Fall 11-2013

Student Success and Perceptions of Course Satisfaction in Face-to-Face, Hybrid, and Online Sections of Introductory Biology Classes at Three, Open Enrollment, Two-Year Colleges in Southern Missouri

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by

Joyce Diane Hill

November 11, 2013

A Dissertation submitted to the Education Faculty of Lindenwood University

in partial fulfillment of the requirements for the degree of

Doctor of Education

School of Education

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Dr. Sherry DeVore, Dissertation Chair — 11/11/13 Date

Dr. Steven Bishop, Committee Member — 11/11/13 Date

Dr. Rhonda Bishop, Committee Member — 11/11/13 Date

Declaration of Originality

I do hereby declare and attest to the fact that this is an original study based solely upon my own scholarly work here at Lindenwood University and that I have not submitted it for any other college or university course or degree here or elsewhere.

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Acknowledgements

I would like to extend my sincere appreciation to the members of my doctoral committee, Dr. Sherry DeVore, Dr. Steven Bishop, and Dr. Rhonda Bishop for their assistance and professional guidance during this study. I would also like to extend a heartfelt thank you to all the students who volunteered to participate in this study at each of the three locations and online. Without their willingness to participate and honest discourse, this study would never have been possible. A very sincere thank you is also extended to the instructors of the various seated, hybrid, and online sections of introductory biology included in the study. They were willing to take a few minutes of instructional time to describe the study and encourage students to participate. To all my colleagues who assisted me in this study, thank you! I would also like to express my sincere gratitude to my family for their patience and support during this process. Without your love and understanding, it would not have been an achievable goal.

Abstract

Introductory biology courses at two-year, open enrollment colleges in America are presented in a variety of different course delivery formats. Traditionally, most students have enrolled in seated or face-to-face (F2F) lectures and laboratories. There is increased demand for courses presented online or in a hybrid format, although some studies report higher attrition rates, and lower grades for these course delivery formats. The purpose of this study was to examine if there were academic differences among F2F, hybrid, or online introductory biology courses by analyzing precourse and postcourse assessment scores, final grades, attrition rates, and students' perceptions of course satisfaction. This study was grounded in the social constructivist conceptual framework and followed a mixed method design. Four research questions guided the study which involved the collection of both quantitative and qualitative data. The study involved 354 adult students enrolled in three, open enrollment, two-year institutions in Southern Missouri. Statistical analysis indicated significantly higher mean gain scores on postcourse than precourse assessments, regardless of location or course format. There was a significant difference in final course grades for students enrolled in online courses compared to those in F2F or hybrid sections; students enrolled in online sections also had a significantly higher attrition rate. Seven focus groups were conducted, and students completed online surveys indicating their satisfaction level. This study had direct application to the design, implementation, and assessment of introductory biology courses and provided insight into students' academic success and perceptions of course satisfaction with introductory biology classes.

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Chapter One: Introduction

In 2012, the American Association of Community Colleges (AACC) reported 986 publicly funded, two-year colleges in the United States served the educational and workforce training needs of approximately 13 million full-time and part-time students (AACC, 2012). Competition for students and increasing constraints on public funds, when combined with state and federal regulations that predicate funding linked to specific performance and completion rates, has generated enormous pressure on colleges to consider students as consumers (Fisher, Grant, & Ross, 2010). There is a growing demand for institutions of higher education to provide students with instruction and services at a time and location of the students' choice. These factors, in addition to an emphasis from employers and society for graduates to demonstrate competence in learning outcomes, combine to exert enormous pressures on two-year, open enrollment community colleges within the United States.

Background for this Study

A plethora of articles and studies have flooded academia concerning a dramatic shift in the roles publicly funded, open enrollment colleges need to fill in order to address the rapid changes in the American economy. The 2012 report from the AACC, *Reclaiming the Dream,* proposed, "The American dream has stalled. Median income in the U.S. stagnated between 1972 and 2000. Since 2000 median family income has declined by 7%" (AACC, 2012, p. vii). President Barack Obama challenged the nation to produce 50% more students with high-quality degrees and certificates by 2020, while increasing access and quality, which is a lofty goal (Center for Community College Student Engagement, 2010). There is an undeniable connection between education and prosperity; however, as revealed in a report from the Associated Press, nearly 50% of

Americans either are in poverty or have earnings which would classify them as low income (Census Data, 2011).

Studies indicated almost three-fourths of young Americans enter some type of post-secondary training or education within two years of graduating high school (CCCSE, 2010). These traditional-aged college students are joined by an increasing number of adult learners returning to further their education or complete requirements for job retraining. Courses can be presented in a variety of delivery modes including traditional face-to-face (F2F) or seated lectures, Internet-based instruction, or a blended or hybrid version of both F2F and online course delivery, depending on students preferences, learning styles, and schedule constraints (Gerbic, 2011).

One of the courses students are required to complete when seeking a two-year associate's degree is a general education course in natural or life science. These courses satisfy general education science requirements for non-science majors, often representing the only opportunity for these students to better understand the role of science in society and how science produces knowledge (Moore, 2008; Muchovelj, 2009). A centerpiece in a life science course is often its laboratory component, which provides an opportunity to perform hands-on experiments involving formulating and testing hypotheses, gathering and interpreting data from experiments, and experience in forming data-based conclusions (Moore, 2008).

Numerous research studies have examined the value of an online life science laboratory (Mickle & Aune, 2008; Reuter, 2009; Swan & O'Donnell, 2009). Additional studies have examined development and implementation of effective hybrid course delivery methods which attempt to bridge the gap between traditional F2F instruction and their fully online counterparts (Azaiza, 2010; Burnsed, 2011; Jenkins, 2011). However,

data are lacking on direct comparisons between student academic success and perceptions of course satisfaction based on delivery format for introductory biology classes within two-year, open enrollment institutions of higher education in Southern Missouri.

Conceptual Framework

The role and mission of publicly funded, open enrollment, two-year institutions of higher education in America have changed dramatically to adjust to a knowledge-based economy (AACC, 2012). An essential point in *Reclaiming the Dream* proposed, "No matter how diligently community colleges perform their traditional role, they cannot effectively meet the needs of their students and communities without responding to the transformation in the larger economic and societal environment" (AACC, 2012, p. 1). A societal environment containing community colleges and their stakeholders is rooted in the theory of social constructivism, in which groups of individuals interact and construct knowledge, and learning takes place because of group interaction. Social constructivism purports a great deal of human life exists as it does due to social and interpersonal influences (Gergen, 1985). This theory assumes reality is constructed through human activity, learning is a social process, and meaningful learning takes place when individuals are engaged in social activities (Gergen, 1985). Instructional models based on social constructivist perspectives stress collaboration among learners and practitioners in society (Palincsar, 1998).

Social constructivist approaches to learning have been applied in college classrooms through activities such as collaborative learning, reciprocal teaching, peer collaboration, and problem-based instruction in which students communicate and work together to solve real-world problems (Palincsar, 1998). Studies focusing on a level of student involvement and engagement in the learning process, especially in large lecture

general education science courses, reported positive results from courses redesigned to feature small group activities and inquiry-based laboratory experiences fostering active learning (Gill, 2011). The complex process of inquiry learning and formulating scientific explanations based on evidence follow a social constructivist approach to learning defined by Toth, Morrow, and Luduico (2009) as, "…illustrating the purposeful, active construction of knowledge during inquiry" (p. 335).

Several conceptual framework theories are based in the social constructivist approach which is relevant to traditional college classrooms. A 2011 study by Partin et al., summarized the importance of students' attributes for success or failure, described how beliefs about their own abilities influenced levels of motivation, and goals for academic work. Another instructional strategy grounded in social constructivism is computer-supported collaborative learning (Andre, 2000). This strategy gives students the opportunity to practice 21st century skills in communication, knowledge sharing, critical thinking and the use of relevant technologies in the workplace (Andre, 2000). Research on various learning theories supports the contention students who are self-motivated and goal-driven tend to perform better in courses presented in online formats (Mickle & Aune, 2009; Reuter, 2009).

Studies on the use of effective student-led, classroom discussions support and are grounded in the theory of social constructivism. Shwartz et al. (2009) noted participation in group discussions allowed students to develop their analytical and argumentation skills by debating, revising, and building a strong foundation for communicating their ideas. Weber, Lee, Maher and Powell (2008) published a study which concluded student-led discussions in the classroom assisted in synthesizing the ideas of others and building a deeper understanding of what students were learning. A study conducted by Matsumura,

Crosson, and Slater (2008) noted large and small group classroom discussions were beneficial in exercising self-regulation, self-determination, and the ability to solve problems collaboratively. Educational studies often promote the benefits of developing interactive discourse with students in the classroom. Effective, guided discussions can lead to what Shwartz et al. (2009) referred to as, "…powerful mechanisms that allow students to construct meaning of abstract scientific concepts, connect an activity to the main learning goals of an investigation, and reflect on their own experiences" (p. 47).

The social constructivist perspective on teaching and learning forms the basis of the conceptual framework for this study because it focuses on the premise that knowledge is a product of interaction with other humans, and learning should not take place in isolation from one's environment (Palincsar, 1998). Studies have shown benefits of interactive discourse among peers and between students and instructors, which is often an important component of F2F and hybrid courses (Weber et al., 2008). Davis and Snyder (2012) echoed the use of the social constructivist approach for science courses, regardless of the course delivery method:

> Whether face-to-face or online, learning should be framed in constructivist learning theory with students engaging in inquiry into interesting, significant problems or topics linked to everyday contexts that are posed by either the instructor or the learner. (p. 24)

However, the premise that all students are prepared for and capable of succeeding in entirely online versions of introductory biology courses warrants further investigation due to the disparity in final grades and rates of attrition, when compared to seated versions of the same course (Jenkins, 2011).

Statement of the Problem

The demand for online courses in all disciplines of higher education is increasing; however, questions abound concerning the quality of online courses compared to identical F2F or hybrid versions. Although numerous studies have been conducted presenting various facets of this issue, a study centered on the direct comparison of student success and perceptions of course satisfaction among F2F, hybrid, and online versions of introductory biology courses at two-year, open-enrollment colleges in Southern Missouri does not exist. This study was designed to fill the gap in the literature concerning this important research topic. Therefore, this research was needed in order to examine the trend noted in the literature about online courses having higher attrition rates and lower final grades when compared to identical F2F versions (El Mansour & Mapinga, 2007; Jenkins, 2011).

The problem investigated in this study was to determine if significant differences existed in student success, as well as perceptions of overall course satisfaction, with introductory biology classes presented F2F, hybrid, or online at two-year, open-enrollment institutions of higher education in Southern Missouri. Student success was measured using gain scores between precourse and postcourse assessments, final course grades, and attrition rates. Data included in the study were collected from three different two-year, open-enrollment colleges in Southern Missouri.

Purpose of the Study

This study utilized a mixed-methods approach through the collection and analysis of both quantitative and qualitative data from several sources (Frankel, Wallen, & Hyun, 2012). The purpose of the study was to determine if significant differences existed between academic success and perceptions of course satisfaction for groups of students

enrolled in introductory biology courses presented F2F, hybrid, or online. The study included students enrolled in introductory biology courses from three different two-year, open enrollment colleges in Southern Missouri during the spring semester, 2013.

Research Questions and Hypotheses

The following four research questions guided this study:

1. What academic difference exists, if any, among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by the difference between average gain scores from precourse and postcourse assessments?

2. What academic difference exists, if any, among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by final course grades?

3. What academic difference exists, if any, among groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by attrition rates?

4. What were the perceptions, as they related to overall course satisfaction, among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges?

The following null hypotheses were tested during this study:

$H1_0$: No academic difference existed among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by the difference between average gain scores from precourse and postcourse assessments.

$H2_0$: No academic difference existed among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by final course grades.

$H3_0$: No academic difference existed among groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by attrition rates.

Limitations and Assumptions

The following limitations were present in this study:

1. This study involved students enrolled in only introductory level, general education life science courses developed and taught by faculty at three different two-year, open enrollment colleges in Southern Missouri. Therefore, the results of this study cannot be generalized to a larger population.

2. This study was limited to the students who voluntarily agreed to participate and were enrolled in introductory level, general education life science courses at two-year, open enrollment colleges in Southern Missouri during the spring semester, 2013. Therefore, the results are limited in scope and represent conditions existing during the five-month span of time in which the data were collected.

3. An online survey was developed using the software program Remark and deployed via the Learning Management System (LMS) Blackboard. The survey was administered to students who voluntarily agreed to participate in the research project during the spring semester, 2013. The survey instrument was considered a potential limitation due to the phrasing of the questions and potential variability in the interpretation of the results. In order to reduce the variability of interpretation, as well as correct any discrepancies in the phrasing of questions, the survey was field-tested prior to

deployment with volunteer students enrolled in introductory biology courses that were not included in the current study.

4. The interpretation of discussions occurring within focus groups consisting of select students, and the opinions they expressed, may not have been representative of the entire population of students who participated in the study. Focus group discussions were conducted at each of the three institutions, and all participants were invited to attend. However, only a few students elected to attend the voluntary discussions. The smallest focus group consisted of six participants, and the largest consisted of nine.

5. The academic success of individual students in a particular course may have been influenced by several factors other than those involved in the study. These included the student's aptitude for technology, the class size, and the student's comfort level with technology. Furthermore, the instructor's motivation and teaching experience might have influenced student performance. In order to reduce the effect of as many of these variables as possible, the same instructor taught the F2F and hybrid sections at each institution.

The following assumptions were accepted in this study:

1. The responses of student participants were offered honestly and without bias. The identity of each student participant was kept strictly confidential, and each participant was informed he or she could withdraw from the study at any point during the semester without repercussion. Students in the focus group discussions were allowed to select their own pseudonyms, which were used in all discussions.

2. The introductory biology courses at each of the three institutions included essentially the same topics and were considered equal in their level of academic rigor. The course syllabi and abstracts were reviewed by the principal investigator prior to the beginning of the study to ensure they were essentially equal.

3. The qualifications and effectiveness of the various instructors at all three participating institutions included in the study were assumed to be equal. The F2F and hybrid introductory biology courses at each of the three institutions included in the study were taught by the same instructor, and each instructor had a minimum of 10 years teaching experience at the college level.

4. Introductory biology classes presented online included the same information as the courses presented F2F or hybrid at all three institutions included in the study. Online introductory biology courses were offered by only one of the three participating institutions, and the course abstract and syllabus was reviewed by the principal investigator prior to the beginning of the study to ensure they were covering the same information as the F2F and hybrid sections.

Definition of Key Terms

For the purposes of this study, the following terms are defined:

Attrition. The decrease in the number of students attending a course, a program, or an institution (Boyles, 2000).

Blended learning. In its simplest form, blended learning refers to a combination of face-to-face (physical) and online (virtual) learning environments (Stacey & Gerbic, 2009).

Face-to-face (F2F) delivery. Also referred to as traditional, or seated, this format for course delivery involves regular class meetings between an instructor and students according to a fixed schedule and physical location (Oram, 2006).

Gain score. The numerical difference between the score on a postcourse and a precourse assessment (Frankel et al., 2012).

Hybrid delivery. Also referred to as blended course delivery, it is a combination of online components and face-to-face instruction within a given course (Means, Toyama, Murphy, Bakia, & Jones, 2010).

Online delivery. Also referred to as web-based delivery, in which digital information is provided for access by students via the internet at a time and location of their choosing (Means et al. 2010).

Persistence. The completion of a course in which a student is enrolled (Harrell & Bower, 2011).

Precourse and postcourse assessments. Questions that are administered prior to a course, and again after completion of the course, to determine a student's level of knowledge or skill concerning various topics (Angelo & Cross, 2010).

Summary

Two-year, open enrollment colleges serve an important role to an increasingly diverse constituency of students nationwide (CCCSE, 2010). Through rapid changes in technology, more students enroll in courses other than F2F, including online, and hybrid (Instructional Technology Council, 2012). A student's experience in an introductory biology course, regardless of his or her intended field of study, should be engaging, enjoyable, and presented at an appropriate level of academic rigor. The student's perception of his or her experience with a course should not be determined entirely by format for delivery of material. This study was guided by four research questions, and three null hypotheses were tested. Key terms were defined and were referenced throughout the remainder of this document. This study had limitations, and key assumptions were made that influence applicability of results to other populations.

A review of literature pertinent to this research was presented in the following chapter, beginning with an analysis of the significance of publicly funded, two-year, open enrollment colleges in the United States. The role of technology in online education, especially as it applies to introductory science courses, was presented. A description of how science courses were structured and assessed, as well as what factors influenced student success in introductory science classes presented in various methods of delivery, was addressed in the following chapter.

Chapter Two: Review of Literature

This chapter includes a summary of relevant literature to establish the background and context for this study. First, there is a review of the significance of publicly funded, two-year, open enrollment colleges in the United States, including a brief review of the historical context in which these colleges emerged, their present relevance, and a projection of how these institutions might influence the future of higher education. The second section is a review of the role of technology in online course delivery formats, including the history, present status, and future of online course delivery. Section three is a review of college level science courses including how these courses have been structured historically, how the courses are presented now, and a brief description of how they might be presented in the future. Section four presents the best practices for measuring the effectiveness of seated, hybrid, and online course delivery formats for college level introductory science classes.

Publicly Funded, Two-year Open Enrollment Colleges in America

Historical perspective. Vaughan (2006), author of *The Community College Story: A Tale of American Innovation,* described the history of publically funded, two-year, open enrollment colleges in the United States. In 1862, the Morrill Act, also referred to as the Land Grant Act, expanded access to public higher education (Vaughan, 2006). The first community college, Joliet Junior College, was founded in 1901 in Illinois, and is the oldest community college in the nation still in operation (Vaughan, 2006). Community colleges began forming professional associations with the organization of the American Association of Junior Colleges, now referred to as the American Association of Community Colleges (AACC), which was founded in the early 1900s, and held its first meeting in St. Louis, Missouri, during the spring of 1920

(Vaughan, 2006). In 1944, Congress passed the GI Bill of Rights, also referred to as the Servicemen's Readjustment Act (Vaughan, 2006). The GI Bill provided financial assistance to more than 2.2 million veterans of WWII to pursue a degree in higher education, and millions of veterans and their families attended two-year, open enrollment colleges around the nation (Vaughan, 2006).

In order to meet the increasing demand for higher education, the President's Commission on Higher Education established a network of public community colleges in 1947 (Vaughan, 2006). The legislation was designed to establish publicly funded community colleges to serve the geographic region in which they were located. Beginning with the Higher Education Act of 1965 and its subsequent amendments, the Federal Government made it possible for nearly everyone to attend college (Vaughan, 2006). The Federal Pell Grant program provided the opportunity for millions of students to pursue a degree in higher education (Vaughan, 2006).

Current relevance. Nearly one-half of all U.S. undergraduates have attended a publicly funded, two-year open enrollment college (AACC, 2012). Community colleges were considered by many as a gateway to opportunity by providing an accessible, affordable education for students interested in transferring to a baccalaureate-granting institution, or to pursue technical and work force development certifications (AACC, 2012). Of the 1,132 community colleges operating in the U.S. in 2012, 986 were publically funded, and served the educational needs of approximately 13 million full-time and part-time students (AACC, 2012).

Future relevance. The future of community colleges in America hinges on their ability to transform the educational experience of their students in a rapidly changing world. In a report released on April 21, 2012, the president of the AACC, Dr. Walter G. Bumphus indicated the critical role of community colleges in the nation:

> We need to completely reimagine community colleges for today and the future. It is important that college graduates be not just globally competitive but also globally competent. In today's knowledge economy, intellectual capital is a nation's greatest, most renewable natural resource. Higher education is struggling with low student success rates and employers complain about inadequate student preparation for the job market. Our underinvestment in higher education not only wastes our human capital, it threatens U.S. global economic leadership, contributes to the erosion of or middle class, and calls into question the viability of the American dream, with its promise of upward mobility for each generation. (AACC, 2012, p. vii)

Additional students pursuing degrees in science, technology, engineering, and mathematics (STEM) fields are needed to fill job openings in this rapidly growing sector of the workforce. In December of 2012, a national directive designed to entice more students to pursue STEM degrees was announced:

> The Department of Commerce estimates that STEM occupations will grow 1.7 times faster than non-STEM occupations over the period from 2008-2018. In order to meet these workforce needs, the United States will need approximately 1 million more STEM professionals than are projected to graduate over the next decade. (Feder, 2012)

If community colleges expect to play an important role in helping to educate and prepare future generations to compete in an ever changing global economy, there must be a commitment to redefine institutional roles in order to meet the needs of a 21st century workforce.

Fifty percent more college graduates by 2020. The publication, *The Heart of Student Success: Teaching, Learning, and College Completion,* is produced by the CCCSE, part of the Community College Leadership Program at the University of Texas, Austin (CCCSE, 2010). The 2010 CCCSE report highlighted efforts to improve college completion in light of the national challenge presented by President Barack Obama to produce 50% more students with high-quality degrees and certificates by the year 2020 (CCCSE, 2010). This goal coincided with an effort to increase access and quality, positioning the United States to lead the world in the proportion of citizens with postsecondary credentials (CCCSE, 2010). The CCCSE has joined five other national community college organizations and signed the Community College Completion Commitment document (CCCSE, 2010). The collective focus on improved rates of community college completion represented a shift from the more traditional emphasis of providing varied post-secondary educational opportunities (CCCSE, 2010).

The CCCSE (2010) reported approximately three-quarters of young Americans enter some kind of postsecondary training or education within two years of graduating from high school. However, the open door to many community colleges has become a revolving one, with only 28% of first-time, full-time, associate degree students graduating within three years (CCCSE, 2010). The study noted only 52% of first-time, full-time college students in public community colleges returned for their second year. While not all students enrolled in community colleges were intent on completing a

certificate or a degree, a sizable gap existed between the percentage of students who indicated their goal was to complete credentials and those who successfully attained their educational goal. Among CCCSE respondents, 52% of students reported completing a certificate, while 84% reported obtaining an associate's degree as their goal; however, only 45% of students earned a degree or certificate within six years of enrolling in a community college (CCCSE, 2010).

Educational attainment in America has declined, not only in comparison with other countries, but also between successive generations of its own citizens (CCCSE, 2010). The CCCSE study conducted in 2010 ranked the United States 10th globally in the percentage of young adults who hold a college degree, and if the trend continues, the current generation of college-age Americans will be less educated than their parents for the first time in U.S. history. This trend coincided with an increased emphasis in higher education, and the challenge of producing graduates who were globally aware and able to function in a more interconnected economy (CCCSE, 2010).

The role of technology. Historically, community colleges have met the needs of a diverse student body including recent high school graduates and adult workers returning to college to learn new job-related skills, many of whom are first-generation college students (AACC, 2012). Although community college students demonstrate diverse backgrounds, most share one thing in common: limited amounts of time. A majority of community college students work either part-time or full-time, and many provide care for dependents while juggling personal, academic, and financial challenges (CCCSE, 2010). Effective engagement in the learning process, which is foundational in the social constructivist theory, is fostered by an understanding of students' needs (Shwartz et al., 2009). Engagement in the learning process also helps students address the barriers to

their success and helps keep them enrolled and progressing toward their academic goals (AACC, 2012).

Changes in technology have been a driving force behind the challenges faced by publicly funded, open-enrollment, two-year colleges in the United States (Burnsed, 2011). Technological innovations in the workplace require individuals to obtain training to remain competitive, while innovations in course delivery systems helps to erase the boundaries, which historically defined the domain of publicly funded community college (Howell, 2009). Technological innovations have attempted to bridge the gap and provide a sense of community and interaction in the online environment, which according to the social constructivist theory was essential to the learning process (Palincsar, 1998). Involvement in distance education by institutions of higher education grew significantly from the involvement of only a few states in 1987, to the inclusion of almost all states offering some type of distance education courses by 1989 (Gunawardena & McIsaac, 2004). Improvements in telecommunication technologies allowed colleges to reach rural student populations which had been relatively isolated from access to higher education courses in their communities (Gunawardena & McIssac, 2004).

Distance learning in higher education. Important aspects involved with adopting technology for use in distance education were outlined by Gunawardena and McIsaac (2004) and included selecting a delivery mode which considers where, how, and when students have access to the course materials, establishing the amount of social interaction possible within the delivery mode, and evaluating the degree of competency students need to effectively navigate the course. Distance education was a generic term used to describe correspondence courses and has broadened to include courses available via CDs, DVDs, satellite, and audio conferencing among other modes of delivery

(Gunawardena & McIssac, 2004). Institutions of higher education described distance education as synonymous with online, internet-based technology where the percentage of the course's delivery format determines in which category it belongs (Gunawardena & McIssac, 2004). Definitions of distance education courses vary; however, an online course typically does not require any F2F meetings between the students and instructor, whereas a hybrid or blended courses includes 30% to 79% of the content delivered online (Allen & Seamen, 2011). Web or computer facilitated courses were defined as requiring anywhere from 1% to 29% of the instructional material be delivered through a course-management system in order to supplement F2F instruction, with a traditional seated course described as entirely F2F instruction and interaction between students and the instructor (Allen & Seamen, 2011).

Course delivery modes. Traditionally, most community college courses have followed the seated, F2F delivery instructional mode where the professor stood before a group of students and presented course content (Parry, 2010). By its very nature, traditionally structured lecture courses limit contact between the instructor and the students, especially in large groups (Parry, 2010). One student succinctly described the lack of interaction between the instructor and students in large, seated lecture courses by stating, "If you want to experience distance education, sit in the back row of a 500 seat lecture" (Parry, 2010, p. 6).

Fully online and hybrid course delivery systems have grown at an astounding rate nationwide as evidenced by the Babson Survey Research Group's 2011 study (Allen & Seaman, 2011). According to the study, more than 6.1 million students enrolled in at least one online class during the fall semester of 2010, a 10% increase from the previous year, whereas the total enrollment in higher education for the same time period increased

less than one percent (Allen & Seaman, 2011). In a study published in 2010, Serhan outlined numerous reasons why students preferred to enroll in online versus traditional F2F lecture courses presented at the college level. Many students reported working either part-time or full-time while attending school, and described the convenience of taking online classes scheduled around their work (Serhan, 2010). Students in the study identified another advantage of online classes as the flexibility of completing coursework on their schedule, anytime during the day or night, which was especially important for students who had family obligations (Serhan, 2010).

Wilson and Gerber (2008) concluded similar findings in a study focused on strategies for working with the millennial generation, where students reported the flexibility of schedules and the ability to learn at one's own pace in the comfort of one's own environment as advantages of online instruction. Aoun (2011) proposed, in a study about the demand for diversifying delivery systems, colleges were less defined by their existing buildings and campuses and have moved away from place-based education toward a more global system. Lynch (2010) echoed similar findings when he stated, "Online learning is rapidly increasing as an acceptable and sometimes preferred mode of instruction. It offers unique resources and an instructional environment that enhances learning" (p. 777).

The growth rate for online courses has been considerable; however, research studies report mixed results in the areas of student success and their perception of overall course satisfaction when comparing online with F2F modes of course delivery (Aragon & Johnson, 2008; El Mansour & Mupinga, 2007; Fike and Fike, 2008; Lytle, 2011; Online Learning, 2010; Serhan, 2010). In light of the social constructivist theory, the students' perception of the courses in which he or she is enrolled forms the basis for their reality

and is essential to their learning (Palincsar, 1998). In his article, *Why are so many student still failing online?,* Jenkins (2011) documented student success rates in online classes as only 50%, compared to a 70-75% student pass rate in identical F2F classes. Several studies, including those published by El Mansour and Mapinga (2007) indicated attrition rates for students enrolled in entirely online courses was significantly higher than attrition rates for students enrolled in the same course in a traditional, F2F method of course delivery. Researchers echoed concern with student retention rates in online courses when they stated, "Many higher education institutions report persistence rates in their online courses that are much lower than those in face-to-face courses" (Harrell & Bower, 2011, p. 189).

The 2011 study entitled, *Student Characteristics that Predict Persistence in Community College Online Courses,* Harrell and Bower noted the key factors which influenced student persistence in online classes were learning style, grade point average (or GPA), and their level of computer skills. The study involved an online survey administered to 225 students enrolled in online classes at five community colleges in Florida (Harrell & Bower, 2011). Students with, "…an auditory learning style were associated with an increase in course withdrawal" (Harrell & Bower, 2011, p. 187). Harrell and Bower (2011) surmised this result was due to the majority of the information presented in online classes is in written format, and auditory learners, "…may not be able to comprehend online course material as well as students with other types of learning styles" (p. 187). The second predictor of student persistence in online community college courses noted in the study was GPA. There was an indirect relationship between student's GPA and course withdrawal. Harrell and Bower (2011) contended, "Students with higher GPAs show evidence that they have learned how to navigate college courses

and understand what it takes to be successful in the college environment" (p. 187). An unexpected finding from this study was an inverse relationship between students' basic computer skills and rates of course persistence (Harrell and Bower, 2011). Harrell and Bower (2011) described several explanations including; students overestimate their levels of computer experience, they may have been more likely to succumb to the distractions of the Internet, or the result is a statistical anomaly based on the small sample size included in the study. Student learning styles were also noted as an essential component of success in online classes in a study conducted by Battalio (2009), when the author noted reflective learners excelled in both collaborative and self-directed versions of online classes.

Instructional technology in higher education. The Instructional Technology Council (2012) publishes an annual distance education survey in the fall of each year. The survey noted a majority of colleges continue to do more with less as the effects of a recession continue to linger (ITC, 2012). Notable trends included the deployment of cloud-based computing solutions, a growing interest among students to make higher education courses fit on smaller mobile devices such as smart phones and tablet computers, trends which challenge educators to examine content and find better ways to package and deliver materials to their students (ITC, 2012). The study also examined the future of different learning management systems, such as Blackboard and Desire2Learn (ITC, 2012). Cloud computing offers an alternative platform for virtual learning environments, and many campuses included in the survey reported they have switched to open source solutions such as Moodle and Sakai to save on licensing costs (ITC, 2012).

The Council of Regional Accrediting Commissions (C-RAC) has addressed accreditation of distance programs within institutions of higher education through the

development of the Interregional Guidelines for the Evaluation of Distance Education published during the fall of 2011 (ITC, 2012). These guidelines were designed to assist institutions in planning distance education programming and to provide an assessment framework for existing online courses (ITC, 2012). All of the regional higher education accrediting organizations in the United States has adopted these guidelines, which were intended for use by accreditation evaluation teams (ITC, 2012).

Financial aid fraud rings in distance education. Federal and state government's interest in distance education intensified as enrollment in online programs outpaced enrollment in traditional F2F courses within institutions of higher education (ITC, 2012). Individuals attempting to defraud institutions of federal financial aid money caused a problem unique to distance education (ITC, 2012). The ITC 2012 report contained the following information concerning financial aid fraud rings within online education:

> On September 26, 2011, the Office of Inspector General released a report which alerted the Department of Education and higher education institutions to the presence of an increasing number of financial aid fraud rings that have targeted community colleges and other distance learning course providers. The members of these rings have applied for and obtained student financial aid after enrolling to take courses which they never intended to complete. Typically, a ringleader steals the social security numbers or other information he or she needs to fabricate a group of straw students, or individuals provide their personal information in exchange for a portion of the proceeds. During the past year, the University of Phoenix has discovered 810 fraud rings made up of 18,000 individuals. The fraud rings have targeted community colleges due to their lower tuition rates, since a

> balance remains after tuition is paid to cover housing and other expenses. Rio Salado Community College helped convict and sentence 64 individuals who tried to defraud their institution of $538,000. Six individuals were indicted and pled guilty for enrolling 62 straw students in order to steal $200,000 from the Los Rios Community College District. (ITC, 2012, p. 4)

When Congress reauthorized the Higher Education Act, also referred to as the Higher Education Opportunities Act, in 2008, institutions offering distance education courses were required to verify, "…the student who registers in a distance education or correspondence education course or program is the same student who participates in and completes the course or program and receives academic credit" (ITC, 2012, p.19). In its rulemaking proceeding, the Department of Education clarified accrediting bodies only needed to require institutions to use, "…methods such as a secure login and pass code, proctored examinations, and new or other technologies and practices that are effective in verifying student identification." (ITC, 2012, p. 5)

Educating the millennial generation and beyond. Individuals born after 1992, the millennial generation, comprise the generation of students who have entered colleges and universities (Census Data, 2011; Koeller, 2012). Studies indicate millennials learn through a variety of teaching methods and considered themselves to be multi-taskers, learning through collaborative group activities and the application of material to real life issues (Ayala, 2009). A majority of students in this generation grew up with technology and reported learning effectively when a variety of instructional strategies were used (Wilson & Gerber, 2008). According to an annual survey of distance education, almost half of all secondary students believed online classes were integral to their learning, especially since access to learning resources online in secondary schools has tripled since

2007 (Internet World Statistics, 2011; Mills-Patterson, Turnbull-Chavaux, & Helvey, 2011; Project Tomorrow Survey, 2011).

Colleges were historically defined by their physical campuses; however, the days of institutions being limited in the courses they can offer is no longer determined by parking or classroom and laboratory availability. There is a growing trend for institutions of higher education to diversify their course delivery systems, expanding to include completely online and hybrid courses (Burnsed, 2011). Hybrid courses provide students a large portion of their lecture material online, but meet in person several times throughout the semester (ITC, 2011). Aoun (2011) illustrated this important trend in higher education by noting an increased number of working adults attending community colleges either for job retraining or to complete a particular certification . He concluded colleges were catering to this increased percentage of their enrollment by expanding the courses offered during the evenings and on weekends, further de-emphasizing the traditional campus experience (Aoun, 2011).

Higher education courses identified as being among the most challenging to convert to an online format include those in science, math, nursing, the arts, and foreign languages (ITC, 2012). Regardless of the particular focus of the course and the method of instructional delivery, learning should be framed using principles of the social constructivist learning theory where students were engaged in inquiry into interesting, significant problems or topics linked to everyday contexts, posed either by their instructor or by the learner (Davis & Snyder, 2012). Online learning has increased the learners' communication beyond classrooms, states, and countries and has expanded the learning community beyond traditional boundaries, becoming the model for education without walls (Dixson, 2010).

Online for locals and open courseware. Although there is a trend toward globalization in higher education courses, studies reveal over one-third of students who enroll in online courses live within 50 miles of the institution, with almost two-thirds of the students living within the institution's geographic region (Aoun, 2011). There are exceptions to this general trend noted in the growing number of Massive Open Online Courses (MOOCs) where learners of all ages around the world enrolled in courses offered by some of the most prestigious colleges and universities, free to anyone with Internet access (Marklein, 2012). Massachusetts Institute of Technology and Harvard have committed $30 million each to found edX, a non-profit partnership which offered seven MOOCs during the fall of 2012. A company called Coursera, founded by two Stanford University professors, has contracts with 16 research universities, three of which are outside the U.S., to offer over 115 different courses in math, science, world music, and poetry (Marklein, 2012).

Questions surround the emerging technology of MOOCs, including if the courses were profitable, and if they should be accredited. Additional concerns include how to regulate the courses and if certificates of completion should have been granted to graduates of these online programs (Marklein, 2012). The trend of presenting material through a MOOC has already impacted institutions of higher education through increased pressure to diversify course offerings in response to student demand (Marklein, 2012).

Mangan noted in a 2012 study there were millions of students worldwide who logged on to free courses offered through Yale, Massachusetts Institute of Technology (MIT), The University of California at Berkeley, and start-ups like Peer 2 Peer University and Saylor.org. MIT started offering free online classes in 2002 and has expanded to offer 2,100 undergraduate and graduate classes through MIT Open Course Ware, with an

estimated 125 million students viewing the content since 2003 (Mangan, 2012). Another source of free instructional information was Kahn Academy, a repository of over 3,250 digital lectures available free of charge online via YouTube (Webley, 2012). The Kahn Academy, founded by Selman Khan in 2009, has become a very successful venture, gaining the support of Microsoft, Google and Netflix (Webley, 2012).

The Babson Survey Research Group, as cited in Allen and Seaman (2011) noted over 6.1 million students, or 31% of all students in higher education, were enrolled in at least one course online during the fall term of 2010 (Allen & Seaman, 2011). This represents an increase of 560,000 students over the previous year (Allen & Seaman, 2011). The study was based on responses to survey questions submitted from more than 2,500 colleges and universities across the nation. Sixty-five % of all chief academic officers at reporting institutions indicated online learning was a critical part of their long-term strategy (Allen & Seaman, 2011). Initially, many colleges might have welcomed the global aspect of fully online courses and programs, but the survey concluded a majority of students enrolled in online classes live and work within their service district (Allen & Seaman, 2011). The trend of online classes being completed by local students was mirrored in a publication by Parry in 2009. Surveys conducted by Eduventures Inc., an education-consulting firm, noted approximately two-thirds of students interested in online courses preferred to take them from a local institution (Parry, 2009).

National distance education survey. The ITC created an annual distance education survey in the fall of 2004. The 2011 ITC survey results indicated more than 89% of the institutions identified as associates colleges reported an 8.2% increase in distance education course enrollment from the fall of 2010 to the fall of 2011 (ITC

Survey, 2011). This increase in distance education enrollments substantially outpaced overall enrollment, which averaged less than 1% nationally (Allen & Seaman, 2011).

A component of the ITC survey involved asking distance education program administrators to rank the challenges their programs face. The number one challenge reported for several years was the need for additional support staff for training and technical assistance (ITC Survey, 2011). However, the survey results from 2011 indicated the need for adequate student services for distance education students had become the number one challenge for a majority of distance education program administrators (ITC Survey, 2011). The second biggest challenge reported for 2011 was the need for adequate assessment of distance education classes, followed by compliance with new financial aid attendance requirements (ITC, 2012)

Accreditation of online courses continues to be an area of concern in higher education. Standards require distance education courses be equivalent or better than those taught in a F2F environment in terms of content and academic rigor (ITC, 2012). In 2011, nearly 80% of the distance education administrators responding to the ITC survey indicated the online classes offered by their institutions were equivalent or superior to F2F courses being instructed at their campuses (ITC, 2012).

In 2008, the ITC survey introduced questions about courses delivered in a hybrid or blended format and Web-facilitated courses. The survey defined a blended or hybrid course as one where online instruction merged with F2F delivery and 30-79% of the content was delivered online (ITC, 2012). A web-facilitated course (also referred to as a Web-enhanced or Web-assisted course) was a F2F course which incorporated the Internet, and anywhere from 1-29% of the content was delivered online (ITC, 2012). Examples of courses following a Web-facilitated format included when an instructor

posted the syllabus, course schedule, and assignments within a learning management system or on a Web page (ITC, 2012). In the 2011 survey, 63% of respondents reported offering completely online courses, and 27% offered hybrid courses. Fifty-five % of the respondents indicated their institution planned to increase the number of hybrid courses it offered each term (ITC, 2012).

Student challenges in online classes. Although demand for online courses has increased, several issues surround student preparation, including a lack of basic computer skills, a misunderstanding of the online learning environment, and insufficient study skills are factors noted in studies of online course persistence (Harrell & Bower, 2011). A lack of orientation and preparation for distance education courses was the greatest challenge reported to ITC in 2012, followed by the need to improve assessment of student learning and performance, and low student completion rates for online courses. Fifty-three % of reporting institutions indicated retention rates were lower for online classes than for F2F courses at their colleges and 40% reported retention was comparable between the two course delivery formats at their institutions (ITC, 2012). Four % of those surveyed reported retention rates for online courses exceeded F2F retention rates at their respective colleges (ITC, 2012).

The typical online student. Student demographic data from the 2012 ITC survey indicated students between the ages of 18 and 25, or traditional-aged college students, comprised 48% of enrollment in online classes, followed closely by non-traditional students over the age of 26, who comprised 47% of online enrollment from the survey (ITC, 2012). The survey noted, although older students may not be as comfortable using technology as their younger counterparts, they were more motivated to succeed, and had a higher average GPA and completion rate than students who had recently graduated

from high school (ITC, 2012). The ITC survey has consistently confirmed more women than men enroll in online courses, reporting 62% of students enrolled in online courses nationwide were female (ITC, 2012). With regard to student authentication, the 2008 Higher Education Opportunities Act, followed by the Department of Education's corresponding regulations, required accreditors to ensure colleges authenticated the identity of students enrolled in online education courses, and 99% of reporting institutions indicated they had complied with the regulations (ITC, 2012).

Advantages and disadvantages of online learning. Serhan (2010) conducted a study focused on the advantages and disadvantages of courses delivered in an online format from the student's perspective (Serhan, 2010). Students indicated flexibility and increased access to materials, along with the ability to participate openly without embarrassment as several of the positive aspects of online learning (Serhan, 2010). However, the following disadvantages to online learning were identified by students, and included difficulties with the technology, a lack of F2F interaction with classmates and the instructor, and self-discipline and time management issues (Serhan, 2010). The study included students' perspectives toward online learning, and identified several disadvantages which were categorized into five themes, including a lack of immediate feedback, a lack of live interaction, technical problems, extra responsibility of learning on one's own, and the amount of material covered (Serhan, 2010).

The question of whether or not online learning is the best format for delivery of courses in higher education has been the subject of numerous studies. In one study, student success rates in online courses of only 50%, compared to 70-75% success rates in identical F2F courses were reported (Jenkins, 2011). In a study conducted by two researchers from East Carolina University, 43% of online students dropped out of a

graduate-level business administration course compared to just 11% who withdrew from the identical course offered in a F2F format when both groups had a similar undergraduate GPA (Parry, 2009). Fast-paced gains in student enrollment have led many institutions in higher education to offer online courses in all disciplines (Allen & Seaman, 2011). However, should every course be offered online? Is every student capable of succeeding in online courses? Jenkins (2011) noted online courses are typically more rigorous and often require a tremendous amount of self-discipline, academic ability, and technical competence when compared to identical F2F courses.

The future of online education. As online education becomes more mainstream, the future of distance learning for students in higher education is limitless (Howell, 2009; Lytle, 2011; Schwab, 2013). Many institutions, such as the University of Maryland, required undergraduates to take a minimum of 12 credits in alternative learning modes, which included online and hybrid classes, and the University of Minnesota State Colleges and Universities system is pushing to have 25% of credits earned online by 2015 (Parry, 2010). A Department of Education meta-analysis reviewed more than 1,000 studies of online education conducted from 1996 through 2010, and concluded students in strictly online settings performed marginally better than students in F2F courses (Burnsed, 2011). However, the quality of instruction, no matter what the means of delivery, had the greatest effect on a student's performance and overall retention (Burnsed, 2011). Educational research has shown the level of interaction between students and instructors within the classroom environment helps establish a sense of community within the group and is a key component of student success (Fata-Hartley, 2011).

Technology and STEM Courses

Effective online courses in the fields of science, technology, engineering, and mathematics (STEM) have been of particular interest to many stakeholders in higher education. A National Science Foundation (NSF) report released in 2011 illustrated the involvement of women, ethnic minorities, and persons with disabilities and noted students from these underrepresented groups received only 17% of bachelor's degrees, 10% of master's degrees, and 9% of doctorate degrees in STEM fields (Flowers, 2011). Suggestions for increased diversity of the STEM workforce included the development of effective online STEM courses, implementing online STEM enrichment programs, online mentoring programs, webinars, and virtual conferences (Flowers, 2011; Lawrence, 2011).

Science instruction has traditionally taken place in lectures where an instructor provides information to a passive audience. This type of instruction often fails to fully engage and excite students, and reinforce the interconnections among the various disciplines of science (Gill, 2011). In accordance with literature on best-practice teaching methods, changes have been implemented that revised the way science is taught (American Association for the Advancement of Science, 2010; Brownell, Kloser, Fukami, & Shavelson, 2012; National Academy of Sciences, 2010; Wood, 2009). Research supports student-centered instructional methods, emphasizing an inquiry-based approach to understanding as the most effective mode of science instruction (AAAS, 2010; Edgcomb, Britner, McConnaughay & Wolffe, 2008). A critical component of higher order thinking in science courses is the ability to understand concepts, synthesize information, draw conclusions, and make predictions based on observations (Demir, Schmidt & Abell, 2010). Process skills demonstrated and practiced in laboratories

emphasize the type of analytical thought processes needed to encourage the development of the conceptual understanding of ideas (Fata-Hartley, 2011).

In an effort to encourage students to be more motivated to learn concepts in biology and zoology, a group of researchers in the Department of Biology at the University of Puerto Rico in San Juan, developed a seamless biology curriculum (SBC) model which integrated lecture topics, followed by laboratory activities emphasizing the concepts immediately after they were discussed. Results on student learning indicated the SBC model was more effective than traditional, non-integrated curricula at improved learning, and students in classes following the SBC model demonstrated better developed scientific processing skills (Burrowes & Nazario, 2008). Students expressed they enjoyed the integration of laboratory activities within lecture in the courses using the SBC model (Burrowes & Nazario, 2008).

A study designed to test web-based learning enhancements through the introduction of video lecture through voice-over PowerPoints in a majors-level introductory biology course at The City University of New York was conducted by Lents and Clfuentes in 2009. Students received lecture information via a prerecorded voice-over PowerPoint video or through traditional F2F lectures with the same instructor, while both groups participated in F2F laboratories and mandatory discussion sessions (Lents & Clfuentes, 2009). Several disadvantages to the web-based instructional component were addressed in the study, including a lack of instant feedback to questions and a loss of rapport between instructor and students (Lents & Clfuentes, 2009). However, the study concluded students who watched the web-based lectures performed as well on exams as their counterparts who attended traditional F2F lectures (Lents & Clfuentes, 2009).

STEM classes and student engagement. According to the social constructivist theory, student engagement in the learning process has been shown to be an important component of college level instruction in the sciences (Davis & Snyder, 2012). Classes designed with a lecture which includes small-group activities, laboratories designed as inquiry-based experiences, and infused with technology have become more common within institutions of higher education (Gill, 2011). Research studies indicated increasing levels of disengagement from students enrolled in traditional lecture-based, instructor centered course delivery formats, where students reported feeling disengaged and viewed the material being presented as irrelevant to their lives when science courses were an authoritarian presentation of the material by the instructor (Turner & Peck, 2009). If students are to be able to understand and help resolve contemporary issues, they must be allowed the opportunity to creatively process information and demonstrate higher order thinking skills and teamwork (Demir et al., 2010). Active learning has been identified as an effective method of encouraging students to actively engage in science courses, and improve their scientific literacy and reasoning skills; yet, most introductory science courses often reinforce students' passive attitudes toward learning (Fata-Hartley, 2011).

Student engagement in the learning process is an essential component in the pursuit of improved student performance (Demir, Schmidt, & Abell, 2010; Gooding & Metz, 2012). The importance of providing active learning opportunities for students in post-secondary STEM classes was reinforced by Miller, Pfund, Pribbenow and Handelsman, (2008) in their description of a course where one-third of the class time is devoted to instructor-centered lecture, and two-thirds involved data analysis and small group presentations. Research conducted at Washington State University noted the results of redesigning an introductory environmental science course from a traditional

instructor-led, large lecture course, to a more student-centered course with small group activities and inquiry-based labs infused with popular media technology (Gill, 2011). The course moved from a more content-oriented approach to a more thematic structure by focusing on environmental science issues that directly impact students' daily lives (Gill, 2011).

The redesign of undergraduate science courses has been the focus of several publications, all of which have highlighted the importance of emphasizing active student engagement in the laboratory component of the course (AAAS, 2010; NAS, 2010). Brownell, Kloser, Fukami, and Shavelson, (2012) noted the importance of students actively engaged in learning, and utilizing their problem-solving skills. Brownell et al. (2012) conducted a study comparing traditionally structured, *cookbook-type* labs with a research-based laboratory course for undergraduates, with 20 students participating in each course group. The study noted students completing the research-based labs exhibited higher self-confidence in lab-related tasks and displayed an increased interest in pursuing future scientific research (Brownell et al., 2012). The study was limited in scope; however, it did address an important gap in the literature through the use of a matched control group (Brownell et al., 2012).

Demir et al. (2010) conducted a study engaging nonscience majors in an integrated, team-taught honors science class designed to foster active learning and encourage inquiry-based skills. Students were divided into groups consisting of three to five members and given a tape measure, graph paper, string, and a meter stick and were sent to measure the surface area of an ornamental pond on the campus of the University of Missouri, Columbia (Demir et al., 2010). The students finalized their calculations back in their classroom, and the authors concluded the activity was a success because,

"Their measurements approximate reality rather than represent it completely…and demonstrated that scientific knowledge is tentative and that scientists, like the students themselves, create models of nature rather than learn some absolute truth about it" (Demir et al., p. 26).

STEM classes and virtual lab software. As technology becomes more widely available to most students enrolled in higher education courses across the nation, the evaluation of software used in virtual laboratories has gained attention (Annetta, Klesath, & Meyer, 2009). Simply converting a particular scientific concept into a virtual format may not meet the student learning goals or objectives of the course (Lear, 2009). It is important to assess the efficiency and design of the technology to verify it is appropriately addressing the desired outcomes for which it is being used (Annetta et al., 2009). Several advantages noted by students enrolled in online laboratories included the following: the ability to access the course material at any time wherever they can access the Internet, the ability to repeat virtual experimental procedures as needed in order to reinforce challenging concepts, and the ability to learn at their own pace (Swan & O'Donnell, 2009). Toth, Morrow, and Ludvico (2009) described the benefit of using virtual laboratories as, "…software tools that allow the user to conduct the same scientific inquiry afforded by hands-on investigation but at a reduced expense, with increased safety, and within the time constraints of higher education classrooms" (p. 334).

Online laboratory simulations allow instructors to share information from several expert resources, and the learning environment can be customized. The Virtual Biology Laboratory (VBL) was a virtual media program developed by members of the Department of Life Science at Rutgers University and provided an innovative, web-based learning environment for first year students enrolled in general biology courses (Swan &

O'Donnell, 2009). In a study conducted to determine the effect, if any, the virtual biology software had on student success and course satisfaction, VBL was offered as an optional resource to those students who were willing to voluntarily utilize it (Swan & O'Donnell, 2009). The study concluded that of the 1200 students who enrolled annually in General Biology 101 at Rutgers, those who voluntarily utilized VBL, performed better in the classes, especially on the laboratory final exam (Swan & O'Donnell, 2009). When students were surveyed about VBL, users reported generally favorable comments, indicating they preferred the color slides and diagrams to the black and white versions in their printed lab manual and the ability to play video clips of challenging concepts at their preferred pace. Additionally, students mentioned a benefit from completing practice quizzes and exams which were especially helpful to review because they provided immediate feedback (Swan & O'Donnell, 2009).

Recent developments in technology have led to an increased interest in virtual learning scenarios. According to a study conducted by Anetta et al. (2009), a virtual learning environment, "…refers to the immersive, three-dimensional space where people can interact in real time online" (p. 27). The researchers designed an online supplemental lab activity called, "The Bug Farm" for students enrolled in an entomology course at North Carolina State University. The development of the online, 3-D program simulated a farm where students *captured* virtual insects and taxonomically classified them (Anetta et al., 2009). The authors noted, "The results of this study suggest that students have a high level of presence and immersion in the 3-D virtual environment created for an entomology course" (Anetta et al., 2009, p. 31). Although the authors cautioned their study was limited to 18 students, and the virtual software they developed served as a supplement to other online laboratory activities, it demonstrates the ability to design

virtual environments to engage students in online classes in active learning opportunities (Anetta et al., 2009).

Comparing F2F and Online Science Courses

Researchers have noted there are certain skills and methodologies best suited to hands-on instruction in the sciences, such as the operation of laboratory equipment and microscopes (Carr, 2000). Many have attempted to address this and other technical questions concerning the comparable quality of F2F and online science courses. The Open University, the first distance teaching university established in England in 1969, had pioneered numerous technologies in distance education including the use of a digital microscope software program available to students in online biology courses (MacQueen & Thomas, 2009). In the article, *Teaching Biology at a Distance: Pleasures, Pitfalls, and Possibilities*, the authors noted, "…the digital microscope is an interactive DVD package that introduces students to the principles of microscopy and allows them to view slides from a library" (MacQueen & Thomas, 2009, p. 146).

Numerous colleges across the country have attempted to bridge the gap in the pursuit of hands-on, inquiry- based science laboratories offered online through the use of kits of materials students enrolled in introductory courses purchase and conduct experiments at their homes (Mickle & Aune, 2008; Reuter, 2009). Carr (2000) cited two researchers who believed the laboratory component of an online science course could be developed. Thomas M. Lancraft, as cited in Carr (2000), an assistant professor in the department of natural sciences at Florida's St. Petersburg Junior College, developed a kit for students enrolled in his introductory biology for non-majors class which contained the materials needed to conduct the experiments outlined in the course syllabus. Despite his initial reluctance, Landcraft held the belief his students learned more by completing the

labs at home, “Students have more opportunities to problem-solve and gather data. In a traditional lab setting, you only have two or three hours to get the data” (as cited in Carr, 2000, p. A60). Betsy Ott, a biology instructor at Tyler Junior College in Texas and chair of the technology committee of the National Association of Biology Teachers, believed most instructors have been successful at creating exploratory labs using distance technology, but she was concerned about the proliferation of online options and how they have influenced the future of science education (as cited in Carr, 2000). Ott stated, “I’m not saying that online labs can’t be exploratory…it’s going to be difficult for a motivated educator to provide consistently good experiential lab activities online” (as cited in Carr, 2000, p. A62).

At North Carolina State, students enrolled in Biology in the Modern World, a three credit hour lecture course, are also required to enroll in a one credit hour laboratory course to fulfill their general education requirement for a life science course (Mickel & Aune, 2008). Students who were enrolled in online sections of the course were required to schedule on campus labs until an alternative lab course was designed for distance leaners (Mickle & Aune, 2008). Instructors developed kits containing most of the supplies students in the non-science majors’ course would need to conduct experiments outside the conventional laboratory (Mickle & Aune, 2008). The goal was to construct the labs so they mirrored the F2F versions and were safe for students and their families (Mickel & Aune, 2008). After re-configuring the lab manual to reflect the seated labs, the kits were made available to the students enrolled in the online sections of the course (Mickel & Aune, 2008).

The home-based laboratory kits were supplemented with virtual labs which were viewed online to demonstrate more complex experiments via computer simulation

(Mickel & Aune, 2008). Students enrolled in the online sections of the introductory biology courses involved in the study reported, although the labs involved a lot of work, they enjoyed them (Mickel & Aune, 2008). None of the students in the study viewed the home-based labs as an easier alternative to a campus-based lab; however, due to scheduling constraints with work and family obligations, the online lab course allowed at least three nontraditional students to complete their general education requirement and matriculate for graduation (Mickle & Aune, 2008).

The comparison of student learning outcomes in F2F and online versions of introductory science courses is an area of educational research which demands further exploration. Additional research should be conducted to determine if it is possible to offer hands-on, inquiry-based general education introductory science courses presented entirely online. Further studies need to be conducted to determine if students' experiences are similar and as effective as those of a student in an on-campus, F2F course with access to lab facilities and equipment.

In a study conducted at Oregon State University, an introductory soils class was offered in the traditional F2F format and as an online course where students purchased a laboratory kit which contained a majority of the equipment and materials needed to perform the labs in the class (Reuter, 2009). Students were also required to purchase or provide common household materials including plastic wrap, rulers, measuring cups and a shovel (Reuter, 2009). Lab methods were outlined in detail with accompanying photographs and digital video (Reuter, 2009). Students were instructed to complete the labs independently and photo-document their work, which was electronically submitted (Reuter, 2009). On campus students attended synchronous lectures using the same lecture materials as the online classes (Reuter, 2009). Student success in both course

delivery formats was determined using precourse and postcourse assessments, a comparison of final course grades, and completion of a survey (Reuter, 2009).

The study reported no significant difference between final course grades received by students completing either the online or the on campus courses (Reuter, 2009). The study noted an intriguing trend in the data collected from precourse and postcourse assessments between the F2F and online classes (Reuter, 2009). Although the average score improved between the precourse and postcourse assessment, the students in the online sections had the largest percent gain at a 42% average improvement verses a 21% improvement in scores from students enrolled in the F2F sections, a difference that was significant at the 0.001 level (Reuter, 2009). The data from this study would indicate students enrolled in the online sections of the course had a steeper learning curve as compared to their counterparts enrolled in the F2F sections of the course on campus. Several important confounding issues regarding the study were discussed, including student age distribution, gender, and the possibility online learners were self-selected to be more self-motivated and dedicated than their peers in F2F sections of courses (Reuter, 2009). The same finding was revealed in a study which compared students in online and hybrid global information science courses (Detwiler, 2008).

Research has focused on the relationship between students' performance and attendance in the laboratory component of introductory biology courses and how it may influence their grade in the lecture portion of the course (Moore, 2008). The laboratory component of an introductory science course typically accounts for approximately one-third of the students' overall grade, and in one study, up to 50% of students enrolled in introductory science courses earned a D or an F for their final grades, or they ended up withdrawing from the course (Moore, 2008). The study focused on the relationship

between students' attendance in the laboratory component of an introductory biology course at the Twin Cities campus of the University of Minnesota, and indicated there was a link between attendance and academic success (Moore, 2008).

Hybrid or Blended Course Delivery

The term *blended learning* was first used to describe a combination of traditional, F2F instruction and the elements of online learning (Osguthorpe & Graham, 2003). In 2008, ITC introduced questions centering on blended/ hybrid and Web-facilitated courses. The survey defined a blended or hybrid course as one that merges online instruction with F2F delivery and 30-79% of the content is delivered online, with online discussions and some F2F meetings (ITC, 2012). A web-facilitated course (also referred to as a Web-enhanced or Web-assisted course) is a F2F program that incorporates the Internet, and anywhere from 1-29% of the content of the course is delivered online (ITC, 2012). Examples of courses following a Web-facilitated format include when an instructor would post the syllabus, course schedule, and assignments within a LMS, or on a Web page (ITC, 2012). In the ITC survey, 63% of respondents reported offering completely online courses, with 27% offering hybrid courses, and 55% of the respondents indicating their institution plans to increase the number of hybrid courses offered each term (ITC, 2012).

Teaching and learning in higher education has been shifted from instructor centered toward increased levels of student collaboration (Fata-Hartley, 2011). Hybrid courses offered in most disciplines have met this challenge through the use of advanced technology. A U.S. Department of Education meta-analysis study released in 2010 concluded hybrid learning was the most effective teaching method, results echoed by Dr. Marc Loudon, a professor of medicinal chemistry at Purdue University (Burnsed, 2011).

Loudon examined the performance of 226 organic chemistry students in a blended course he instructed during the fall semester of 2009 (Burnsed, 2011). Students who completed online homework assignments in combination with the homework assigned in their textbook during lecture finished the course an average of one letter grade higher than their peers who elected not to study with the aid of the online tool (Burnsed, 2011). Dr. Loudon checked to see if the students who completed the extra homework online were more driven, or were better students overall, but found no correlation between their organic chemistry grades and their grades in general chemistry, concluding, "Students are highly engaged when they work online because they get instant feedback" (as cited in Burnsed, 2011, p. 1). The hybrid course delivery method bridged the gap between F2F and online classes by maintaining personal interaction for discussions and question and answer sessions. Career experts noted, although many students were able to successfully learn online, they missed out on developing interpersonal skills that were critical to function effectively in a professional setting (Burnsed, 2011). Matt Eventoff, a communication strategist with Princeton Public Speaking, summarized this important point by stating, "In a work environment, face-to-face interaction and communication is crucial to success, and therefore the more experience interacting in professional situations face-to-face, the more experienced a person becomes" (as cited in Burnsed, 2011, p. 1).

A study conducted at Michigan State University compared the attendance and participation of students in passive, F2F lectures, with students enrolled in the same course presented in a hybrid format (Moore, 2008). Moore (2008) noted a direct relationship between attendance and student performance. In the study, attendance in the hybrid courses was defined as attempting to complete at least half of the online assignments which consisted of bi-weekly, web-based problem sets (Moore, 2008). The

study concluded students, especially upperclassmen, were more likely to complete online assignments compared with attending passive lectures, indicating hybrid course delivery was a superior alternative for students enrolled in general education courses in the natural and life sciences (Moore, 2008). In contrast, attendance rates of freshmen to active-learning lectures in the hybrid course format were lower than attendance rates to the passive lectures, underscoring the importance of F2F interaction for first year college students' academic success (Moore, 2008). The study highlighted the importance of careful consideration of the format of course delivery, and the target student population likely to benefit from a hybrid mode of instruction (Moore, 2008).

There is a growing body of literature supporting hybrid instruction, as noted by Azaiza (2010) in a review of the book, *Blended Learning in Higher Education: Framework, Principles, and Guidelines*, by Garrison and Vaughan. Social presence, cognitive presence, and teaching presence were described as essential components in an effectively designed blended course (Azaiza, 2010). Gerbic (2011) also summarized the importance of blended learning when he stated:

> The broader literature on blended learning clearly indicates that teachers will not be replaced with technology and that teachers will continue to have a pivotal role in learning, particularly through course design. This is a time of transition…but also opportunities to create new learning relationships which might be more reciprocal and collaborative and based on recognition of the different expertise of the teacher, in the discipline, and with many students, in the new media. (p. 232)

Summary

The relevant literature establishing a context and background for this research study has been reviewed. The development of the open enrollment, publicly funded, two-year community colleges was described in reference to its history and how these institutions are poised to impact the future of higher education in America. The impact developing technology has already made on institutions of higher education, and the impact it may have in the future was addressed, along with the importance of STEM education. A comparison was drawn between F2F instruction and online course delivery systems, followed by the analysis of hybrid courses and their impact on STEM education.

In the next chapter, the methodology applied to examine the research questions which guided the current study, along with the accompanying hypotheses was explained. The population and sample, which formed the basis of the study, were introduced, along with a description of the instrumentation employed during the collection and analysis of the data.

Chapter Three: Methodology

This chapter includes an overview of the research problem, a description of the purpose of the study, and a review of the conceptual framework and methodology used to answer the research questions guiding this study. Also presented in this chapter are descriptions of the population and the sample chosen. The development of the precourse and postcourse assessment tool and the survey instrument used in the study is described in detail, followed by a description of the procedure used during data collection. The data analysis portion of this chapter describes the tests performed for specific statistical analysis, and the chapter concludes with a summary.

Research Problem and Purpose of the Study

There is a variety of different delivery formats commonly used for college level coursework, including the following: traditional seated or F2F instruction, hybrid, or blended instruction, and courses delivered entirely online (Rosenbaum, Redline, & Stephan, 2007). A combination of increased enrollment, decreased funding, and improved technology enticed institutions of higher education to provide online classes in all disciplines (Aoun, 2011; Online Learning, 2010). The ninth annual report from the Babson Survey Research Group, *Going the Distance: Online Education in the United States, 2011*, determined over 6.1 million students, an estimated 31% were enrolled in at least one online course during the fall semester, 2010. This statistic represents an increase of 560,000 students from the previous year and equated to an average of 10% annual growth in online enrollment for institutions of higher education in the U.S. By comparison, the growth rate in the student population for all of higher education was less than 1% for the same time period (Allen & Seaman, 2011).

The demand for online courses in all disciplines of higher education is increasing (Allen & Seaman, 2011; Burnsed, 2011; Davis & Snyder, 2012); however, questions surrounding the quality of online courses when compared to identical F2F or hybrid versions abound. This research was timely and served to examine the trend in the literature of courses presented in an entirely online delivery format often reporting higher attrition rates and lower final grades when compared to identical F2F versions of the same course (El Mansour & Mapinga, 2007; Jenkins, 2011).

Although numerous studies have been conducted presenting various facets of this issue, a study centered on the direct comparison of student success and perceptions of course satisfaction with F2F, hybrid, and online versions of introductory biology courses at two-year, open enrollment colleges in Southern Missouri has not been conducted. This study was designed to fill the gap in the literature concerning this important research topic. The purpose of the study was to determine if significant differences existed in academic success and perceptions of course satisfaction among groups of students enrolled in introductory biology courses presented F2F, hybrid, and online. The study included students enrolled in introductory biology courses from three, two-year open enrollment colleges in Southern Missouri during the spring semester, 2013.

Research Questions and Hypotheses

The following four research questions guided this study:

1. What academic difference existed, if any, among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by the difference between average gain scores from precourse and postcourse assessments?

2. What academic difference existed, if any, among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by final course grades?

3. What academic difference existed, if any, among groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by attrition rates?

4. What were the perceptions, as they related to overall course satisfaction, among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges?

The following null hypotheses were tested during this study:

Ho1: There was no academic difference among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by the difference between average gain scores from precourse and postcourse assessments.

Ho2. There was no academic difference exists among intact groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by final course grades.

Ho3. There was no academic difference among groups of students enrolled in F2F, hybrid, or identical online sections of introductory biology courses at two-year, open enrollment colleges as measured by attrition rates.

Research Design

This study utilized a mixed-methods approach through the collection and analysis of both quantitative and qualitative data from several sources. A mixed-methods approach was selected due to the nature of this study and the focus of the research

questions being addressed (Creswell, 2009; Fraenkel, Wallen, & Hyun, 2012). Research studies following a mixed-methods design are widely supported in the literature as noted by Fraenkel et al. (2012) when they stated, "Mixed method research can help to clarify and explain relationships found to exist between variables [and] …can help to confirm or cross-validate relationships." (p. 558). Creswell and Garrett (2008) also confirmed the value of using a mixed-methods design for research studies by describing the approach as a blend of quantitative and qualitative designs which creates an enhanced perception of the research problem (Creswell & Garrett, 2008).

In order to conduct this study, approval through Lindenwood University Institutional Review Board (IRB) was required. To demonstrate ethical considerations, and to be approved through IRB, the principal investigator completed National Institutes of Health training on the protection of human research participants (see Appendix A). After IRB approval was obtained, the following data was collected to satisfy the methodology selected for this study.

Quantitative data. This study involved the collection and analysis of numerous pieces of quantitative data in order to evaluate trends between introductory biology courses presented F2F, hybrid, and fully online. The quantitative components of this research study included the collection and statistical analysis of data from precourse and postcourse assessments, final course grades, and attrition rates for students enrolled in each of the three different course delivery formats at the three participating institutions during the spring semester, 2013.

Qualitative data. The qualitative component of the study which was interpretive and relational, relied on information gathered from student surveys and from discussions within focus groups (Fraenkel et al., 2012). Focus groups are an effective means of

gathering qualitative data with the advantage of allowing group interaction (Krueger & Casey, 2009). Cozby and Bates (2012) state the use of focus groups in research provides "an advantage…because group interaction is possible [and]…people can respond to each other" (p. 141).

Population and sample. The population for the study consisted of 1,501 adult students who were enrolled in F2F, hybrid, or online sections of introductory biology classes from each of the three participating, two-year open enrollment institutions included in the study during the spring semester, 2013. A convenience sample of 354 students (24% of the total) was given the opportunity to participate in the study. The sample was based on the format of course delivery and the instructor. One F2F and one hybrid section taught by the same instructor was selected from each of the institutions. The online sections were taught by a total of eight different instructors employed by one of the institutions. Administrators at each institution were contacted via electronic mail (e-mail) and telephone by the principal investigator during the fall semester of 2012, and informed about the study. Administrators at each institution signed permission letters to participate in the study (see Appendix B) which were stored in a secure location. Following approval of the study by the Institutional Review Board of Lindenwood University (see Appendix C), the instructors of the various sections of introductory biology included in the study were contacted at each institution and provided a copy of the Instructor's Informed Consent for Participation in Research Activities (see Appendix D). The signed informed consent forms from instructors of sections included in the study were stored in a secure designated location.

The instructors described the study to their classes and provided the Informed Consent to Participate forms (see Appendix E) to each student enrolled in a section of

introductory biology selected to participate during the spring semester, 2013. Participation in the study was entirely voluntary, and it was explained to students their participation would not influence either their grade or their standing in the class, and they could withdraw from the study at any point without repercussions. Students who elected to participate in the study signed Informed Consent for Participation in Research Activities forms, which were stored in a secure designated location. Students were allowed to self-enroll and participate in one of the seven focus groups which took place during the tenth and eleventh week of the spring semester, 2013. The identities and other demographic and personal information about the participants were kept strictly confidential at all times during the study.

Quantitative Data Instrumentation

Precourse and postcourse assessments. The precourse and postcourse assessment document (see Appendix F) was developed with questions selected from the course abstracts and core learning objectives for introductory biology classes. Assessments administered prior to a class and again after the completion of the semester have been shown to be effective tools to measure academic progress (Angelo & Cross, 2010). In order to ensure the validity of the precourse and postcourse assessments utilized in this study, the assessment was field-tested with 824 students enrolled in seated and online sections of general biology at one of the participating institutions during the fall semester, 2012. The questions on the precourse and postcourse assessment were clearly worded and were in either a multiple-choice or true/false format.

The precourse assessment was administered to students enrolled in F2F and hybrid sections included in the study on the first day of the spring semester, 2013. Students enrolled in online sections included in the study completed their precourse

assessment via a link provided on Blackboard during the first 72 hours of the spring semester, 2013. Postcourse assessments were administered to students enrolled in F2F and hybrid sections during the last class period before the final exam. Students enrolled in online sections included in the study could elect to complete the postcourse assessment at any time during the last 72 hours the course was available on Blackboard, prior to the final exam. All students were informed the precourse and postcourse assessment was not for points in the class, and their completion of the assessment was entirely voluntary.

Instructors of F2F, hybrid, and online sections of general biology included in the study were provided with an Excel spreadsheet to record the scores for each student completing the assessments during the semester. The instructors were told to assign random numbers to each student and record his or her score on both the precourse and the postcourse assessments accordingly. If a student withdrew from the course prior to completing the postcourse assessment, or if the student was absent for either assessment, the score was not included in the data set. Instructors participating in the study sent their completed Excel spreadsheets via email to the principal investigator at the conclusion of the spring semester, 2013.

Online student surveys. A portion of the surveys completed by students who volunteered to participate in the study included questions designed to gather quantitative data, including the following: how many credit hours they were enrolled in; how many credit hours of higher education coursework they have completed up to and including the spring semester, 2013; and the average number of hours they spend each week preparing for their introductory biology course (see Appendix G). The questions on the survey instrument were designed according to a standardized format (Cheek & Schutt, 2012). In order to ensure the validity of the questions on the survey, it was field-tested with a

group of 46 volunteer students enrolled in seated sections of introductory biology at one of the participating institutions during the fall semester, 2012.

Beginning the last month of the classes during the spring semester, 2013, students enrolled in F2F, hybrid, and online sections included in the study had two weeks to complete the online survey of course satisfaction. The online survey was developed using the software program Remark, and was deployed via LMS Blackboard. Each of the three institutions participating in the study has adopted Blackboard as their preferred LMS, and students and instructors at the institutions utilize the program extensively. The same online surveys made available to students via Blackboard were photocopied and provided as handouts for each of the seven focus group sessions conducted during the tenth and eleventh week of the spring semester, 2013.

Qualitative Data Instrumentation

Focus group interviews. Interviews were conducted with seven different focus groups consisting of students enrolled in F2F, hybrid, or online sections of introductory biology courses included in the study. Focus group interviews were conducted at each of the three participating institutions at prescheduled times agreeable to all participants during the tenth and eleventh week of the spring semester, 2013. All students who completed the Informed Consent for Participation in Research Activities were invited to participate in a focus group discussion. The students were informed the focus group discussions were completely voluntary, and their participation would not influence their standing in their course in any way. Students were assured their identity would be protected, and information discussed during the focus group sessions was kept strictly confidential. Students were also reminded the focus groups would be recorded in both an

audio and video format. Students were not monetarily compensated for their participation in the focus group discussions; however, lunch was provided to all participants.

A minimum of two focus groups were conducted at each of the three participating institutions using the same questions made available to all students online via the Remark survey as a beginning point for the discussions. The maximum number of students who attended one of the focus group discussions was nine, and the minimum number of students attending was six. Each focus group discussion lasted an average of one and one-half hours, with the longest session lasting two hours and fifteen minutes. Each focus group consisted of approximately equal numbers of male and female students, with a wide variety of ages, backgrounds, and educational goals represented. Questions discussed during the focus groups with students centered on their expectations and experiences during the course, and themes within the discussions were noted (Creswell, 2009).

Quantitative Data Collection by Research Question

Research question one. Quantitative data pertaining to the first research question of what differences existed, if any, among intact groups of students enrolled in F2F, hybrid, or online sections of introductory biology and their average gain scores from precourse and postcourse assessments were collected from each student who volunteered to participate in the study. Students completed the precourse assessment, and their instructors assigned the students a random number within their section. After they completed the postcourse assessment, the instructor compiled the data for each student and entered it into an Excel spreadsheet which was sent via e-mail to the principal investigator. Data from the precourse and postcourse assessments were grouped for all students enrolled in F2F, hybrid, or online sections, regardless of the institution location.

The data were analyzed using the MegaStat statistical analysis program in Excel. A one-tailed, paired *t*-test, where the average performance of students grouped by course delivery format was conducted at an alpha = 0.05 level (Bluman, 2009; Triola, 2006). A one-tailed *t*-test was selected because it was assumed students would perform better on the postcourse assessment after completing 16 weeks of instruction, than they did on the precourse assessment, as noted in the literature (Angelo & Cross, 2010). A paired *t*-test was selected because each student who participated in the study was tested two separate times with the same course assessment tool, and scores were paired for each student. An alpha level of 0.05 was selected because it represented the standard level of confidence in a majority of published studies (Fraenkel et al., 2012; Triola, 2006).

Research question two. Quantitative data pertaining to the second research question of what academic difference existed, if any, among F2F, hybrid, and online introductory biology courses and final course grades, were collected for all students in participating sections at the conclusion of the spring semester, 2013. All sections of introductory biology included in the study followed a straight percentage grading scale, where, for example, a student earning between 70% and 79% of the available points in the course would earn a letter grade of C. The number of students earning each letter grade was grouped based on course delivery format, regardless of the institution where they were enrolled. A chi-square test for homogeneity of proportions (Bluman, 2009) was utilized to statistically analyze the data from the final course grades of all students participating in the study.

The observed value was the total number of students earning each respective final letter grade in the course, and the expected value was the sum of the total number of students enrolled in introductory biology courses presented in a F2F format at all three

participating institutions during the spring semester, 2013. The expected value was utilized because it represented the traditional format of course delivery. The chi-square test for homogeneity of proportions was selected because final course grades represent data classified as categorical in nature, and the calculated chi-square value was compared to a critical value to determine if there was a significant difference between the groups being studied (Bluman, 2009; Triola, 2006).

Research question three. Data pertaining to the third research question, the attrition rates of students enrolled in F2F, hybrid, and online sections of introductory biology classes, were collected and combined for the three reporting institutions. Attrition rates were calculated based on the total number of students who either voluntarily withdrew, or were administratively withdrawn from F2F, hybrid, or online sections of introductory biology included in the study at all three participating institutions. A chi-square test for homogeneity of proportions was conducted on the attrition data collected from the study. The reported numbers of student who withdrew from either F2F, hybrid, or online sections included in the study were entered in to MegaStat as the observed values. The expected values were the total number of students who withdrew from any F2F section of introductory biology at all three institutions combined, during the spring semester, 2013. The chi-square test for homogeneity was selected because the attrition data are categorical in nature (Bluman, 2009; Triola, 2006).

Research question four. A portion of the quantitative data from the Remark survey pertained to the fourth research question, which centered on students' perceptions of satisfaction with introductory biology courses. A majority of the questions on the survey used a five-point Likert scale consisting of the categories strongly agree, agree, neutral, disagree, or strongly disagree. Studies support the use of Likert scales in

educational research because it does not provide a simple, "…yes or no answer from the respondent, but rather allows for degrees of opinion, or even no opinion at all. Therefore quantitative data is [*sic*] obtained, which means the data can be analyzed with relative ease" (McLeod, 2008, para. 8). Student surveys from all three participating institutions were grouped according to mode of course delivery, and the results of the surveys were analyzed using descriptive statistics applied to determine if there were significant differences between the three modes of course delivery of introductory biology courses at the various institutions included in the study (Bluman, 2009; Creswell, 2009).

Qualitative Data Collection

Research question four. Information pertinent to the qualitative component of the fourth research question in this study centered on in-depth interviews within focus groups comprised of between six and nine students. A total of seven focus groups were conducted during the 10th and 11th week of the spring semester, 2013, with a minimum of two focus groups at each participating institution. Student volunteers who participated in the focus group discussions answered a series of prescribed questions and then described their experiences in their F2F, hybrid, or online section of introductory biology. Focus group sessions were recorded, and themes within discussions were noted after each discussion was transcribed by the principal investigator (Patton, 2002). This component of the study represented the qualitative portion of the research and important trends in the participants' attitudes and experiences relating to the delivery method of an introductory biology course (Creswell, 2007).

Summary of Quantitative and Qualitative Data Collection

Data from this study were collected during and after the conclusion of the spring semester, 2013. Consent for participation in a research study forms were made available

to the instructors and the students of the various F2F, hybrid, and online sections of introductory biology courses involved in the study. The precourse assessment instrument was administered to those students who agreed to participate during their first class period for F2F and hybrid sections, and made available to complete within the first 72 hours of the course for students enrolled in online sections. Seven focus groups, consisting of between six and nine students, were conducted during the 10th and 11th week of the spring semester, 2013. Focus groups included students enrolled in each of the three modes of course delivery. Discussions from the focus groups were transcribed, and themes within the discussions were noted (Creswell, 2007).

Online surveys were administered to students enrolled in each of the three course delivery formats over a two week timeframe during the last month of the course. Data from the Remark surveys were compiled and analyzed. Postcourse assessments were administered to participating students in F2F and hybrid sections during the last class period and were made available to complete on Blackboard during the final 72 hours of the course for students enrolled in participating online sections. At the conclusion of the spring 2013 semester, the final course grades and the total number of students who withdrew from participating sections from each of the three institutions were collected.

Summary of Quantitative and Qualitative Data Analysis

Data from the precourse and postcourse assessments were combined for all reporting sections from each of the three participating institutions following the same course delivery format. The data were analyzed using a paired, one-tailed *t*-test, at the alpha = 0.05 level of significance (Bluman, 2009). After the data were analyzed, and the *p*-value was computed, the null hypothesis was either retained or rejected based on the proximity of the *p*-values to the established level of significance (Triola, 2006).

The final course grades from all participating sections at each of the three institutions were collected after the conclusion of the spring semester, 2013. The final course grades were analyzed using a chi-square test for homogeneity where the total number of students in each mode of course delivery was compared against the expected ratio of grades from the F2F sections. A chi-square test for homogeneity analysis was selected to analyze the data because the final letter grades were categorical in nature, and the total number of students who earned each particular letter grade was a quantitative, discrete value (Bluman, 2009; Triola, 2006).

The total number of students who withdrew from each section of introductory biology included in the study from all three participating institutions was reported at the conclusion of the spring, 2013 semester. A chi-square test for homogeneity was conducted to evaluate if there was a significant difference in student attrition rates between the three course delivery formats, at alpha = 0.05. A chi-square test for homogeneity was selected to analyze this data because the status of the student as either completing or withdrawing from the course was categorical in nature, and the total number of students in each category was a quantitative, discrete value (Bluman, 2009; Triola, 2006). The quantitative data pertaining to the fourth and final research from the online student surveys were statistically analyzed (Bluman, 2009; Triola, 2006). The qualitative components of this research study included themes which emerged from the in-depth discussions within focus groups, and student provided responses to questions from the online survey. Themes and important trends in the discussions were noted (Creswell, 2007).

Summary

Due to increased student demand, institutions of higher education are offering most, if not all, of their academic courses in a variety of delivery formats, including fully online (Parry, 2010). Enrollment in online courses continues to quickly outpace enrollment in F2F sections of the same course at many institutions nationwide (Allen & Seaman, 2011). However, experts disagree if online courses offer the same level of rigor and interaction students in comparable F2F or hybrid sections receive, and if student learning outcomes are comparable between the modes of course delivery (Jenkins, 2011; Parry, 2010).

The purpose of this research study was to examine if differences existed among student success and levels of course satisfaction in F2F, hybrid, and online sections of introductory biology classes at two-year, open enrollment colleges in Southern Missouri. Student success was measured quantitatively by comparing mean academic growth from precourse and postcourse assessments, final grades, attrition rates, and perceptions of satisfaction with the course collected from surveys. Qualitative information was gathered from student responses to online survey questions, and discussions within focus groups. Four research questions guided this study, along with accompanying null hypotheses, which were tested during the study. Due to the nature of the research questions being analyzed, the study combined both quantitative and qualitative research perspectives. The quantitative data collected were statistically analyzed using the MegaStat add-on through Excel, and a combination of descriptive statistical analysis tests. Paired, one-tailed *t*-tests, *F*-tests, and chi-square tests for homogeneity were conducted on the data. The qualitative data were collected from student responses to an

online survey and participation in focus group discussions. Important trends and themes emerged from discussions within the focus groups and from the online survey.

In the next chapter, the quantitative and qualitative data collected in the study pertaining to each of the four research questions are presented. The results of the statistical analysis of the quantitative data were described, along with explanations of each of the statistical tests used in the study. Lastly, the themes which emerged from student surveys and discussions within focus groups were presented and described.

Chapter Four: Analysis of Data

The purpose of this study was to examine whether differences exist between student success and perceived levels of course satisfaction, in introductory biology classes presented in three different course delivery formats: traditional seated F2F classes, hybrid classes, and classes presented in an entirely online format. The study was conducted at three, two-year open enrollment colleges in Southern Missouri. Due to the nature of the research questions analyzed, the study combined both quantitative and qualitative research perspectives (Creswell, 2007; Fraenkel et al., 2012).

The research in this study was framed by four questions, which were tested utilizing both quantitative and qualitative data gathered from a total of 354 adult students who volunteered to participate during the spring semester, 2013. The first research question addressed whether there was a difference between the average gain scores on precourse and postcourse assessments based on the delivery format of the course. Data pertaining to the second research question were collected to determine if a significant difference existed between final course grades earned by students enrolled in each of the three course delivery formats. The third research question examined whether a difference in attrition rates existed for students enrolled in F2F, hybrid, or online introductory biology courses. The fourth research question centered on perceptions students had about their introductory biology course, which included the collection and analysis of both quantitative and qualitative data.

Demographics

The population for this study included 354 adult students enrolled in introductory biology courses presented F2F, hybrid, or online at three, two-year open enrollment colleges in Southern Missouri during the spring semester of 2013. The students enrolled

in F2F and hybrid introductory biology classes completed a precourse assessment on the first day of class, and the postcourse assessment on the final day of the course. For those enrolled in online sections, the precourse assessment was available to complete via Blackboard during the first 72 hours of the course.

The postcourse assessment was available for those in online sections to complete over a 72 hour period during the final week of the class. In addition to the assessments, an online survey was available on Blackboard for all participants via the software program, Remark. The online survey was available for students to complete over a two-week period, beginning the twelfth week of the semester. Also, seven focus group discussions were conducted during the study, with a total of 55 students representing each of the three different modes of course delivery from each of the participating institutions. The number of students participating in each focus group ranged from six to nine. Table 1 lists the delivery format, number of sections, and the total enrollment in each section.

Table 1

Delivery Format and Enrollment for Introductory Biology Courses, Spring 2013

Delivery Format	Sections	Total Enrollment
Face-to-Face	3	77
Hybrid	3	65
Online	12	212
Total	18	354

**Note*: Data were collected from three institutions of higher education in Southern Missouri.

Quantitative Data

Multiple pieces of data were collected and analyzed during this study. One component of the quantitative data gathered was from a survey instrument that was developed and administered to students who participated in the study at each of the three institutions (see Appendix G). The survey included demographic questions and questions specific to introductory biology classes presented F2F, hybrid, or online. It was available to complete online for all participants in the study via the software program Remark. The link to the survey was available on Blackboard for a two-week period, one month before the end of the semester. A total of 140 students elected to complete the survey, and there was representation from students enrolled in F2F, hybrid, and online introductory biology courses from each of the three institutions participating in the study.

Another component of the quantitative data gathered and analyzed in this study was the comparison of mean gain scores among intact groups of students in each of the three course delivery formats on precourse and postcourse assessments (see Appendix F). A total of 191 students completed both the precourse and postcourse assessments from F2F, hybrid, and online sections combined during the spring semester, 2013. Students enrolled in F2F and hybrid sections included in the study were given the precourse assessment on the first day of class, and the postcourse assessment on the last day of class, immediately before the final exam was administered. The assessments were completed by a total of 65 students enrolled in the three F2F sections, 51 students in the three hybrid sections, and 75 students from the 12 online sections of introductory biology.

Two other important indicators of student success were analyzed using quantitative methods in this study. The final course grade earned by each student

participating in the study was analyzed using an independent chi-square analysis to determine if a significant difference existed between final course grades and course delivery format. In addition, attrition rates for students enrolled in F2F, hybrid, and online sections of introductory biology were analyzed. These results were discussed, in combination with the specific research question being addressed, later in this chapter.

Qualitative Data

Qualitative data collected and analyzed in the study included student perceptions of course satisfaction as indicated on the online survey, with additional qualitative data gleaned from the focus groups conducted at each of the three participating institutions for students enrolled in F2F, hybrid, and online sections of introductory biology. Krueger and Casey (2009) defined focus groups as, "A carefully planned series of discussions designed to obtain perceptions on a defined area of interest in a permissive, nonthreatening environment" (p. 2).

Focus group discussions generated both individual and interactive opinions. The number of participants in seven separate focus groups ranged from six to nine. Each focus group was conducted in a quiet setting and lasted 1-2 hours. The participants were asked a series of questions about their perceptions of the level of course satisfaction for their introductory biology course. All focus group sessions were recorded using an audio and video format. The principal investigator transcribed the discussions, and in a manner similar to the procedure described by Krueger and Casey (2009), analyzed the resulting manuscripts for important trends and themes that emerged from the discussions.

In addition to the seven focus group discussions conducted at the three participating institutions, an online survey was provided to participants in the study via the software program Remark, and was made available to complete on Blackboard. Each

of the three participating institutions has adopted Blackboard as their LMS, and the students and instructors use it extensively. The online survey was available to all participants in each of the three course delivery formats in the study to complete over a two-week period during the last month of the spring semester, 2013. The online survey yielded important results pertaining to the students' level of satisfaction with his or her introductory biology course.

Research Questions

The first three research questions guiding this study were quantitative in nature, and the data was analyzed statistically. The fourth research question was analyzed quantitatively and qualitatively. An alpha level of 0.05 was used in all statistical analyses. The 0.05 alpha level was selected because it represented the standard level of significance reported in published studies (Bluman, 2009; Frankel et al., 2012).

The first research question guiding this study was: *What academic difference exists, if any, among intact groups of students enrolled in F2F, hybrid, or online sections of introductory biology courses at two-year, open enrollment colleges as measured by the difference between average gain scores from precourse and postcourse assessments?* The null hypothesis *(H_0)* accompanying this research question stated there was no significant difference between the precourse and postcourse assessment scores for students enrolled in F2F, hybrid, or online sections of introductory biology included in the study. A total of 77 students were enrolled in F2F sections of introductory biology at the three institutions participating in the study during the spring semester of 2013. Sixty-five of those students completed both the precourse and postcourse assessments. The remaining 12 students either withdrew from the course, or were absent the days the assessments were administered.

There were 51 students enrolled in hybrid sections of introductory biology included in the study who completed both the precourse and postcourse assessments. The remaining 14 students either withdrew, or were absent on the days the assessments were administered. A total of 75 of the 212 students enrolled in online sections of introductory biology completed both the precourse and postcourse assessments. A one-tailed *t*-test using paired data was conducted on the average gain scores from precourse and postcourse assessments administered to students enrolled in each of the three course delivery formats (Bluman, 2009; Triola, 2006). The one-tailed *t*-test was selected because the data being analyzed represented the mean gain in basic knowledge expressed by the students before and after completing a semester of introductory biology (Angelo & Cross, 2010; Fraenkel et al., 2012). The data from the precourse and postcourse assessments were paired for each student from each of the three course delivery formats (Bluman, 2009; Triola, 2006). The results of the comparison between average gain scores on the precourse and postcourse assessments for students enrolled in each of the three course delivery formats was presented in Table 2.

Table 2

Pre and Post Assessment Differences Based on Course Delivery Format, Spring 2013

		Course Delivery Format		
	Assessment	Seated (N = 65)	Hybrid (N = 51)	Online (N = 75)
Mean *(M)*	Precourse	5.09	5.30	4.99
	Postcourse	6.67	6.75	6.58
Standard Error *(SE)*	Precourse	0.13	0.17	0.25
	Postcourse	0.13	0.14	0.16
[a]Standard Deviation *(SD)*	Precourse	1.07	1.22	2.15
	Postcourse	1.02	1.02	1.42
Sample Variance *(S^2)*	Precourse	1.14	1.49	4.61
	Postcourse	1.04	1.03	2.02

Note. N = Total number of students in each course format at all three participating institutions.

[a] Standard deviation was based on the samples being analyzed.

A total of 65 students enrolled in F2F sections completed both the precourse and postcourse assessments, along with 51 students from the hybrid sections, and 75 students from the online sections. Descriptive statistical tests were conducted on the precourse and postcourse assessment scores which were grouped by mode of course delivery for the students included in the study. All students, regardless of course delivery format, performed on average better on the postcourse than on the precourse assessment, indicating knowledge and or skills were gained from completing the course, as noted in the literature (Angelo & Cross, 2010). The students enrolled in online and F2F sections had similar average gains between precourse and postcourse scores, with an average gain of 1.59 points for online and 1.58 points in F2F sections. The students in hybrid sections had the lowest average gain of 1.45 points. The standard error *(SE)*, a measurement of the variability in sample means (Bluman, 2009; Triola, 2006), was calculated using

MegaStat. The *SE* between the precourse and postcourse assessment scores for students in F2F sections was exactly the same at 0.13. The *SE* for students in hybrid sections was higher, at 0.17 for precourse and 0.14 for postcourse assessments. The *SE* on precourse assessments for students in online sections was the highest value recorded at 0.25, and it dropped to 0.16 for the postcourse assessments. This indicates the students in online sections had the highest variability between sample means on the precourse assessments when compared to other course delivery formats.

The standard deviation *(SD)* between scores on the precourse and postcourse assessments for students enrolled in each of the three course delivery formats was presented in Table 2. There was a negligible difference between the *SD* for students in F2F sections on the two assessments. The students in hybrid sections had a larger difference between *SD* when compared to the F2F sections; however, the students in online sections had the largest *SD* at 2.15 for the precourse, and 1.42 for the postcourse assessments, further confirming there was more variability in the scores compared to the mean. The sample variance *(S^2)* was calculated for all course delivery formats, and the data in Table 2 illustrated the greatest variance in the data set was from students enrolled in online sections. (Fraenkel et al., 2012).

In order to determine if there was a significant variance between the precourse and postcourse assessment scores for students in each of the three course delivery formats, *F*-tests were conducted on the data. The level of significance was set at alpha 0.05, in accordance with a majority of published studies (Bluman, 2009; Triola, 2006). The result of an *F*-test conducted on the variance between precourse and postcourse assessment scores for students enrolled in F2F sections generated a test statistic *(F_{crit})* of 0.73, at 64 degrees of freedom *(df)* (Bluman, 2009), which means there was no significant

difference in sample variance between the assessment scores at $\alpha = 0.05$ (Bluman, 2009; Fraenkel et al., 2012). In order to further confirm the results, a one-tail *t*-test with assessment scores paired for each student in F2F sections was conducted, resulting in a *p*-value of 2.71×10^{-16}. The results of the *t*-test substantiated the mean difference in precourse and postcourse assessments were highly significant (Bluman, 2009; Triola, 2006), and the students did gain knowledge, skills or abilities from completing their introductory biology courses in a F2F format.

The result of an *F*-test conducted on the S^2 between precourse and postcourse assessments for students enrolled in hybrid sections generated a F_{crit} of 0.20, at 50 *df (*Bluman, 2009). The value was below the individual sample variances, indicating there was no statistical difference between sample variances at $\alpha = 0.05$ (Bluman, 2009; Fraenkel et al., 2012). In order to further confirm the results, a one tailed *t*-test with the precourse and postcourse assessment scores paired for each student enrolled in hybrid sections, resulted in a *p*-value of 4.86×10^{-12}. The *t*-test further confirmed the mean difference on assessments from students enrolled in hybrid sections of introductory biology courses included in the study was highly significant (Bluman, 2009; Triola, 2006).

The result of an *F*-test conducted on precourse and postcourse assessment scores for students enrolled in online sections included in the study resulted in a F_{crit} of 4.95×10^{-4}, with 74 *df,* which indicated there was not a significant difference in variation between the assessment scores (Bluman, 2009). A one-tailed *t*-test with assessment scores paired for each student resulted in a *p*-value of 1.08×10^{-11}. The result of the *t*-test confirmed the mean difference on assessments was highly significant for students

enrolled in online sections of introductory biology included in the study (Bluman, 2009; Triola, 2006).

Additional statistical tests were conducted on the data in order to determine if there were significant differences in the gain scores between the precourse and postcourse assessments for students enrolled in the three course delivery methods included in the study. A gain score was defined as the numerical difference between the score on a postcourse and a precourse assessment (Fraenkel et al., 2012). The gain scores analyzed in this study included both positive and negative values. One-way Analysis of Variance (ANOVA) tests were conducted to determine if there was a significant difference in the gain scores for students enrolled in F2F, hybrid, or online courses included in the study (Bluman, 2009; Triola, 2006). The results of the statistical tests on the gain scores from each of the three course delivery formats were presented in Table 3.

Table 3

Summary of Gain Scores from Precourse and Postcourse Assessments, Spring 2013

Course Format	Sample Size *(N)*	Mean *(M)*	Standard Error *(SE)*	[a]Standard Deviation *(SD)*	Sample Variance (S^2)
Seated	69	1.58	0.15	1.24	1.54
Hybrid	51	1.44	0.16	1.17	1.37
Online	75	1.59	0.20	1.75	3.06

Note [a]Standard Deviation was based on the samples being analyzed.

The data from the analysis of the gain scores from precourse and postcourse assessments for students enrolled in F2F, hybrid, and online sections of introductory biology included in the study indicated the average gain score was not significantly different at $\alpha = 0.05$. However, the *SD* and the S^2 in the average gain score of students

enrolled in the online sections of introductory biology was higher than the same values calculated from both F2F and hybrid course delivery formats (Bluman, 2009; Triola, 2006). This indicated students enrolled in online sections had greater variability in their average gain score when compared to students in either F2F or hybrid sections.

A one-way analysis of variance (ANOVA) test was applied to determine if there was a significant difference among the average gain scores on precourse and postcourse assessments from groups of students enrolled in introductory biology courses presented in each of the three different delivery formats. The results of the one-way ANOVA test on the mean gain scores were presented in Table 4.

Table 4

Analysis of Variation Based on Course Delivery Format, Spring 2013

Source of Variation	Sum of Squares *(SS)*	Degrees of Freedom *(df)*	Mean Square *(MS)*	F Statistic (F_{crit})	*P*-value
Between Groups	0.81	2	0.40	0.19	0.82
Within Groups	399.86	192	2.08		
Total	400.66	194			

Note. $N = 195$

The results of the one-way ANOVA test on the mean gain scores for the three different course delivery formats presented in Table 4 indicated no statistical difference in assessment scores based on format for course delivery, because the calculated *p*-value of 0.82 exceeded $\alpha = 0.05$ (Bluman, 2009; Triola, 2006). It is important to note that the sum of squares *(SS)*, which represented the variation in scores on the assessments between groups, was 0.81 which indicated a negligible amount of variation at $\alpha = 0.05$.

This means there was little variation in assessment scores between groups, regardless of whether the course was F2F, hybrid, or online. However, when the *SS* was calculated within groups, there was a significant amount of variation *(SS* = 399.86) in assessment scores between course delivery formats (Bluman, 2009; Triola, 2006). This indicated there was variation between the assessment scores for students enrolled in F2F, hybrid, or online course delivery formats between institutions, and within different sections of the courses at each individual institution participating in the study.

The second research question guiding this study was: *What academic difference exists, if any, among students enrolled in traditional seated, hybrid, or online sections of introductory biology courses at two-year, open enrollment colleges as measured by final course grades?* The H_0 accompanying this research question stated there was no significant difference between the final course grades for students completing an introductory biology course in a F2F, hybrid, or online format. After the completion of the spring semester, 2013, the final course grades earned by each student participating in the study were combined from each reporting institution. The introductory biology courses at each of the three participating institutions followed a straight percentage grading scale. For example, a student earning between a 70-79%, would be assigned a C as their final letter grade in the course.

A chi-square statistical analysis was performed on the data to determine if there were significant differences in course grades earned by students enrolled in F2F, hybrid, or online sections of introductory biology included in the study. A chi-square test was selected because the data being analyzed were categorical in nature (Bluman, 2009; Triola, 2006). The final letter grades assigned to all students enrolled in seated sections of introductory biology courses at each of the participating institutions during the spring

semester, 2013, served as the expected values for all chi-square analysis, because the traditional method of instructing courses has been through F2F contact with students (Allen & Seamen, 2011). Courses presented in a hybrid or online delivery format are relatively new to higher education and represented a change in course delivery format. The total number of each assigned letter grade from F2F, hybrid, and online sections was converted into a percentage which was analyzed using a chi-square test for homogeneity of proportions (Bluman, 2009). The expected grades used in the chi-square test for homogeneity of proportions was a sum of all final grades for all F2F sections of the course at each of the three institutions combined, a total of 682 final grades, converted into a percentage.

There were a total of 73 final grades assigned to students completing F2F sections of introductory biology at the three institutions included in the study during the spring semester of 2013. A total of 61 students completed hybrid sections and were assigned a final grade in their course, and a total of 167 students completed online sections and were assigned a final grade. The data in Table 5 represented the total number of assigned letter grades earned by each student participating in the study.

Table 5

Final Course Grades in F2F, Hybrid, and Online Introductory Biology Classes, Spring 2013

Course Format	A (90-100%)	B (80-89%)	C (70-79%)	D (60-69%)	F (below 59%)
F2F (N = 73)	18	45	25	8	4
Hybrid (N = 61)	16	43	26	10	5
Online (N = 167)	12	34	30	11	13

Note. N = Number of students earning a final grade in each section.

A chi-square test for homogeneity of proportions was conducted on the data from final course grades earned in all F2F sections of introductory biology included in the study, and resulted in a p-value of 0.73, at 8 df. The p-value exceeded $\alpha = 0.05$, which indicated there was not enough evidence to reject the H_0 of no significant difference between the grades earned by students in the F2F sections, compared to students in all F2F sections at the three participating institutions combined during the spring semester, 2013. Regardless of the institution attended, the final grades earned by students enrolled in F2F sections of introductory biology who participated in the study were essentially in the same proportions as all students completing the course in a F2F format at any of the three participating institutions during the spring semester, 2013.

The final course grades from the hybrid sections were analyzed using the same procedure followed for the F2F classes. These final grades from hybrid sections resulted in a p-value of 0.55, at 8 df. The p-value calculated for the final grades of students

enrolled in hybrid sections included in the study exceeded $\alpha = 0.05$, also indicating not enough evidence to reject the H_0 of no significant difference between final grades and format for course delivery. The final course grades earned by students enrolled in hybrid sections of introductory biology participating in the study were essentially in the same proportions as all students completing the course in a F2F format at any of the three participating institutions during the spring semester, 2013.

However, the chi-square test for homogeneity of proportions for final course grades earned by students enrolled in online sections yielded a *p*-value of 5.65×10^{-4}, which was significantly smaller than $\alpha = 0.05$. This result indicated there was enough evidence to reject the H_0, because final grades earned by online students in the study were significantly different. According to the data, students enrolled in online sections of introductory biology included in the study received fewer A's, and a disproportionately higher number of F's, when compared to students enrolled in F2F sections of the same course at each of the three participating institutions.

The third research question guiding this study was: *What academic difference exists, if any, among students enrolled in traditional seated, hybrid, or online sections of introductory biology courses at two-year, open enrollment colleges as measured by attrition rates?* The H_0 accompanying the third research question stated there was no significant difference, at $\alpha = 0.05$, between the attrition rates for students enrolled in F2F, hybrid, or online sections of introductory biology included in the study. The total number of students who withdrew from any section of introductory biology, presented in any of the methods of course delivery at the three institutions participating in the study combined, was 61 out of a total of 741 students enrolled, which was equal to an 8% attrition rate. The 8% attrition rate was used as the expected value in the chi-square

analysis on attrition rates of students participating in the study. The attrition rates of students enrolled in F2F, hybrid, or online introductory biology courses included in the study was presented in Table 6.

Table 6

Student Attrition Rates in F2F, Hybrid, and Online Introductory Biology Classes, Spring 2013

Enrollment Status	F2F (*N* = 77)	Hybrid (*N* = 65)	Online (*N* = 212)
Completed Course	70	61	167
Withdrew from Course	7	4	45

Note. *N* = Number of students enrolled in each of the three course delivery formats.

The number of students who withdrew from the F2F sections included in the study was an average of 9%, and the attrition rate for students enrolled in hybrid sections included in the study was calculated at 6%. The attrition rates for students enrolled in either F2F or hybrid sections of introductory biology involved in the study had similar rates of attrition to the 8% reported for all courses, regardless of delivery format. However, the attrition rate for students enrolled in online sections of introductory biology included in the study was calculated at 21%, which was more than double the attrition rate for all participating institutions

Data pertaining to the final research question which guided this study were analyzed using a combination of quantitative and qualitative methods. Research question number four was: *What are the perceptions, as they relate to overall course satisfaction, among those students enrolled in F2F, hybrid, or online sections of introductory biology courses at two-year, open enrollment colleges?* Quantitative data pertaining to this research question were gathered from an online survey which was open to all student

participants in each course delivery format for two weeks during the spring semester, 2013. Qualitative data pertaining to this research question was gathered from student responses to questions from the online survey, and from seven focus group discussions.

Quantitative Data from the Online Student Survey

A total of 67 students enrolled in introductory biology courses in each of the three course delivery formats participating in the study elected to complete an online survey of course satisfaction made available through Blackboard. The time frame for all students to complete the survey occurred between the tenth and twelfth week of the semester. A total of 15 students enrolled in F2F sections elected to complete the online survey. When asked how satisfied they were with the lecture component of the course, eight of the students (53%) indicated they were *Very Satisfied*, and seven (47%) reported they were *Satisfied*. When asked how satisfied they were with the laboratory component of the class, six students (40%) indicated they were *Very Satisfied*, seven (47%) indicated they were *Satisfied*, seven students (7%) were *Neutral*, and one student (representing 7% of those surveyed) indicated he/she was *Very Dissatisfied* with the laboratory component of their F2F class. When responding to the question of how they would rate the class overall, eight students (53%) indicated it was *Excellent*, three (20%) indicated they would rate the class as *Above Average*, and the remaining four students (27%) rated it as *Average*.

When asked if they would consider taking the class in either a hybrid or online format, only one (7%) of the 15 surveyed indicated *Yes*, with the remaining 14 students selected *No*. In response to the question of whether they would recommend the F2F class to another student, all 15 of the students indicated *Yes*. It is important to note only 15 of

the 77 students enrolled in F2F sections elected to complete the online survey of course satisfaction, which equated to only a 20% participation rate.

A total of 52 students enrolled in introductory biology classes presented in a hybrid or online format elected to complete the online survey available through Blackboard during the spring semester, 2013. The results of the survey were combined the results from the online and hybrid sections, with a majority of students completing each question on the survey. When answering the question if this was the first time they had enrolled in a hybrid or an online course, 16 (33%) of the students responded *Yes*, with 32 (67%) responding *No*. When ask how satisfied they were with the lecture component of the class, 20 students (38%) indicated they were *Very Satisfied*, with 21 (40%) selecting *Satisfied*, 8 (15%) selecting *Neutral*, 2 students (4%) indicated they were *Somewhat Dissatisfied*, and one student (2% of those surveyed) indicated he/she was *Very Dissatisfied*. When asked how satisfied they were with the laboratory component of the course, 21 students (40%) selected *Very Satisfied*, 18 students (35%) selected *Satisfied*, eight students (15%) were *Neutral*, four students (8%) reported being *Somewhat Dissatisfied*, with one student (representing 2 % of those surveyed) reported being *Very Dissatisfied* with his/her hybrid or online introductory biology course.

When asked to rate the course overall, 20 students (38%) rated it as *Excellent*, 14 students (27%) selected *Above Average*, 16 students (31%) selected *Average*, one student (2%) rated it as *Below Average*, and the remaining student rated the class as *Inferior* overall. In response to the question if they would recommend this introductory biology class delivered in a hybrid or online course format, 35 (69% of those surveyed) students answered *Yes*, with 16 students (the remaining 31%) answering, *No*. The rate of response from the students enrolled in hybrid and online sections matched that from the

F2F sections, with a total of 52 of the 277 students completing the online survey, a response rate of approximately 19%.

Qualitative Data from the Online Student Survey and Focus Group Discussions

The students who completed the online survey or chose to participate in one of the seven focus groups conducted at the three participating institutions, answered questions and participated in discussions centering on their perception of satisfaction with their introductory biology course, which was F2F, hybrid, or online during the spring semester, 2013. The online survey was made available to all students participating in the study from the 10th through the 12th week of the course, via the LMS, Blackboard. Focus group discussions consisting of between six and nine students met for 1-2 hours during the 10th or 11th week of the spring 2013 semester. Focus group discussions were conducted at each of the three participating institutions. The written responses from students who completed the online survey were grouped with the responses from recorded focus group sessions, based on the same course delivery format, and the data were transcribed by the principal investigator (Creswell, 2007; Patton, 2002).

Students who completed the online survey, or participated in the focus group discussions, indicated they were from a wide variety of backgrounds and had a diverse set of educational goals. The Associate of Arts transfer degree was noted as the educational goal of many of the students, while other career and educational goals were listed, ranging from an Associate of Arts in general studies to an Associate of Science in Nursing. Many of the students indicated a desire to transfer to a four-year institution of higher education to pursue a Bachelor's degree, and several listed a Master's degree as their career goal. Students who participated in the focus group discussions included groups of individuals of various ages with an equal percentage of women and men.

Students were given the opportunity to select their own pseudonyms to protect their anonymity, and during discussions within the focus groups, students were referred to by their pseudonyms. After the focus group sessions, the discussions were transcribed, and the following themes were most prevalent: scheduling and time management, learning style, sense of community, technology, and the most and least enjoyable aspects of introductory biology.

Scheduling and time management. The theme of effective time management, flexibility, and convenience emerged from students enrolled in hybrid and online sections of introductory biology included in the study. Many students mentioned they worked either part-time or full-time, and were parents of young children. One student who completed the online survey mentioned she was, "A full-time student and a single parent of two children, who works full-time as a home health care assistant" (Online Survey, p.1). Another student who completed the online survey said, "I am 21 years old, and I have a daughter who is one-week old. I am going to school to complete my Associate's degree so I can provide for my family" (Online Survey, p. 1). Several students mentioned they were not financially able to afford to drive to a campus several times a week to attend classes. One student who completed the online survey mentioned, "I live over an hour and a half from campus, and can't afford to miss work and drive to school for a seated class" (Online Survey, p. 17). A student who participated in the online focus group, *Alisa*, mentioned, "I have two young children and work full time. I have to take all my classes online, otherwise I would not be able to attend school" (Focus Group 4, p. 1). Another student participating in the online focus group, *Butch*, mentioned, "I like the ability to complete my schoolwork at my own pace, on my own schedule." (Focus Group 4, p. 7).

However, not all students agreed that taking their introductory biology class in a hybrid or online format was the best solution for their busy schedules. One student who completed the online survey indicated why the F2F format was preferable for their busy schedule:

> I do better with in-class instruction because I tend to procrastinate if I'm not in the classroom setting. It is hard for me to find the time to study a lot at my house because we are so busy with our young children. If I took this class as a hybrid or fully online, I would not have the time to devote to it (Online Survey, p. 7)

Another student, *Ellie*, who participated in a focus group discussion with students enrolled in online sections of introductory biology, mentioned that the flexibility of courses presented entirely online was not always a benefit when she stated:

> It can be pretty overwhelming to take classes entirely online. I have four kids at home, and it is difficult because with online classes, the majority of the learning is on the student, whereas in seated classes it is the opposite. People think online classes are better for moms with kids, but it really isn't because you don't have the time you need to be away and go to class. At home, so many things can come up, and there are so many distractions that it is hard to get everything accomplished for an online class. (Focus Group 4, p. 6)

Time management was a key factor for many students who completed the online survey or elected to participate in the focus group discussions. A majority of the students worked either part-time or full-time, and many also had family obligations that they balanced with their school schedules. Several students mentioned the flexibility and convenience of taking their introductory biology course in either a hybrid or online format as an advantage over F2F course delivery. However, not every student was in

favor of hybrid or online instruction. A student, *Odette*, who was enrolled in a F2F section, stated:

> I feel I would not learn enough if it were offered as a hybrid or an online class. The online labs wouldn't benefit anyone unless they already know exactly what they were doing, or if they had done the lab before. (Focus Group 5, p. 5)

A student, *Sarah*, who had attempted an online introductory biology class during the fall, 2012 semester stated, "I took this class last semester online and had to drop because I was failing, but this semester in the seated class I am doing much better" (Focus Group 5, p. 5).

Learning style. An important theme questions about learning styles emerged from students in fully online and hybrid classes when they described themselves as independent and self-motivated. One student mentioned on the online survey, "I am a highly motivated person. I work best independently and enjoy doing work at my own pace rather than in a classroom setting" (Online Survey, p. 1). Another student, *Bill*, participated in the online focus group discussion and described why he elected to enroll in an online introductory biology section:

> I am an older student and already have one degree under my belt. I work full-time at a local hospital and do not have a lot of time to commit to face-to-face classes. Online classes seem to fit my busy schedule better.
>
> (Focus Group 4, p. 1)

Students in F2F sections, who responded to the question about what they enjoyed the most from their introductory biology course, had a variety of responses, and one recurring theme emerged, they enjoyed the seated labs. One student, *Cecelya*, mentioned, "I enjoy the labs because they are very interesting and a fun way to learn the

material" (Focus Group 1, p. 6). Another student, *Alex*, commented, "I enjoyed the lab days the most. We worked together and it helped me understand why the information we were covering in lecture mattered" (Focus Group 1, p. 6). A student, *Azra*, mentioned, "I am a hands-on type of learner, and if I can see it and touch it, I can understand how it works" (Focus Group 6, p. 6). *Cryssy* commented on why she preferred the F2F course delivery format:

> I like the labs, and I like to work in groups so I am able to bounce ideas off the other people in my group. It helps me look at it from a different perspective and retain more information. I'm a people-person, and if I can related to it in any way, I can retain it (Focus Group 6, p. 7)

A majority of students enrolled in seated sections of introductory biology who participated in the study also emphasized they would not consider taking the course in either a hybrid or online format. One student, *Angel*, mentioned why she preferred the F2F course delivery format:

> The interaction among the class with the instructor is very important to me. This class would be quite difficult to understand without a teacher meeting with you face-to-face. Plus, the seated labs really help me put the information from lecture into perspective. (Focus Group 6, p. 8)

Another student, *Robin Hood* said, "I would not consider taking this course in a hybrid or online format. I enjoy meeting with my classmates and the instructor, and being able to have my learning time in class because it helps keep me focused" (Focus Group 6, p. 8). The subject matter of the course was also mentioned by several students who enrolled in seated sections. *Sunshine,* stated, "For a class like biology, I like to take it face-to-face with the instructor in the room because I am an active learner, and if I have

a question or something, I need to get it answered right now" (Focus Group 6, p. 8). An important observation about non-verbal communication was made by *Joe*, who was enrolled in a hybrid section, when he mentioned, "In person when an instructor is delivering a lecture, they can stomp their foot or do something else that gives the point emphasis. But in the online lecture, you don't get any of that feedback or body language" (Focus Group 3, p. 8).

Several students enrolled in hybrid sections of introductory biology expressed why they elected to not take the class in an online format. One student, *Professor Plum*, mentioned, "I like hybrid classes because I get distracted really easy and when I'm at home trying to do something online it's like, hey look…Netflix"(Focus Group 2, p. 3). Another student, *Miss Julia*, mentioned she preferred hybrid classes:

> …because I have a language barrier, and sometimes I like to meet the teacher face-to-face if I have a question about a term or procedure I need to have clarified. I was offered this class in a fully online format, but I decided to take it as a hybrid and I like it so far. (Focus Group 2, p. 3)

Students have a variety of learning styles, and they tend to enroll in courses delivered in a format that best suits their particular learning style. Self-motivated students who enjoy learning at their own pace tend to enroll in courses offered entirely online. Students who responded to the question about what they enjoyed the most about their introductory biology course often found the laboratory sessions to be the most interesting and informative.

Sense of community. Students had a variety of responses to the question of whether they felt a sense of community in their introductory biology course, which aligned with the delivery format. A student, *Nicki*, in a F2F section mentioned, "I do feel

a strong sense of community in our class this semester because we work together in small groups during lab" (Focus Group 5, p. 3). Another student, *Angel*, commented, "Yes, because we are all in the same boat. We have meaningful conversations about what we have learned in class" (Focus Group 6, p. 4). A student enrolled in a hybrid section included in the study, *Jack*, emphasized the importance of having a group of peers that one can relate to when he stated, "I sit with the same people in lecture and in lab. We are kind of like our own study group in the class" (Focus Group 2, p. 6).

However, not everyone in F2F sections indicated they felt a sense of community in their class. One student, *John*, mentioned, "No, everyone just talks to the people at their own lab table" (Focus Group 1, p. 4). Another student, *Helen Keller*, reported, "No, there are a lot of different types of people in the class and a lot of them stay to their groups" (Focus Group 1, p. 4). *Trudy* mentioned why she did not feel there was a strong sense of community in her F2F class:

> Not really, I have done a lot on my own, because when I first started the class, I wasn't being allowed to participate in the group I was in, and when I switched groups, none of the people in my new group were hardly ever there.
>
> (Focus Group 6, p. 4)

Students enrolled in hybrid sections of introductory biology had positive remarks about the sense of community they felt with their classmates. One student, *Joe Bob Blue*, mentioned, "I do feel a sense of community in my hybrid section because we work together in lab, and there are several in class group activities that provide an opportunity for us to get to know our classmates" (Focus Group 7, p. 6). Another student, *Lynn*, was in agreement with the strong sense of community in her hybrid class when she mentioned:

> There is a strong sense of community in our class this semester, because several of us have a couple of different hybrid classes together that all meet on the same day, so we get to know each other fairly well early on during the semester. (Focus Group 7, p. 6)

The students enrolled in courses presented entirely online did not indicate a sense of community, as indicated from a majority of their survey responses and their focus group discussions. A few of the students indicated that they were able to connect with their classmates through the introductory discussion board assignment and if the instructor assigned a group project during the semester. However, a majority of the students in online sections mirrored this observation from, *Rick,* who said, "I didn't sign up for the class online to feel a sense of community with my classmates. I just wanted to learn the information and pass the class" (Focus Group 4, p. 7). Another student, *Mary,* commented, "I am a very shy person, and it is hard for me to interact with others in a group setting, and that is why I prefer to take most of my courses online" (Focus Group 7, p. 3).

Technology. Common themes from the online survey and focus group discussions, for those in online sections were connection issues and lack of technological support. A student who participated in the online focus group, *Amy*, mentioned, "I live out in the country, and my internet connection is spotty at best. I drive into the nearest Wi-Fi location to submit my labs and take my exams, because I got tired of getting kicked off the internet" (Focus Group 4, p. 7). Several students mentioned a lack of personal contact with their instructor as a disadvantage in taking online classes. One student, *Rick*, commented, "Sometimes it would take my instructor a day or two to get back with me about a question I had about an assignment" (Focus Group 4, p. 7).

Another student, *Carolyn*, indicated the quality of the course was directly dependent on the instructor when she stated:

> I have had some really good online instructors that were really involved, and I have also had some not so good instructors that just weren't involved with the class. I think it depends on the instructor assigned to teach the class. (Focus Group 2, p. 4)

Several students mentioned online exams and quizzes should be considered open source, but they often experience difficulties with the technology required to support online learning. One student, *Craft*, mentioned changes in technology in online courses were a challenge when he said:

> The biggest complaint I have about taking online classes is that they need to keep the website the same each semester and it should be uniform for every class. It seems like every semester there are updates, and just when you get familiar with the way Blackboard operates, it changes. (Focus Group 1, p. 4)

Most and least enjoyable aspects of introductory biology. Students in F2F sections responded to the question about what component of the class they enjoyed the most with comments by students, such as, *Mae*, who said, "I've enjoyed this entire class so far this semester. The subject is fascinating to me, and I've enjoyed the connection I have made with the instructor and my fellow students in the class" (Focus Group 5, p. 4). Many students said the hands-on labs were their favorite component of their seated class with comments, such as the one by *Honey*, when she said, "I've enjoyed doing the labs in this class this semester, unlike in previous lab-based classes I have taken because I felt like I knew what was going on and what I was doing in lab" (Focus Group 5, p. 4).

Students in F2F sections responded to what they enjoyed least about the class with comments, such as the one by *Ashlyn* when she stated, "The fact that it's biology. I've never been a big science fan" (Focus Group 3, p. 8), and the comment by *Jordon* who said, "The seats in the classroom are extremely uncomfortable" (Focus Group 3, p. 8). Several students in seated sections mentioned there was not any particular part of the class that they did not enjoy, although a few students did say the exams were their least favorite part of the class. One student in a seated section, *Ann,* mentioned, "The lab manual is poorly written because some of the questions are confusing and redundant" (Focus Group 7, p. 7).

Students in hybrid sections of the course mentioned several components of the class they enjoyed the most, such as the recurring theme of hands-on labs, coupled with the flexibility of the lecture portion of the class condensed into one day a week. A student's comment, such as the one from *Michelle,* expressed her satisfaction with the laboratory component of her introductory biology class when she said, "I enjoyed the labs because they allowed us to work with living organisms and use the microscopes and other equipment" (Focus Group 3, p. 8). Another student in a hybrid section, *Carl,* mentioned, "I enjoyed the lectures being only one day a week. It worked with my busy schedule, but I was still able to connect with my classmates and participate in seated labs for the course" (Focus Group 7, p. 7).

Students in the hybrid sections indicated they least enjoyed the amount of material being covered and the pace of the course. One student, *Joe*, said, "We cover several chapters each class period, and once I figured out how to do the online review questions, it really helped me prepare for the exams." (Focus Group 7, p. 3). Another student, *Sue*, commented on the academic rigor of the hybrid section she was enrolled in:

> You really have to do your homework to keep up with this class. We cover a lot in our lectures, and you have to complete the online quizzes and reviews and read through the labs to know what is going on. (Focus Group 7, p. 6)

Students responding to what components they enjoyed the most and the least about their online introductory biology classes included comments associated with the convenience of the class, the pace and workload of the class, connection issues, and communication issues with their instructors. Students indicated that the pace of the class was rigorous, and the workload was more than they had expected when they registered for the class. Comments, such as the one from *Alisa* indicated the level of commitment it takes to be successful in an online introductory biology class:

> I had to drop this class the first time I signed up for it, because I didn't realize how much time it required. Now that I am able to devote the extra time to this class, I am doing much better this semester. (Focus Group 4, p. 8)

Another student, *Bill*, mentioned, "You literally have to study two or three hours each day to keep up with all the reading assignments and work in this class" (Focus Group 4, p. 5).

Summary

The purpose of this study was to examine whether differences existed between student success and perceived levels of course satisfaction with introductory biology classes presented in three different course delivery formats: F2F, hybrid, and classes presented in an entirely online format. The study was conducted at three, open enrollment, two-year colleges in Southern Missouri, with 354 adult students who volunteered to participate during the spring semester, 2013. The study was guided by four research questions, and the information presented in this chapter represented the

quantitative and qualitative analysis of the data. The following chapter presents the summary and conclusions based on the data collected in this study, implications for practice, and recommendations for future research on this topic.

Chapter Five: Summary and Conclusions

This study was conducted to determine if there were significant differences in academic success and students' perceptions of course satisfaction among groups of students enrolled in introductory biology courses presented F2F, hybrid, or fully online. The study was administered at three, two-year, open enrollment institutions of higher education in Southern Missouri, with 354 adult volunteers during the spring semester, 2013. The study was guided by four research questions, which were tested utilizing quantitative and qualitative data. This chapter included a review of the demographics of the population included in the study, the findings from the statistical analysis of data, along with the conclusions drawn from the results. This chapter also included a discussion of the implications for practice drawn from the results of this study, and recommendations for future research on this topic. Finally, a summary of the conclusions of the study was presented.

Demographics

The population for this study included 354 adult volunteer students enrolled in introductory biology courses presented F2F, hybrid, or online at three, two-year, open enrollment colleges in Southern Missouri during the spring semester of 2013. Students were given the opportunity to take a precourse and a postcourse assessment, complete an online survey, and participate in a focus group discussion about experiences with their introductory biology course. Seven focus group discussions were conducted during the study, with a total of 55 students representing each of the three different modes of course delivery from each of the participating institutions. The number of students participating in each focus group ranged from a minimum of six to a maximum of nine. Both

quantitative and qualitative data were collected in the study, and the results are presented with each of the four accompanying research questions in the following section.

Findings from Research Question One

The first research question guiding this study was: *What academic difference exists, if any, among intact groups of students enrolled in F2F, hybrid, or online sections of introductory biology courses at two-year, open enrollment colleges as measured by the difference between average gain scores from precourse and postcourse assessments?* The purpose of this question was to determine if a significant difference in gain scores existed (Angelo & Cross, 2010). The null hypothesis for the first research question stated there was no significant difference between the average gain score on precourse and postcourse assessments for students enrolled in F2F, hybrid, or online sections of introductory biology included in the study. A total of 65 of the 77 students enrolled in F2F sections completed both the precourse and postcourse assessments, with 51 of the 65 enrolled in hybrid sections completing both, and 75 of the 212 students enrolled in online sections of introductory biology completing both assessments.

The result of an *F* test conducted on the variances between the precourse and postcourse assessment scores for students enrolled in F2F sections resulted in a test statistic of 0.73 at 64 *df*, which indicated no significant difference in sample variance between the two assessments at $\alpha = 0.05$ (Bluman, 2009). Regardless of the location of the institution, students enrolled in F2F sections of introductory biology included in the study preformed essentially the same on the two assessments. However, the results of a one-tailed *t*-test with the assessment scores paired for each student enrolled in F2F sections, resulted in a *p* value of 2.71×10^{-16}, which substantiated the mean difference between the two assessments as highly significant (Bluman, 2009; Triola, 2006). There

was sufficient evidence to reject the $H_{0,}$ which means regardless of the location a student participating in the study completed his/her F2F introductory biology course, they did significantly better on their postcourse assessment compared to the score they earned on their precourse assessment.

The result of an *F* test conducted on the variances between the precourse and postcourse assessment scores for the 51 students enrolled in hybrid sections of introductory biology resulted in a test statistic of 0.20 at 50 *df*, which indicated no significant difference in sample variance between the two tests (Bluman, 2009). However, the results of a one-tailed *t*-test with the assessment scores paired for each student resulted in a *p* value of 4.86×10^{-16}, which substantiated the mean difference between the two assessments were highly significant at $\alpha = 0.05$ (Bluman, 2009; Triola, 2006). There was sufficient evidence to reject the H_0, which means regardless of the location where students participating in the study completed his/her hybrid introductory biology course; they did significantly better on their postcourse assessment compared to the score they earned on their precourse assessment.

The result of an *F* test conducted on the variances between the precourse and postcourse assessment scores for the 75 students enrolled in online sections of introductory biology resulted in a test statistic of 4.95×10^{-4} at 74 *df*, which indicated no significant difference in sample variance between the two tests (Bluman, 2009). However, the results of a one-tailed *t* test with the assessment scores paired for each student resulted in a *p* value of 1.08×10^{-11}, which substantiated the mean difference between the two assessments were highly significant at $\alpha = 0.05$ (Bluman, 2009; Triola, 2006). There was sufficient evidence to reject the H_0, which indicated a student participating in the study who completed his/her online introductory biology course did

significantly better on the postcourse assessment compared to the score earned on the precourse assessment.

Additional statistical tests to determine whether significant differences existed in the gain scores from precourse and postcourse assessments for students in F2F, hybrid, and online sections indicated an important difference between course format and sample variance. The gain scores analyzed in this study included both positive and negative values, and the results of descriptive statistical tests on the data did not indicate a significant difference between mean gain scores on precourse and postcourse assessments between the three course delivery formats. However, it is important to note that the sample variance and standard deviation between scores for students enrolled in online sections of introductory biology was higher than the same values calculated for students in F2F or hybrid sections included in the study (Bluman, 2009; Triola, 2006). Although students enrolled in online classes who completed both assessments had the highest average gain score (1.59 points), their group also had the most variance within the sample (3.06) and the highest standard deviation (1.75). These values could be attributed to variability in timely submission of the assessments, or potential access to the answers on the assessments via online resources.

The results of a one-way ANOVA on the mean gain scores for the three different course delivery formats indicated no statistical difference in precourse and postcourse assessment scores, because the calculated *p*-value of 0.82 exceeded the $\alpha = 0.05$ (Bluman, 2009; Triola, 2006). It is important to note that the *SS*, which represents the variation in scores on the assessments among groups, was 0.81 indicating a negligible amount of variation. This means there was little variation between scores on assessments among groups, regardless of whether the course was taken F2F, hybrid, or

online. When the *SS* was calculated within groups, there was a significant amount of variation (SS = 399.86). This result indicated there was variation between the assessments scores recorded for students taking introductory biology, regardless of course format, both within sections of the course and among institutions participating in the study.

Findings from Research Question Two

The second research question guiding this study was: *What academic difference exists, if any, among students enrolled in F2F, hybrid, or online sections of introductory biology courses at two-year, open enrollment colleges as measured by final course grades?* The H_0 accompanying this research question stated there was no significant difference among the final grades for students completing an introductory biology course F2F, hybrid, or online. After the completion of the spring semester, 2013, the final course grades earned by each student participating in the study were combined from each reporting institution, and a chi-square statistical analysis was performed on the data. The chi-square test was selected because the data being analyzed were categorical in nature (Bluman, 2009; Triola, 2006). The letter grades assigned to all students enrolled in F2F sections of introductory biology courses at each of the participating institutions during the spring semester, 2013, served as the expected values for the chi-square tests when compared to the hybrid and online sections, because the traditional method of instructing courses has been through F2F contact with students (Allen & Seamen, 2011). The total number of each assigned letter grade from each of the three different course formats was converted into a percentage, which was analyzed using a chi-square test for homogeneity of proportions (Bluman, 2009). The expected grades used in the chi-square test for homogeneity of proportions was a sum of all the assigned letter grades for all F2F

sections of the course at each of the three institutions included in the study, a total of 682 final grades, which was converted into a percentage.

There were a total of 73 final grades assigned to students completing F2F sections of introductory biology at the three institutions included in the study during the spring semester of 2013. A total of 61 students completed hybrid sections and were assigned a final grade in their course, and a total of 167 students completed their online introductory biology course. The introductory biology courses at each of the participating institutions followed the same straight percentage grading scale.

The results of a chi-square test for homogeneity of proportions conducted on the data from final course grades earned in all F2F sections of introductory biology included in the study resulted in a *p*-value of 0.73, and eight *df*. Because the calculated *p*-value exceeded $\alpha = 0.05$, there was not enough evidence to reject the H_0 of no significant difference (Fraenkel et al., 2012). The final grades earned by students enrolled in F2F sections of introductory biology who participated in the study were essentially in the same proportions as the final grades earned by all students completing the course in a F2F format at any of the three participating institutions during the spring semester, 2013.

The chi-square test for homogeneity of proportions for final course grades earned by students enrolled in the hybrid sections included in the study resulted in a *p*-value of 0.55, and eight *df*. The *p*-value calculated for the final grades of students enrolled in hybrid sections exceeded $\alpha = 0.05$ level, also indicating not enough evidence to reject the H_0 of no significant difference (Fraenkel, et al., 2012). This means the final course grade earned by students enrolled in hybrid sections were essentially in the same proportions as all students completing the course in a F2F format at any of the three participating institutions during the spring semester, 2013.

However, the chi-square test for homogeneity of proportions for final course grades earned by students enrolled in online sections yielded a *p*-value of 5.65×10^{-4} which was significantly smaller than $\alpha = 0.05$. This result indicated there was enough evidence to reject the H_0, because the final grades earned by online students in the study were significantly different when compared to final grades earned by all students enrolled in F2F sections at each of the three participating institutions. For example, there were only 12 students of the 167 participating in the study (7.2%) who earned a letter grade, *A*, in their online introductory biology course, compared to an expected 21% of students who earned an *A* from all the F2F sections combined. Likewise, there were 13 of the 167 students included in the study (7.8 %) who earned a letter grade of *F,* in their online biology course, compared to the expected 5% who failed the F2F sections of the same course. This result indicates for the students who attempted to complete their online introductory biology course, fewer students earned an *A*, and a significant number earned a failing grade when compared to the final grades earned by students completing the course in F2F sections, mirroring a trend that has been published in other studies (El Mansour & Mapinga, 2007; Jenkins, 2011).

Findings from Research Question Three

The third research question guiding this study was: *What academic difference exists, if any, among students enrolled in traditional seated, hybrid, or online sections of introductory biology courses at two-year, open enrollment colleges as measured by attrition rates?* The H_0 accompanying the third research question stated there was no significant difference between the attrition rates for students enrolled in F2F, hybrid, or online sections of introductory biology included in the study. The total number of students who withdrew from any section of introductory biology presented F2F, hybrid,

or online at the three institutions combined was 61 out of a total of 741 students enrolled, which is equal to an 8 % attrition rate. The 8% attrition rate was used as the expected value in the chi-square analysis on attrition rates of students participating in the study.

There were a total of seven students out of 77 enrolled who withdrew from F2F sections included in the study, which equated to a 9% attrition rate. The attrition rate for students enrolled in hybrid sections was calculated at 6%, because only four of the 65 students withdrew during the spring semester, 2013. However, the attrition rate for students enrolled in online sections was calculated at 21%, which represented the 45 students who withdrew from the course out of the 212 enrolled. The attrition rate for students in online sections was more than double the attrition rate for all three participating institutions, and represented a significant number of students who were unsuccessful in the online sections included in this study. These results aligned with studies published by other researchers (El Mansour & Mapinga, 2007; Jenkins, 2011).

Findings from Research Question Four

Quantitative data. The fourth research question guiding this study was: *What are the perceptions, as they relate to overall course satisfaction, among students enrolled in F2F, hybrid, or online sections of introductory biology courses at two-year, open enrollment colleges?* Data pertaining to this final research question were gathered and analyzed using a combination of quantitative and qualitative methods. A portion of the quantitative data for this research question was gathered from an online survey, which were open to all student participants in each course delivery format for two weeks during the spring semester, 2013.

Only 15 of the 77 students enrolled in F2F sections of introductory biology elected to complete the online survey of course satisfaction, which represented 20% of

the students enrolled in the course. Of those who responded, a majority (60%) indicated they were either *Very Satisfied* or *Satisfied* with the lecture portion of their course. Eighty-seven % of the respondents indicated they were either *Very Satisfied* or *Satisfied* with the laboratory component of their course. When responding to the question of how they would rate their introductory biology course overall, 53% selected *Excellent*, with 20% selecting *Above Average*, and 27% rating the course as *Average*. All 15 students responded they would recommend taking an introductory biology course F2F, and 93% indicated they would not consider taking the course in either a hybrid or completely online format. This was an interesting response, which may be attributed to factors including the following: a lack of familiarity with technology, unreliable access to the Internet, or as noted in the social constructivist conceptual framework, they had a desire to interact on a personal level with their peers and instructors.

A total of 52 students enrolled in either hybrid or online sections of introductory biology completed the online survey of course satisfaction. A majority of students responded they were either *Very Satisfied*, (38%), or *Satisfied*, (40%), with the lecture portion of their hybrid or online course, with only two students (4%) indicating they were *Somewhat Dissatisfied*, and one student (2% of those surveyed) selecting they were *Very Dissatisfied* with lecture. When responding to the question of how satisfied they were with the laboratory component of their hybrid or online course, three-fourths of those surveyed were either *Very Satisfied*, or *Satisfied*, with eight students (15%) answering they were *Neutral*, four students (8%) reported being *Somewhat Dissatisfied*, and one student (2%) reported being *Very Dissatisfied* with the laboratory component of their course. It is important to note the Remark survey students completed was made available online through the LMS Blackboard, and it did not differentiate between responses from

students enrolled in hybrid or online sections. All hybrid sections of introductory biology participating in the study conducted F2F labs identical to the seated sections.

A majority of students enrolled in hybrid and online sections of introductory biology included in the study rated their course as *Excellent* (38%), or *Above Average* (27%), and 31% rated their course as *Average*. When responding to the question if they would recommend this course delivered in either a hybrid or online format, 69% of those surveyed indicated they would, with the remaining 31% answering they would not. This response was important because it represented a significant percentage of the students enrolled in either hybrid or online sections were not satisfied with their course, which was a very different from the one given by the students enrolled in F2F sections of introductory biology included in the study. The difference may be attributed to the greater number of students in online sections who eventually withdrew, or were earning a failing grade in the course when the survey was administered.

Qualitative data. A total of 55 students from F2F, hybrid, and online sections, representing each of the three institutions, participated in seven different focus groups. The opinions students expressed varied. However, several important themes emerged including: scheduling and time management, learning style, sense of community, technology, and the most and least enjoyable aspects of their introductory biology course. The theme of flexible scheduling was reported by a majority of students enrolled in hybrid and online sections, and was the most important reason students elected to enroll in those particular course delivery formats. This finding coincides with numerous studies on why students elect to enroll in hybrid and online classes (Fike & Fike, 2008; Parry, 2010; Serhan, 2010). Although once they enrolled, several students who participated in the focus group discussions mentioned they were not aware of the time commitment

involved to be successful in online courses, mirroring important findings noted in studies including the one conducted by Harrell and Bower (2011).

Discussions within the focus groups with regard to learning styles resulted in several important insights into why students would elect to enroll in F2F, hybrid, or online sections of an introductory biology course. Not surprisingly, a majority of students enrolled in hybrid or online sections described themselves as independent, self-motivated, and goal-driven, aspects mirrored in similar studies published by Serhan (2010), and Harrell and Bower (2011). This finding was in sharp contrast by the opinions expressed by students enrolled in F2F sections, who often referred to the importance of personal contact and interaction with their peers and instructor, as mentioned in studies conducted by El Mansour and Mupinga (2007), Reuter (2009), and Battalio (2009).

Discussions within focus groups of whether or not students felt a sense of community in their introductory biology course, the responses generally aligned with the format of course delivery. A majority of students enrolled in F2F sections reported a high level sense of community within their classes, especially when working in the laboratory. Students enrolled in hybrid sections, all of which completed labs identical to the F2F sections included in the study, also reported a strong sense of community within their sections.

However, the students enrolled in online sections reported only a negligible sense of community, most of which resulted from discussion board posts. It is important to note for a majority of students electing to enroll in online classes, their self-reported learning style is usually not dependent on a strong sense of community in the classroom environment. However, a key component of the social constructivism conceptual framework is providing a sense of community and interaction, which is essential to the

learning process in an environment where students are actively engaged in inquiry-based learning (Davis & Snyder, 2012; Palincsar, 1998).

Interestingly, many of the students enrolled in F2F sections of introductory biology expressed an interest in having access to additional online resources, such as links to animations and videos, flashcards to practice the definition of terms, practice quizzes, and other online study tools. This observation was in alignment with studies noting the preference by individuals in the millennial generation who grew up using technology and reported benefitting from a wide variety of instructional methods (Wilson & Gerber, 2008). The students in F2F sections were not necessarily willing to enroll in online or even hybrid sections of introductory biology, but they did express an interest in additional technology being infused into their F2F courses.

Several students enrolled in online sections expressed a frustration with the technology required for success in their online class. Students noted interruptions in Internet connections, and delayed responses from their instructors, as two examples of their frustrations with technology. These themes were echoed in a study conducted by Harrell and Bower (2011) where the researchers noted an inverse relationship between students' basic computer skills and rates of course persistence. In their study, the researchers (Harrell & Bower, 2011), reported students enrolled in online science courses were apt to overestimate their level of experience with technology, or succumb to the distractions of the Internet. One student, *Professor Plum* who participated in a focus group discussion with other students enrolled in a hybrid section, echoed this very sentiment when he described why he elected to enroll in a hybrid and not a fully online section of introductory biology.

A majority of the students enrolled in F2F or hybrid versions included in the study described the most enjoyable aspect of the course as the laboratory component. This finding was in direct agreement with numerous studies grounded in the social constructivist theory, indicating individuals learn best when they are actively engaged in the process (Ayala, 2009; Davis & Snyder, 2012; Edgcomb et al., 2008). The laboratory component of an introductory biology course is often the most engaging aspect of the class. Students have the opportunity to work cooperatively to collect, analyze, and report data and make informed predictions about their observations (Anetta et al., 2009; Swan & O'Donnell, 2009; Toth et al., 2009). Several studies indicated the effective use of kits containing most of the necessary supplies to conduct basic scientific experiments at home as a successful way to accomplish the laboratory component of online science classes (Mickel & Aune 2009; Reuter 2009); however, not all online courses utilized these resources to augment the laboratory courses their institution offers.

Students enrolled in F2F sections of introductory biology described their least enjoyable aspect of the class with responses ranging from the subject matter, the time of day the class was offered, the wording of the questions in the lab manual, to the uncomfortable seats in the lab room. Students in hybrid sections noted the amount of material being covered, and the pace of the class moving too quickly as their least favorite components. Students enrolled in online sections were in agreement with the amount of material being covered, and several mentioned the course was more academically rigorous than they expected. One student noted she had withdrawn from an online section during the previous semester, and was now better prepared to successfully complete the course.

Conclusions

This study was conducted to examine if there were differences among student success and perceptions of course satisfaction with introductory biology classes presented F2F, hybrid, or online. The study involved 354 adult students from three, two-year institutions of higher education in Southern Missouri, and data were collected during the spring semester, 2013. The study was guided by four research questions and involved the collection and analysis of numerous pieces of quantitative and qualitative data. The conclusions of the study pertaining to each research question are presented in the following section.

An important conclusion from data collected and analyzed in conjunction with the first research question guiding this study was, regardless of the location or delivery format of their introductory biology course, all students performed better on their postcourse assessment than on their precourse assessment, indicating they did learn basic principles of science during their sixteen-week introductory biology course. The students enrolled in F2F and hybrid versions of the course had a negligible amount of variation within assessment scores, and each method of course delivery had a significant gain between precourse and postcourse scores for groups of students. Students enrolled in online sections did not have a significant level of variation within scores, but exhibited more variability in their average gain score between the two assessments than students in either F2F or hybrid versions of introductory biology included in the study.

An important finding from the second research question about final course grades was the revelation that students enrolled in online sections of introductory biology earned final grades in significantly different proportions than students enrolled in either F2F or hybrid versions of the same course. According to the data analyzed in this study,

students enrolled in online versions of introductory biology earned fewer *A's*, and had a disproportionately higher number of *F's* assigned than students in either F2F or online versions of the same course. This finding is in alignment with other studies concerning students in online classes (Jenkins, 2011; Parry, 2010).

The most important finding from the third research question about attrition rates was the disproportionately high number of students who withdrew from online introductory biology classes compared to the rate of those who withdrew from either F2F or hybrid sections of the course. Online sections included in this study had an average attrition rate of 21%, compared to 9% for F2F sections, and 6% for those enrolled in hybrid sections. This finding was in alignment with similar studies including the report published by ITC (2012), Harrell and Bower (2011), and Parry (2009).

The fourth research question guiding this study involved an analysis of the perceptions students had about their level of satisfaction with introductory biology courses presented F2F, hybrid, or entirely online. The data collected on this topic came from both quantitative and qualitative sources. An important note about the online survey available to students for a two-week period during the last month of the semester is that relatively few students elected to complete it. Information from the seven focus groups conducted on the campuses of each of the three participating institutions yielded insight into what students perceived as valuable in their courses. The researcher gained perspective into why students enroll in F2F, hybrid, or online courses, and their perceptions of interactions with classmates and instructors.

Implications for Practice

The findings from this study have direct implications on the design, implementation, and assessment of introductory biology courses presented in F2F, hybrid, or online formats for open enrollment, two-year colleges. This mixed-methods study, based on a social constructivist conceptual framework, involved the collection and analysis of numerous pieces of quantitative and qualitative data. The implications of the results from each of the four research questions guiding this study are presented in order in the following section.

The implications of the results from the first research question, which indicated there was no significant difference between precourse and postcourse assessment scores, regardless of the format of course delivery, could be applicable to future sections of introductory biology classes as an important component of course assessment. Precourse and postcourse assessments have been successfully implemented to track student learning outcomes (Fraenkel et al., 2012), and served as a quantifiable measurement of an often esoteric description of student learning.

The implications of the results of the second research question designed to test if there were significant differences among final course grades earned by students in each of the three course delivery methods included in the study can be referenced in additional research studies into student success in introductory biology courses and the format for course delivery. One finding noted in this study was a significant difference between the final course grades assigned to students enrolled in online sections, compared to either F2F or hybrid sections, was in alignment with studies previously published by Jenkins (2011), and El Mansour and Mupinga (2007).

Findings from the results of the third research question comparing the persistence of students in F2F, hybrid, and online sections of introductory biology noted an average rate of withdrawal of 9% for students in F2F and hybrid sections. This attrition rate was essentially equal to the 8% reported rate of withdrawal from all F2F sections of the course at each of the participating institutions combined. However, the withdrawal rate of students enrolled in online sections had a 21% rate of attrition. This finding was in accordance with other published studies including those by Harrell and Bower (2011), and El Mansour and Mupinga (2007).

The qualitative component of the data gathered for research question number four included statistical analysis of students' response to an online survey about their level of satisfaction with their introductory biology course. Although the number of students enrolled in F2F sections who elected to compete the survey was relatively low (only 15 of the 77 enrolled), their responses aligned with previously reported studies (Aoun, 2011). The responses to the survey from students enrolled in hybrid and online sections at approximately 19%, and most of the responses were in keeping with studies of student satisfaction by Gerbic (2011) and Davis and Snyder (2012).

The findings from the seven focus group discussions conducted in this study have direct implications on the design, implementation, and assessment of introductory biology courses at two-year, open enrollment colleges. Students succinctly expressed their positive and negative opinions about the reason they elected to enroll in a particular course format, their learning style, whether or not they valued and felt a sense of community within their class, the use of technology, and the most and least enjoyable aspects of their course. These results can be directly applied to address issues with

course design and to better meet the needs of students enrolled in F2F, hybrid, and online introductory biology courses.

Recommendations for Future Studies

The topic of student success and perceptions of course satisfaction with introductory biology courses at two-year, open enrollment colleges warrants further research. The limitations of this study noted in chapter one should be addressed in future studies by correcting the limited scope of the sample included in the study. Additional sections of introductory biology courses should be included in any future studies to broaden the applicability of the study. Also, a more comprehensive online survey instrument should be developed and administered to more students in order to achieve a larger representation of opinions concerning students' course satisfaction. If future studies are conducted, the researcher would recommend splitting the results of the online survey to differentiate between responses noted by students enrolled in online and hybrid sections. The survey administered in the current study combined the responses from students enrolled in hybrid introductory biology sections with responses from students in online sections. Students who completed hybrid sections of introductory biology met once a week, F2F, with their instructor and classmates to review and discuss concepts from the text, complete F2F labs, and for proctored exams. Therefore, the experiences for students in hybrid sections differed from the experiences for students enrolled in online sections, which were not accounted for in the Remark survey. Additional focus groups could be scheduled within a larger study in order to obtain more in-depth interviews with students about their perceptions of course satisfaction. This study could also be broadened in scope to include upper division biology courses for majors or non-majors.

Conclusion

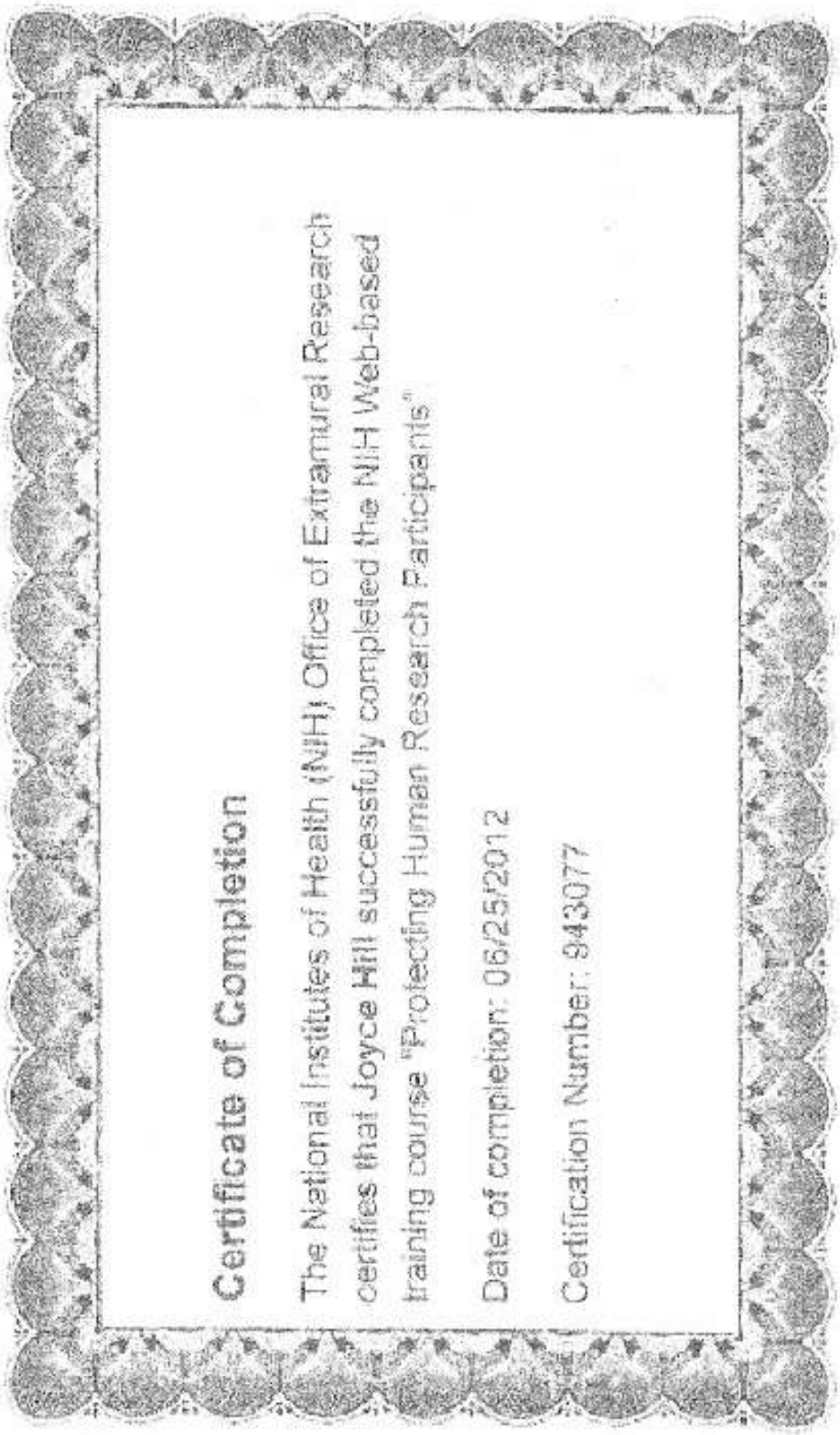
This study provided insight into several important questions regarding why students enroll in certain course delivery formats for introductory biology, and what their perceived levels of course satisfaction were within the context of their chosen mode of course delivery. Although the study was limited in scope, it provided a foundation on which to build future studies on this important topic. Regardless of course delivery format, all college-level courses should be grounded in the social constructivist approach of providing students interesting, engaging, and relevant topics to consider.

Technology is rapidly improving, providing the opportunity to incorporate online resources into F2F and hybrid courses and to augment existing online courses especially in the area of virtual laboratory experiences, enhanced student-student, and student-teacher contact through instant messaging, online study groups, and review sessions (Lents & Cifuentes, 2009). The future of F2F, hybrid, and online introductory biology courses is limitless. The challenge of producing one million more STEM graduates in the next decade is a daunting and exciting goal, and one that should be the objective of educational professionals in every level of society.

An important component of the success of students, whether they are in pursuit of STEM degree, or completing the requirements for an Associate of Arts transfer degree, is to be exposed to a dynamic and engaging introductory biology course, regardless of course delivery format. This goal can be achieved through the recognition of a key player in the learning process, the instructor. According to Dr. Jay Caulfield, Associate Dean of Marquette University's College of Professional Studies and author of a text on how to design and teach hybrid classes, the quality of the instruction, no matter what the means of delivery, had the greatest effect on a student's performance and overall

retention (Burnsed, 2011). Outstanding individuals are teaching F2F, hybrid, and online sections of introductory biology courses and other subjects every day, sharing their passion for education with each student they have the privilege to instruct.

Appendix A



Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Joyce Hill successfully completed the NIH Web-based training course "Protecting Human Research Participants"

Date of completion: 06/25/2012

Certification Number: 943077

Appendix B

Lindenwood University

School of Education

209 S. Kingshighway
St. Charles, Missouri 63301

Permission Letter from Institution

(Date)

Dear _____

I am conducting a research study titled, "Student Success and Perceptions of Course Satisfaction in Face-to-Face, Hybrid, and Online sections of Introductory Biology Courses at Open Enrollment, Two-Year Colleges in Southern Missouri" in partial fulfillment of the requirement for a doctoral degree at Lindenwood University.

The purpose of this research is to determine if significant differences in academic success, and student perceptions of course satisfaction exist among groups of students enrolled in introductory biology classes presented face-to-face, hybrid, or entirely online.

I am seeking your permission to contact the faculty and staff at your institution to determine if they might be interested in participating in this study.

Participation in the study is completely voluntary. The participants may withdraw from the study at any time without penalty. The identity of the participants and the institution will remain confidential and anonymous in the dissertation or any future publications of this study.

Please do not hesitate to contact me with any questions or concerns about participation in the study. A copy of this letter and your written consent should be retained by you for future reference.

Yours truly,

_____

Joyce Hill, Doctoral Candidate at LU

Permission Form

I, _____ grant permission for the instructors and staff of _____to be contacted regarding participation in the study, "Student Success and Perceptions of Course Satisfaction in Face-to-Face, Hybrid, and Online sections of Introductory Biology Courses at Open-Enrollment, Two-Year Colleges in Southern Missouri," by Joyce Hill.

By signing this permission form, I understand that the following safeguards are in place to protect those who choose to participate:

1. The participants may withdraw from the study at any time without penalty.
2. The identity of the participants and the institution will remain confidential and anonymous in the dissertation or any future publications of this study.

I have read the information above, and any questions that I have posed have been answered to my satisfaction.

_____ _____

Signature Date

Appendix C

LINDENWOOD

LINDENWOOD UNIVERSITY ST. CHARLES, MISSOURI

DATE:	February 13, 2013
TO:	Joyce Hill
FROM:	Lindenwood University Institutional Review Board
STUDY TITLE:	[417703-1] Student Success and Perceptions of Course Satisfaction in Face-to-Face, Hybrid, and Online Sections of Introductory Biology Courses at Open Enrollment, Two-Year Colleges
IRB REFERENCE #:	
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	February 13, 2013
EXPIRATION DATE:	February 13, 2014
REVIEW TYPE:	Expedited Review

Thank you for your submission of New Project materials for this research project. Lindenwood University Institutional Review Board has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to the IRB.

This project has been determined to be a Minimal Risk project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the completion/amendment form for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of February 13, 2014.

Appendix D

Lindenwood University
School of Education
209 S. Kingshighway

St. Charles, Missouri 63301

<Instructor Consent>

Informed Consent for Participation in Research Activities

"Student Success and Perceptions of Course Satisfaction in Face-to-Face, Hybrid, and Online Sections of Introductory Biology Courses at Open Enrollment, Two-Year Colleges in Southern Missouri."

Principal Investigator: Joyce Hill Telephone: (417) 447-6676 Email: hillj@otc.edu

Participant: _____ Contact Information _____

1. You are invited to participate in a research study conducted by Joyce Hill under the guidance of Dr. Sherry DeVore. The purpose of this research is to determine if there are significant differences in student success and perceptions of course satisfaction with introductory biology courses presented in three different course delivery formats.
2. a) Your participation will involve administering a pre-course and post-course assessment, reporting the final course grades and numbers of students who withdraw from select sections of introductory biology courses at your institution beginning with the spring, 2013, semester. Students who volunteer to participate in the study may also be asked to serve in a focus group that will meet one time during the semester to discuss their introductory biology course.

   b) The amount of time involved in your participation will be approximately two hours total time over the course of the spring, 2013, semester.

   Approximately 50 students from your institution will be involved in this research. There are three research sites participating in the study, with a total student population of approximately 350.

3. There are no anticipated risks associated with this research.
4. There are no direct benefits for you participating in this study. However, your participation will contribute to the knowledge about effective delivery of introductory science courses at two-year colleges.
5. Your participation is voluntary and you may choose not to participate in this research study or to withdraw your consent at any time. You may choose not to answer any questions that you do not want to answer. You will NOT be penalized in any way should you choose not to participate or to withdraw.
6. We will do everything we can to protect your privacy. As part of this effort, your identity will not be revealed in any publication or presentation that may result from this study and the information collected will remain in the possession of the investigator in a safe location.
7. If you have any questions or concerns regarding this study, or if any problems arise, you may call the Investigator, Joyce Hill at (417) 447-6676 or the Supervising Faculty, Dr. Sherry DeVore at (417) 881-0009. You may also ask questions of or state concerns regarding your participation to the Lindenwood Institutional Review Board (IRB) through contacting Dr. Jann Weitzel, Vice President for Academic Affairs, at 636-949-4846.

I have read this consent form and have been given the opportunity to ask questions. I will also be given a copy of this consent form for my records. I consent to my participation in the research described above.

_____ _____

Participant's Signature Date Participant's Printed Name

_____ _____

Signature of Principal Investigator Date Investigator Printed Name

Appendix E

Lindenwood University

School of Education
209 S. Kingshighway

St. Charles, Missouri 63301

<Student Consent>

Informed Consent for Participation in Research Activities

"Student Success and Perceptions of Course Satisfaction in Face-to-Face, Hybrid, and Online Sections of Introductory Biology Courses at Open Enrollment, Two-Year Colleges in Southern Missouri"

Principal Investigator: Joyce Hill Telephone: (417) 447-6676 E-mail: hillj@otc.edu

Participant: _____ Contact Information _____

1. You are invited to participate in a research study conducted by Joyce Hill under the guidance of Dr. Sherry DeVore. The purpose of this research is to determine if there are significant differences in student success and perceptions of course satisfaction with introductory biology courses presented in three different course delivery formats.
2. a) Your participation will involve completing a pre-course and post-course survey of the introductory biology course at your institution (beginning with the 2013 spring semester). If you choose to participate in the study, you may also be asked to consider participating in a focus group that will meet one time during the semester to discuss the introductory biology course. The focus group interviews will be audio taped for accuracy.

   If I participate in the focus group interview, I give my permission for the interview to be audio taped. (Participant's initials: _____)

   b) The amount of time involved in your participation will be approximately 10-15 minutes to complete the survey. The amount of time allowed for the focus group interview is approximately 45 minutes.

Approximately 50 students from your institution will be involved in this research. There are three research sites participating in the study, with a total student population of approximately 350.

3. There are no anticipated risks associated with this research.
4. There are no direct benefits for you participating in this study. However, your participation will contribute to the knowledge about effective delivery of introductory science courses at two-year colleges.
5. Your participation is voluntary and you may choose not to participate in this research study or to withdraw your consent at any time. You may choose not to answer any questions that you do not want to answer. You will NOT be penalized in any way should you choose not to participate or to withdraw.
6. We will do everything we can to protect your privacy. As part of this effort, your identity will not be revealed in any publication or presentation that may result from this study and the information collected will remain in the possession of the investigator in a safe location.
7. If you have any questions or concerns regarding this study, or if any problems arise, you may call the Investigator, Joyce Hill at (417) 447-6676 or the Supervising Faculty, Dr. Sherry DeVore at (417) 881-0009. You may also ask questions of or state concerns regarding your participation to the Lindenwood Institutional Review Board (IRB) through contacting Dr. Jann Weitzel, Vice President for Academic Affairs, at 636-949-4846.

I have read this consent form and have been given the opportunity to ask questions. I will also be given a copy of this consent form for my records. I consent to my participation in the research described above.

_____ _____

Participant's Signature Date Participant's Printed Name

_____ _____

Signature of Principal Investigator Date Investigator Printed Name

Appendix F

Introductory Biology Precourse and Postcourse Assessment: SP13

Name: _____ Section #:_____

1. True or False _____

The control group in a scientific study serves as a standard against which experimental groups are compared.

2. Multiple Choice _____

Which of the following represents the correct order of increasing complexity within living systems?

A. cell, molecule, organ, tissue

B. organ, tissue, cell, molecule

C. tissue, organ, molecule, cell

D. molecule, cell, tissue, organ

3. Matching: Match the following structures in eukaryotic cells with their function.

_____ organelle where DNA is located

_____ site of protein synthesis

_____ not present in animal cells

_____ site of photosynthesis

A. cell wall

B. chloroplast

C. ribosomes

D. nucleus

4. Multiple Choice _____

The balanced chemical equation for __ is: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + Energy$

A. photosynthesis B. cellular respiration C. fermentation D. hydrolysis

5. Multiple Choice _____

The correct order for the four stages of mitosis is:

A. prophase – anaphase – telophase – metaphase

B. prophase – metaphase – anaphase – telophase

C. metaphase – telophase – anaphase – prophase

D. metaphase – prophase – anaphase – telophase

6. True or False _____

Sunlight is the primary source of energy for a majority of the Earth's ecosystems.

7. Multiple Choice _____

Which of the following are characteristics of living organisms?

A. They acquire and use materials and energy from the environment.

B. They have a complex, organized structure consisting of organic molecules.

C. They grow and respond to stimuli in their environment.

D. All of the above.

8. True or False _____

The carbon cycle is becoming unbalanced due to increased production of CO_2.

Appendix G

Student Survey Questions: Remark Online Survey & Focus Group Discussions
Demographic Information:

1. Please tell me a little bit about yourself, as a person, and as a student:
2. What degree or certificate are you pursuing?
3. Do you plan on transferring to another institution after you complete your degree?

   If yes, indicate where you will be transferring to:
4. How many total credit hours are you enrolled in this semester? _____
5. How many total credit hours of higher education coursework have you completed, including this semester? _____
6. Of the courses you have completed, which of the following formats were your courses delivered in? Place a checkmark by one of the following:

   ___ All classes have been in a seated or "Face-to-Face" format.

   ___ All classes have been delivered online.

   ____ All classes have been in a hybrid or "blended" format.

   ____ I have been enrolled in a mix of seated, hybrid and online classes.

Questions Specific to Students Enrolled in F2F, Hybrid or Online Biology Courses:

1. Are you enrolled in a Face-to-Face, hybrid or fully online version of this course? (Check one):

   _____ Face-to-Face course format

   _____ Hybrid / Flex / Blended course format

   _____ Online course format
2. Is this your first course in this delivery format? _____ (Yes or No)

   A. If yes, why did you elect to take this course in this format this semester?

   B. If no, how many other courses in this format have you completed? _____
3. On average, how many hours do you spend on this course per week? _____
4. How satisfied are you with the lecture component of this course? (Check one):

   _____ Very satisfied

   _____ Satisfied

   _____ Neutral

   _____ Somewhat Dissatisfied

   _____ Very Dissatisfied

5. How satisfied are you with the laboratory component of this course? (Check one):

_____ Very satisfied

_____ Satisfied

_____ Neutral

_____ Somewhat Dissatisfied

_____ Very Dissatisfied

6. Overall, how would you rate this introductory biology course? (Check one):

_____ Very satisfied

_____ Satisfied

_____ Neutral

_____ Somewhat Dissatisfied

_____ Very Dissatisfied

7. What strategies has the instructor used to build a "sense of community" among the students in your introductory biology course this semester?

8. What did you enjoy the most about this course this semester?

9. What did you enjoy the least about this course this semester?

10. What areas of improvement would you suggest for future sections of this course?

11. Would you consider taking this course in another format (F2F, hybrid or online)? Why or why not?

12. Would you recommend this course, in this format, to another student? Why or why not?

References

Allen, E., & Seaman, J. (2011). *Going the distance: Online education in the United States, 2011*. Retrieved from http://sloanconsortium.org/publications/survey/survey04.asp

American Association for the Advancement of Science. (2010). *Vision and change in undergraduate biology education: A call to action*. Washington, DC: Author. Retrieved from http://visionandchange.org/

American Association of Community Colleges. (2012). *Community college fact sheet* Retrieved from http://www.aacc.nche.edu/Aboutcc/Pages/fastfacts.aspx

American Association of Community Colleges. (2012). *Reclaiming the American dream: A report from the 21st century commission on the future of community colleges.* Washington, DC: Author. Retrieved from http://www.aacc.nche.edu/21stCenturyReport

Andre, K. (2000). *Social constructivism and the philosophy of science*. London, England. Routledge.

Angelo, T., & Cross, P. (2010). *Classroom assessment techniques: A handbook for college teachers.* 2nd.ed. San Francisco, CA: Jossey-Bass.

Annetta, L., Klesath, M., & Meyer, J. (2009). Taking science online: Evaluating presence and immersion through a laboratory experience in a virtual learning environment for entomology students. *Journal of College Science Teaching, 39*(1), 27-33.

Aoun, J. (2011). Learning today: The lasting value of place. *The Chronicle of Higher Education*. Retrieved from http://chronicle.8080/article/In-Learning-

Aragon, S., & Johnson, E. (2008). Factors influencing completion and noncompletion of community college online courses. *The American Journal of Distance Education, 22*(3). 146-158.

Ayala, J. (2009). Blended learning as a new approach to social work education. *Journal of Social Work Education, 45*, 277-288.

Azaiza, K. (2010). Blended learning in higher education: Framework, principals, and guidelines, by D. Randy Garrison and Norman D. Vaughan. *The Quarterly Review of Distance Education, 11*(4), 285-287.

Battalio, J. (2009). Success in distance education: Do learning styles and multiple formats matter? *The American Journal of Distance Education, 23*, 71-78. doi:10.1080/08923640902854405

Bluman, A. (2009). Elementary statistics: A step by step approach (7th ed.). New York, NY: McGraw-Hill.

Boyles, L. (2000). *Exploration of a retention model for community college students*. (Doctoral Dissertation). Greensboro, N.C.: The University of North Carolina. UMI No. 9972048

Brownell, S., Kloser, M., Fukami, T., & Shavelson, R. (2012). Undergraduate biology lab courses: Comparing the impact of traditionally based "cookbook" and authentic research-based courses on student lab experiences. *Journal of College Science Teaching, 41*(4), 36-45.

Burnsed, B. (2011). Your professor, your computer, you. *U.S. News and World Report*. Retrieved from: http://www.usnews.com/education/onlineeducation/articles/2011/01/26/

Burrowes, P., & Nazario, G. (March/April, 2008). Promoting student learning through the integration of lab and lecture. *Journal of College Science Teaching*, 18-23.

Carr, S. (2000). Science instructors ask: Can you teach students at a distance how to use a microscope? *The Chronicle of Higher Education*. Retrieved from http://chronicle.com:8080/article/Science-Instructors-Ask-Can/27448/

Census data. (2011). Retrieved from www.census.gov

Center for Community College Student Engagement. (2010). *The heart of student success: Teaching, learning, and college completion – 2010 CCCSE findings*. Austin, TX: University of Texas at Austin, Community College Leadership Program.

Cheek, J., & Schutt, R. (2012). *Research design and data collection.* Boston, MA: Sage Publications, Inc.

Cozby, P., & Bates, S. (2012). *Methods in behavioral research* (11th ed.), New York, NY: McGraw-Hill.

Creswell, J. (2009) *Research design: Qualitative, quantitative, and mixed methods.* (3rd ed.). Thousand Oaks, CA: Sage.

Creswell, J. (2007). *Qualitative inquiry and research design* (2nd ed.). Thousand Oaks, CA: Sage.

Creswell, J., & Garrett, A. (2008). The movement of mixed methods research and the role of educators. *South African Journal of Education*, *28*, 321-333.

Davis, K., & Snyder, W. (2012). Fostering science education in an online environment: Are we there yet? *Journal of College Science Teaching, 42*(2), 24-31.

Demir, A., Schmidt, F., Abell, S. (2010). Science from the pond up: Using measurement to introduce inquiry. *Journal of College Science Teaching, 39*(4), 23-27.

Detwiler, J. (2008). Comparing student performance in online and blended sections of a GIS programming class. *Transactions in GIS (1)*, 131-144.

Dixson, M., (2010). Creating effective student engagement in online courses: What do students find engaging? *Journal of the Scholarship of Teaching and Learning, 10*(2), 1-13.

Edgcomb, M., Britner, S., McConnaughay, K., & Wolffe, R. (September/October, 2008). Science 101: An integrated, inquiry-oriented science course for education majors. *Journal of College Science Teaching,* 22-27.

El Mansour, B., & Mupinga, D. (2007). Student's positive and negative experiences in hybrid and online classes. *College Student Journal 41*(1), 242-248.

Fata-Hartley, C. (2011). Resisting rote: The importance of active learning for all course learning objectives. *Journal of College Science Teaching, 40*, 36-39.

Feder, M. (2012). One decade, one million more STEM graduates. The White House. Retrieved from http://www.whitehouse.gov/blog/2012/12/18/one-decade-one-million-more-stem-graduates

Fike, D., & Fike, R. (2008). Predictors of high risk among community college telecourse students. *The American Journal of Distance Education, 5*(1): 24-35.

Fisher, D., Ross, D., & Grant, M. (2010). Building background knowledge. *Science Teacher, 77*(4), 23-26.

Flowers, L. (2011). Online courses can be used to boost minority numbers in STEM fields. *Diverse Issues in Higher Education 28*(22), 19.

Fraenkel, J., Wallen, N., & Hyun, H. (2012) *How to design and evaluate research in education* (8th ed.), Boston, MA: McGraw-Hill.

Gerbic, P. (2011). Teaching using a blended approach – What does the literature tell us? *Educational Media International*, *48*(3), 221-234.

Gergen, K. (1985). The social constructionist movement in modern psychology. *American Psychologist*, *40*(3), 266-275.

Gill, R. (2011). Effective strategies for engaging students in large-lecture, nonmajors science courses. *Journal of College Science Teaching, 41*(2), 14-21.

Gooding, J., & Metz, B. (2012).Folding inquiry into cookbook lab activities. *Science Scope*, National Science Teachers Association.

Gunawardena, C., & McIssac, M. (2004). Distance education. In D. H. Jonassen (Ed.), *The handbook of research in educational communications and technology* (2nd ed.).Mahwah, NJ: Lawrence Erlbaum.

Harrell, I., & Bower, B. (2011).Student characteristics that predict persistence in community college online courses. *The American Journal of Distance Education, 25,* 178-191.
doi: 10.1080/08923647.2011.590107

Howell, S.(2009). Distance learning in higher education: A programmatic approach to planning, design, instruction, evaluation, and accreditation. *Quarterly Review of Distance Education, 10*(2), 239-250.

Instructional Technology Council. (2012).Distance education survey results. *Trends in eLearning: Tracking the impact of eLearning at Community Colleges*. Washington, DC: ITC.

Internet World Statistics. (2011). Internet usage statistics, the internet big picture. Retrieved from http://www.internetworldstats.com/stats.htm

Jenkins, R. (2011). Why are so many students still failing online? *The Chronicle of Higher Education*, *5*(22) Retrieved from http://chronicle.com.8080/article/Why-Are-So-Many-Students-Still/127584/

Koeller, M. (2012). From baby boomers to generation Y millennials: Ideas on how professors might structure classes for this media conscious generation. *Journal of Higher Education Theory and Practice*, *12(1)*.

Krueger, R., & Casey, M., (2009). *Focus groups: A practical guide for applied Research* (4th.ed.). Thousand Oaks, CA: Sage.

Lawrence, F. (2011). Online courses can be used to boost minority numbers in STEM fields. *Diverse Issues in Higher Education*, *28*(22), 19.

Lear, J. (Spring/Summer, 2009). Instructor presence for web-based classes. *The Delta Pi Epsilon*. *51*(2), 86-98.

Lents, N., & Cifuentes, O. (2009). Web-based learning enhancements: Video lectures through voice-over PowerPoint in a majors-level biology course. *Journal of College Science Teaching, 39* (2), 38-46.

Lynch, D. (2010). Application of online discussion and cooperative learning strategies to online and blended college courses. *College Student Journal*, *44*(3), 777-784.

Lytle, R. (2011). Study: Online education continues growth. *US News and World Report* Retrieved from http://www.usnews.com/education/online Education/articles/2011/11/11/study-online-edu/

MacQueen, H., & Thomas, J. (2009). Teaching biology at a distance: Pleasures, pitfalls, and possibilities. *The American Journal of Distance Education, 23,* 139-150.

Mangan, K. (2012). Open education's wide world of possibilities. *The Chronicle of Higher Education*. Retrieved from http://chronicle.com:8080/article/Open-Educations-Wide-World/

Marklein, M. (2012). College may never be the same. *USA Today*, Retrieved from http://usatoday30.usatoday.com/news/nation/story/2012/09/12/college-may

Matsumura, L., Slater, S., & Crosson, A. (2008). Classroom climate, rigorous instruction and curriculum, and students' interactions in urban middle schools. *The Elementary School Journal*, *108*(4), 294-312.

McLeod, S. (2008). *Social Identity Theory – Simply Psychology*. Retrieved from http://www.simplypsychology.org/social-identity-theory.html

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies.* U.S. Department of Education. Retrieved from http://www2.ed.gov./rschstat/eval/tech/evidence-based-practices/finalreport.pdf

Mickle, J., & Aune, P. (May/June, 2008). Development of a laboratory course in nonmajors' general biology for distance education. *Journal of College Science Teaching*. 35-39.

Miller, S., Pfund, C., Pribbenow, C., & Handelsman, J. (2008). Scientific teaching in practice. *Science,* 322.

Mills-Patterson, S., Turnbull-Chavaux, T., & Helvey, R. (September 21-23, 2011). *Defining high-quality online participation at its roots.* Presented at the Midwest Research-to-Practice Conference in Adult, Continuing, Community and Extension Education, Lindenwood University, St. Charles, MO.

Moore, R. (Jan.-Feb., 2008). Are students' performances in labs related to their performances in lecture portions of introductory science courses? *Journal of College Science Teaching*, 66-70.

Muchovej, J. (2009). Online quizzes as a study tool for biology for non-science majors. *Education*, *130*(1), 133-140.

National Academy of Sciences. (2010). *A new biology for the 21st century: Ensuring the United States leads the coming biology revolution*. Washington, DC: National Academies Press. Retrieved from http://www.nap.edu/catalog.

Online Learning. (2010). *Science Teacher*, *77*(6), 26-28.

Oram, F. (2006). *Peterson's guide to online learning*. Lawrenceville, NJ: Thomson Peterson's.

Osguthorpe, R., & Graham, C. (2003). Blended learning environments: definitions and directions. *Quarterly Review of Distance Education*, *4*, 227-233.

Palincsar, A. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology* (49), 345-375.

Parry, M. (2009). They thought globally, but now colleges push online programs locally. *The Chronicle of Higher Education*. Retrieved from http://chronicle.com:8080/article/They-Thought-Globally-but-Now/46982/

Parry, M. (2010). Tomorrow's college. *The Chronicle of Higher Education*. Retrieved From http://chronicle.com.my.otc.edu:8080/article/Tomorrows-

Partin, M., Haney, J., Worch, E., Underwood, E., Nurnberger-Haag, J., Scheuermann, A., & Midden, W. (2011). Yes I can: The contributions of motivation and attitudes on course performance among biology nonmajors. *Journal of College Science Teaching*, *40*(6), 86-95.

Patton, M. (2002). *Qualitative research & evaluation methods*. Thousand Oaks, CA: Sage Publications, Inc.

Project Tomorrow Survey. (2011). The new 3 E's of education: Enabled, engaged, empowered how today's educators are advancing a new vision for teaching and learning. Retrieved from http://www.tomorrow.org/speakup/pdfs/SU10_3EofEducation/

Reuter, R. (2009). Online versus in the classroom: Student success in hands-on lab class. *American Journal of Distance Education*, *23*(3), 151-162.

Rosenbaum, J., Redline, J., & Stephan, J., (2007). Community college: The unfinished revolution. *Issues in Science and Technology*. Retrieved from http://www.issues.org/23.4/rosenbaum.html

Schwab, Z. (2013). Growing STEM students: How late nite labs' online platform is spreading science and saving schools' resources, *Journal of Educational Technology Systems,41*(4), 333-345.

Serhan, D. (2010). Online learning: Through their eyes. *International Journal of Instructional Media 37*(1): 19-24.

Shwartz, Y., Weizman, A., Fortus, D., Sutherland, L., Merrit, J., & Krajcik, J. (2009). Talking science: Classroom discussions and their role in inquiry-based learning environments. *The Science Teacher*, 44-47.

Stacey, E., & Gerbic, P. (2009). Introduction of blended learning practices. In E. Stacey & P. Gerbic (Eds.), *Effective blended learning practices: Evidenced-based perspectives in ICT-Facilitated education* (pp. 1-20). Hershey, PA: Information Science Reference.

Swan, A.,& O'Donnell, A. (2009). The contribution of a virtual biology laboratory to college students' learning. *Innovations in Education and Teaching International*, *46*(4), 405-419.

Toth, E., Morrow, B., & Ludvico, L. (2009). Designing blended inquiry learning in a laboratory context: A study of incorporating hands-on and virtual laboratories. *Innovations in Higher Education, 33,* 333-344. doi: 10.1007/s10755-008-9087-7

Triola, M. (2006*). Elementary statistics* (10th ed.) Lebanon, IN: Pearson.

Turner, S., & Peck, D. (2009). Can we do school science better? Facing the problem of student engagement. *Education Canada*, *49,* 54-57.

Vaughan, G. (2006). *The community college story: A tale of American innovation*. (3rd ed.). Retrieved from http://www.aacc.nche.edu/AboutCC/history/Pages/significantevents.aspx

Wilson, M., & Gerber, L. (2008). How generational theory can improve teaching: Strategies for working with the "Millennials." *Currents in Teaching and Learning*, *1*(1), 29-44.

Weber, K., Maher, C., Powell, A., & Lee, H. (2008). Learning opportunities from group discussions: Warrants become the objects of debate. *Educational Studies in Mathematics, 68*(3), 247-261.

Webley, K. (2012). Reboot the school. *Time, 180*(2), 36-41.

Wood, W. (2009). Innovations in teaching undergraduate biology and why we need them. *Annual Review of Cell and Developmental Biology, 25,* 93-112.

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