Another comparison study could evaluate the graduation rates of nursing students from the participating community college by following students who completed Anatomy 2 in online or online formats.
5. A comparison could be made of success rates of students in hybrid science programs involving both on-ground and online components against the success rates of science courses offered in only on-ground or online formats.
6. Conduct studies of a similar nature at other community colleges that offer on-ground and online science classes.
7. The success rates of students in other disciplines that offer on-ground and online courses could be compared to the results of success rates in science programs to consider if an online presentation is the most amenable approach for courses of this nature.

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