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Students' Performance, Satisfaction and Retention in a Hybrid and Traditional Face-To-Face Science Course, Principles of Biology I, in a Community College

Abdallah Mohammad Matari
abdallah.matari@student.shu.edu

STUDENTS' PERFORMANCE, SATISFACTION AND RETENTION IN A HYBRID AND TRADITIONAL FACE-TO-FACE SCIENCE COURSE,

PRINCIPLES OF BIOLOGY I, IN A COMMUNITY COLLEGE

BY

Abdallah Mohammad Matari

Dissertation Committee

Dr. Genevieve Pinto Zipp (Chair)

Dr. Terrence Cahill

Dr. Deborah Deluca

Dr. Javad Tavakoli

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APPROVAL FOR SUCCESSFUL DEFENSE

Doctoral Candidate, **(Abdallah Mohammad Matari)**, has successfully defended and made required modifications to the text of the doctoral dissertation for the **Ph.D.** during the **(Spring) Semester (2020).**

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(please sign and date beside your name)

Chair:

(Genevieve Pinto Zipp, PT, EdD March 9, 2020) Genevieve Pinto Zipp PT, EdD

Committee Member

(Terrence F.Cahill, EdD, FACHE. March 9, 2020) Terrence F Cahill EdD, FACHE

Committee Member

(Deborah A. Deluca, MS, CHE, JD March 9, 2020) Deborah DeLuca

Committee Member

(Javad Tavakoli, PhD, PE March 9, 2020) Javad Tavakoli

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DEDICATION

This work is dedicated to my family, parents, graduate advisors and friends, for their encouragements during this study.

Prophet Mohammad (PBUH) said “God, His angels and all those in Heavens and on Earth, even ants in their hills and fish in the water, call down blessings on those who instructor others in beneficial knowledge”

“Everything diminishes when it is used except knowledge.” (Imam Ali)

Special Dedication

In addition, I wish to dedicate this work to the selfless and heroic acts of health care professionals throughout the world-doctors, nurses, ambulance workers, firefighters and many more that have been on the front line and are fighting this vicious virus (COVID-19). In this mission they are risking their lives daily and some have fallen. May God (Allah) grant them the highest rewards for the sacrifices they have made and are making.

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ABSTRACT

Hybrid teaching, comprised of both in-class and online teaching, is rapidly becoming a favorite mode of teaching and learning. Online and hybrid courses on have become more and more appealing to both higher education institutions and the students they serve. In particular, hybrid teaching has an increase appeal to community colleges as they serve a diverse student population with varied academic levels, cultural background, and personal responsibilities. Hybrid courses promotes flexibility in course scheduling options for students and enables institutions to accept more students without worrying about physical classroom space concerns. This study explored and compared students' learning outcomes, satisfaction, and retentions for students enrolled in a hybrid versus a traditional face-to-face lab science course in an urban community college. The same instructor taught all sections of the course under both delivery modes and the same course syllabi and grading scale were used.

The first research question assessed students' learning outcomes utilizing standard assessment tools such as assignments, laboratory reports, laboratory exams, quizzes, midterm and final exams. No significant differences were observed in scores between the two modes for assignments, laboratory exams, and midterm exams. Traditional face-to-face students scored higher than the hybrid students in laboratory reports and final exams where the students in hybrid mode did better in quizzes than students in face to face. The second research question assessed students' satisfaction via a questionnaire. Traditional students revealed a positive satisfaction with their course where hybrid students presented more neutral and/or negative satisfaction. The third research question evaluated students' retention. Data revealed that traditional face-to-face students' retention was higher than students enrolled in the hybrid sections.

CHAPTER I

INTRODUCTION

Background

Community colleges are institutions of higher education that as reported by the American Association of Community Colleges (2012) serve more than half the population of undergraduate students in the United States. According to Muilin (2012) community colleges are the primary source of higher education for students from underrepresented populations and serve students from low income families, students of color, and first generation college students. Community college students are different from those who enter the university directly following high school as most are non-traditional students who have responsibilities at home and work full or part time, causing them to take one or two classes that can fit into their schedules. The National Center for Education (2010) reports that, 84% of community college students, work. Portillo's (2011) identified several factors that can affect community college students' college experience such as financial stress, mismatch to the program of study, poor time management, and job obligations. In addition, time allocation to academics and connection to the campus life can be a challenge for working students as job demands never disappear and personal life responsibilities needs attention on the spot.

The community college's open-door policy allows all individuals with a high school diploma or GED, regardless of their past educational experience, to pursue a college degree. Wilmer (2008) asserts that underprepared college students often experience difficulty-making connections within the academic environment and present a lack of academic direction and uncertainty in their academic goals. To address these concerns, professors in the community college often employ diverse teaching strategies to meet the needs of their unique population of students. The student population within community colleges are truly diverse with students' average mean age of 28, 16% being single parents and 59% working part time (LIoyed- Smith, 2010). To meet their students' needs, community college classes are traditionally smaller, allowing for more active learning activities and student engagement in the classroom. Interestingly, Crawford et al (2014), suggested that community colleges are becoming more overcrowded, and underfunded and thus may impact their ability to offer smaller class sizes moving forward.

Historically, in the Academy the professor delivers information to students in a large lecture hall at specific times and days of the week, with the students being responsible for gathering the information presented and regurgitating it later on an examination. This type of teacher-focused instruction can be a challenge to learners, especially for non-traditional students most of whom have jobs and family responsibilities while pursuing their higher education.

Over the past few decades, the Academy has infused a more student focused teaching approach to address the needs of adult learners. Specifically, one of the more prevalent student-focused approaches to learning is online learning. Ahalt et al. (2014)

argued that technology has the potential to help alleviate many of challenges facing today's higher education system, including the use of teacher focused lecture delivery formats. In their white paper, the authors provide a brief overview of 10 emerging technologies that they believe would enhance higher education (the Academy) by providing more of a student focused online learning environment that would better prepare students for the up and coming technology dominated societies. Some of the technologies noted were: electronic textbooks (E-textbooks), simulation technology, active learning classrooms, massive open online courses (MOOCs), collaborative distance learning environments, the active learning forum platform, learning management systems (LMSs), and computerized grading (Ahlat et al, 2014). Clearly technological innovations are now changing the way community colleges and universities teach, and students learn.

Some experts believe that in the future, the traditional classroom setting and face-to-face relationships between professor and students will become outdated (O'Malley & McCraw, 1999). Distance Education (online) is in such demand that offering online and hybrid classes on different subjects, has become more and more appealing to both, institutions and students. Providing the flexibility of scheduling and the ability to reach many students without worrying about classroom space makes hybrid classes very attractive to all academic institutions including community colleges. One teaching and learning model employed has been to offer courses in a hybrid format. According to Crawford et al (2014), the hybrid approach offers a large percentage of the course online with the remainder in class using the face-to-face instruction method. Offering courses via a hybrid learning model reduces the burden of on campus facilities by decreasing the secondary effects resulting from overcrowding in community colleges. Decreasing overcrowding can be especially very advantageous in science courses that require laboratory activities. Specifically, colleges can offer more course sections when courses are offered in hybrid format since non-laboratory activities can be done online, leaving the students to only access college classroom space for hands on laboratory activities. While, hybrid courses can aid in managing the on campus overcrowding it also can support the students' need for flexibility to manage and balance life, work and education. Hybrid format enables students to access the online portion of the course anytime, anywhere and thus provides students more flexibility in balancing life and work responsibilities.

The Sloan Foundation defines a hybrid course as a course with an average of 50% online coursework (Diaz, 2011). The inclusion of hybrid, or as some call it a blended class, provides an avenue for community college institutions to both maximize utilization of their limited resources and meet the educational needs of their students (Gould, 2003). A recent meta-analysis released by the Department of Education provides academic support for the expansion of blended delivery courses (LIoyd-Smith, 2010) especially in community colleges seeking to meet the needs of today's student population while offsetting the rise financial operations cost of the institution.

Statement of the Problem

The hybrid teaching/learning method could eventually become the norm in higher education as Young (2002), who examined hybrid and fully online teaching at several institutions, concluded. The integration of online and face-to-face activities suggest that learners' characteristics, learning goals, available resources, and faculty characteristics all need to be considered because they are essential to the quality of blended learning experiences. Garnham and Kaleta (2002) identified pedagogical richness, access to knowledge, social interaction, personal interactions, cost-effectiveness and ease of course revision, as key components to the quality of hybrid courses. However, some have argued that this emerging mode may not be fit for community college students as indicated by Muilin (2012) and Barker & Syam (2014), because the majority of community college attendees are nontraditional students with insufficient study and time management skills and motivation to learn.

In the literature, the Hybrid model has been found to result in several positive effects on classroom dynamics and interactions which ultimately lead to better student understanding of course content and increased student preparedness for class. In hybrid learning the online modules promoted consistency and flexibility of use and aided in building a community among the students. Students' perception of the hybrid model of learning is variable in the literature. Hoch and Dougher (2011) conducted a case study in a four-year institution to better understand students' perceptions of hybrid vs. traditional face-to-face courses and concluded that the majority of students favored the traditional format experience over the hybrid model due to reduced instructor contact. Alternately, Hoch and Dougher (2011) reported that 75% of the students in their study preferred the hybrid format because of the independence presented in the hybrid format. Literature review demonstrated limited studies comparing learning outcomes for the two modes of teaching in urban community colleges.

Purpose of the Study

The purpose of this study is to understand the academic benefit and student perceptions regarding the use of hybrid model of learning for biological science content at a community college. Specifically, the study compares students' performance in hybrid vs traditional community college science course, as measured by their grades on assignments, quizzes, lab reports, lab exams, midterm and final exams as well as course grade. In addition, students' satisfaction with two learning models, hybrid and traditional-face-to-face will be explored (Charbran et al, 2010).

Research Questions

RQ1: Is there a difference between hybrid and traditional face-to-face community college science course (BIO 115) **learning outcomes** as measured by students' grades on assignments, laboratory: reports and exams, quizzes, midterm & final exams and course grades?

RQ2: Is there a difference between hybrid and traditional face-to-face science course (BIO 115) in community college student **satisfactions** as measured by data collected from the end of semester survey?

RQ3: Is there a difference between hybrid and traditional face-to-face science course (BIO115) **retention rates** as measured by examining the number of students who withdrew from the course in each section?

Research Hypothesis

Ho1A: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in assignments, when compared to the equivalent traditional face-to-face science course.

Ha1A: There is difference between hybrid science course students' knowledge acquisition as determined by their scores in assignments, when compared to the equivalent traditional face-to-face science course.

Ho1B: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in laboratory reports, when compared to the equivalent traditional face-to-face science course.

Ha1B: There is difference between hybrid science course students' knowledge acquisition as determined by their scores in laboratory reports, when compared to the equivalent traditional face-to-face science course.

Ho1C: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in laboratory exams, when compared to the equivalent traditional face-to-face science course.

Ha1C: There is difference between hybrid science course students' knowledge acquisition as determined by their scores in laboratory exams, when compared to the equivalent traditional face-to-face science course.

Ho1D: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in quizzes, when compared to the equivalent traditional face-to-face science course.

Ha1D: There is difference between hybrid science course students' knowledge acquisition as determined by their scores in quizzes, when compared to the equivalent traditional face-to-face science course.

Ho1E: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in midterm exam, when compared to the equivalent traditional face-to-face science course.

Ha1E: There is difference between hybrid science course students' knowledge acquisition as determined by their scores in midterm exam, when compared to the equivalent traditional face-to-face science course.

Ho1F: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in final exam, when compared to the equivalent traditional face-to-face science course.

Ha1F: There is difference between hybrid science course students' knowledge acquisition as determined by their scores in final exam, when compared to the equivalent traditional face-to-face science course.

Ho1G: There is no difference between hybrid science course students' knowledge acquisition as determined by their course grades, when compared to the equivalent traditional face-to-face science course.

Ha1G: There is difference between hybrid science course students' knowledge acquisition as determined by their scores in course grades, when compared to the equivalent traditional face-to-face science course.

Ho2: Community college student satisfactions in hybrid science course is equivalent to traditional face-to-face course as measured by data collected from end of semester survey.

Ha2: Community college student satisfactions in hybrid science course is not equivalent to traditional face-to-face course as measured by data collected from end of semester survey.

Ho3: Retention rate in hybrid science course is equivalent to traditional face-to-face science course in community college as measured by examining students that withdrew from each course.

Ha3: Retention rate in hybrid science course is not equivalent to traditional face-to-face science course in community college as measured by examining students that dropped or withdrew from each course.

Significance of the Study

Findings from this study will provide community college administrators, faculty and students with a clear understanding of the potential influence of hybrid learning in a science course specific to the following parameters:

A- Students preference in selecting the mode of lecture delivery (traditional or hybrid)

B- Students awareness of the differences between the two modes of lecture delivery (hybrid courses are more student centered)

C- Relative knowledge gained by students attending either hybrid or traditional face-to-face sections

Operational Definitions

For the purpose of this study, the following definitions apply:

Community college: Institutions of higher education that serve more than half of the undergraduate student population in the United States according to the American Association of Community Colleges (2012)

Hybrid course: A blended learning course that combines multiple delivery modes designed to complement each other and promote learning (Singh, 2003).

Conceptual Framework

One of the important aspects of education is to prepare graduates for the up and coming work environment. So, it is essential to develop technology awareness and aptitude of current students who are needed for the 21st century workplace. It is estimated that over the next ten years, more than 75% of available jobs will require technology-based skills (Tucker, 2012). Therefore, students must be provided with the environment and opportunity during their education to develop a high technological expertise in order to be prepared for future, technology-rich working market.

Communicating online, working collaboratively online, utilizing digital tools effectively, and working remotely, are some of the technology-oriented skills needed. These technological skills can be presented and practiced within the courses that students take by integrating a technology-based, blended learning system (hybrid course). As institutions and colleges are offering more hybrid science courses, Allen & Seaman (2010) reported that many of these institutions claim that they have had great success in the hybrid platform, providing advantages to the administration, as larger number of classes can be offered to support increasing student enrollments without much impact on operating budget. Distance Education Report of 2004 indicates that hybrid courses are the future of e-learning.

Recent studies have shown that students learn better in a blended model rather than fully online or in a traditional face-to-face environment (McLester, 2011). Blended learning models can offer a student-centered approach which fosters community, collaboration, and communication by combining the most effective strategies of traditional and technology-based education (Pereira et al, 2007).

As educators in higher education, our educational strategies must be rooted in adult learning theory. George Rudy (2018) published updates for andragogy (“the art and science of helping adults learn”), the adult learning theory that was initially introduce by Malcom Knowles in the 1970s. The six principles support adult learning theory:

1. Adults are internally motivated and self-directed. They make choices relevant to their learning objectives and thus the teaching model should give them the freedom to assume responsibility for their choices.

2. Adult learners bring life experiences and knowledge to learning experiences and connect it with current knowledge and activities. It will be helpful if the teaching model is related to their expertise.

3. Adult learners are purpose and goal oriented. They aim to acquire relevant and adequate knowledge, hence, the learning outcomes should be clearly identified and monitored to make sure that they are fulfilled in a reasonable time.

4. Adult learners are relevancy oriented so when the assigned tasks are related to their own learning goals they will be inspired and motivated to engage in the projects.

5. Adult learners are practical so finding ways that convey theories via practical activities would be very helpful. And finally,

6. Adult learners like to be respected. They flourish when there is a continuous mutual interaction with their instructors.

Academicians designing hybrid model learning environments for adult learners in higher education should embrace these six principles as they lay a strong foundation for their course design. Additionally, the following learning theories can offer additional insight for the academician as they seek to create meaningful learning experiences within the hybrid model of learning: the Cognitive Learning Theory, Constructivist Learning Theory, and the Socially Situated Learning Theory (Franks et al, 2016).

The basic concept underlying Cognitive Learning Theory is that humans seek "to interpret information and construct meaning through the organization and structuring of knowledge acquisition." In this theory, knowledge acquisition would be the outcome of interaction between new experiences and existing knowledge in a person's mind. With respect to blended learning, when instructors frame their teaching using a cognitive learning theory approach, students are expected to understand, and apply concepts in terms of their relationships and rebuild new information.

The Constructivist Learning Theory assumes that understanding is gained via an active process of "creating hypotheses and building new forms of understanding through activity." (Peters, 2000). This theory demands learners to show their skills by applying their knowledge in solving real-world problems. The constructivist model involves learner-centered instruction. Research suggests that "the design of learning activities in a constructivist model includes collaboration, cooperation, multiple perspective, real world examples, scaffolding, self-reflection, multiple representations of ideas, and social negotiation" (Franks et al, 2016). The author indicates that "the learner assessment elements consisted of instructor assessment, collaborative assessment, self- assessment." The instructor's role in this theory according to the author is "coaching, guiding, mentoring, acknowledging, providing feedback, and assessing student learning."

The focus of the Socially Situated Learning Theory is on the social distribution of knowledge. When knowledge is positioned in the practices of communities then the outcomes of learning involve the abilities of individuals to participate in those practices successfully. The key elements of the socially situated learning theory are social interaction and collaboration. According to literature, the learner becomes involved in a community of practice which embodies certain beliefs and behaviors to be acquired. As the beginner or novice transitions from the periphery of a community to its center, he/she becomes more active and engaged within the culture and eventually assumes the role of an expert. The Socially Situated Learning Theory can be viewed as the correction to theories of learning in which both the behavioral and cognitive levels of analysis had become disconnected from the social context. The theoretical basis of adult learning is shown in Figure 1.

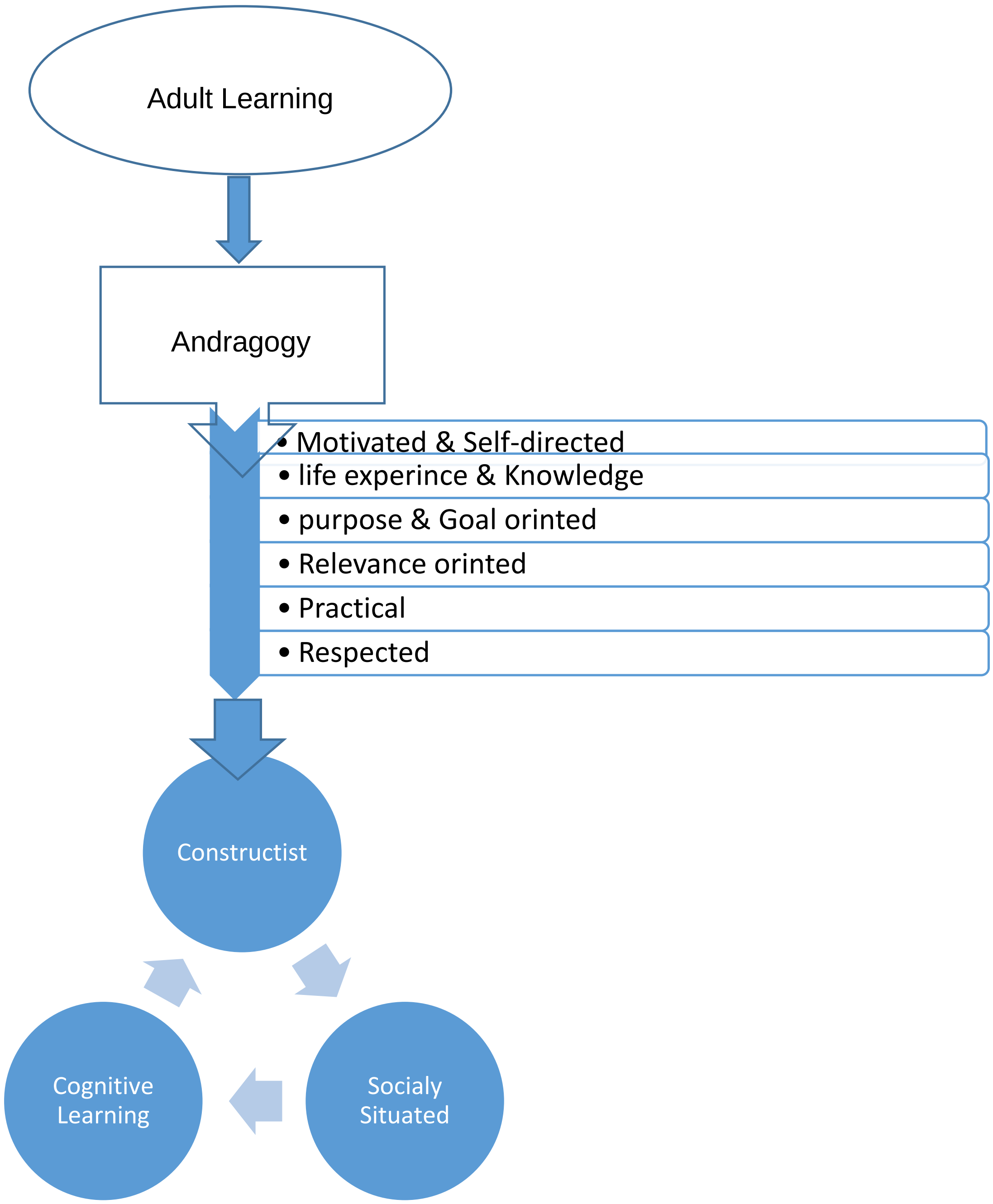


Figure 1. Adult Learning Theories. (McDonough, 2014).

Hybrid courses utilize many of the aspects of Cognitive, Constructive, and Socially Situated Learning styles in their components. Students engage in discussion and collaboration using knowledge basis and personal experience to enhance and augment their knowledge online and their team building and social interactions both online and in classroom setting.

A hybrid course format offers a mixture of face-to-face and online learning that tend to meet community college students' need for flexible time, independent, and group studies along with interaction, both online and in class, with fellow classmates and the instructor. Hybrid science courses can be a challenge to both students and faculty. Literature presents positive and negative concerns about hybrid science courses, particularly the ones with laboratory experiments. Most of the concerns are centered on students' academic performance and their engagements and satisfaction in meeting the course goals and objectives.

The purpose of this study was to compare students' learning outcome in the two modes of instructional delivery, traditional face-to-face (FTF) and hybrid (HYR), in a lab-science course (Principles of Biology I) at an urban community college, Hudson County Community College (HCCC), to determine if there is a significant difference in the learning outcomes, retention and student's satisfaction based upon instructional delivery model.

CHAPTER II

REVIEW OF LITERATURE

Prevalence of Hybrid learning

Enrollment in hybrid courses remains high and the reported rates of student satisfaction indicate that learners by and large view such courses favorably. The American Association of Community Colleges has reported that since 1985 more than half of the community college students are women with majority of them being Black and Hispanic. On average, two thirds of these students are part-time, adult, or what is known as nontraditional, students. The majority of community college students surveyed by Campos and Harasim (1999) preferred mixed-mode learning experiences. In addition, hybrid learning environments have shown to address the frustrations and limitations resulting from the separation of tutor and tutee commonly found with fully online education (Hodges, 2004). Examining the perceptions of female students about hybrid courses, Bhatti et al (2005) reported increase in student satisfaction with mixed-mode learning while the students' dependency on the instructor for assistance decreased.

Researchers studying student satisfaction among the three modes of learning (face-to-face, fully online, and hybrid), have reported student satisfaction to be the highest with the hybrid learning model while the test scores were the same for all three methods of delivery (Rivera et al, 2002). Also, the hybrid teaching method could eventually become the norm in higher education as Young (2002), who examined hybrid and fully online teaching at several universities, concluded that among the three modes of instruction, the hybrid model posed the most substantive benefits for teaching and learning.

One may ask if hybrid courses evaluated differently than traditional and/or fully online learning experiences. Carnevale (2000) found that regardless of the evaluation format, students took into consideration knowledgeable instructors, interaction with instructors, and additional features that create a sense of community when evaluating courses for merit. The importance of technological preparedness, willingness, and the overall mindsets of students has also been acknowledged by educators to play a crucial role in both the hybrid and online learning. Sanders and Morrison-Shetlar (2002) cited the importance of student attitudes toward technology as a significant determining factor in the educational benefits of online learning resources and experiences.

Advantages of Hybrid Learning:

Lloyd-Smith (2010) indicates that a number of potential advantages to blended learning are emerging. Some of these revolve around accessibility, pedagogical effectiveness, and course interaction. Many of today's college students are non-traditional, attempting to balance family, jobs and university life. Coming to campus is often difficult for many of them and reducing the number of required face-to-face hours can help students manage their higher education (Dziuban, Moskal and Hartman, 2005). Referring to the study of Miller and Lu (2003) the author suggests that maintaining the 'anytime, anywhere' mentality of online course delivery "makes sense to working adults who need flexibility" either completing degrees or upgrading skills for job advancement. It is also noted that the availability of e-courses provides the needed flexibility to maintain part-time jobs, especially students from lower socio-economic classes. An important benefit of blended instruction is enabling schools to maximize classroom space and/or reduce the number of overcrowded classrooms. From a physical standpoint, blended instruction allows multiple classes to utilize one physical space, which is particularly important as suggested by Gould (2003), when computer labs are involved. Improvements in classroom utilization have the potential to reduce direct instructional costs by 25-50 percent (Dziuban, Hartman and Moskal, 2004). In addition, the availability of hybrid courses "allow institutions to offer more classes at peak demand times of the day, thus maximizing the scant resources by increasing flexibility in scheduling" (Gould, 2003). Schools can also harvest institutional savings. "On a pure cost basis, hybrids reduce paper and photocopying costs. In hybrid courses, all course documents, including syllabi, lecture notes, assignment sheets and other hard copy handouts, are easily accessible to the students on the course web site" (Gould, 2003).

Some adult learners returning to school may have questionable technical skills and as many as 50% of adults experience some computer-related phobia, Saade and Kira (2009) suggest. Unpleasant side effects associated with technology may include strong, negative emotional states that arise not only during the interaction but even before, when the idea of having to interact with the computer begins. Frustration, confusion, anger, anxiety and similar emotional states which may be associated with the interaction can adversely affect productivity, learning, social relationships and overall well-being (Saade and Kira, 2009). Therefore, it is important that adult learners have access to the support necessary to successfully engage in the online portion of blended course delivery. Lloyd-Smith (2010) emphasizes that faculty teaching hybrid courses need to be aware that not all students have the same degree of technological expertise and ensure that supports are in place to assist those who are beginners in e-learning.

Students Satisfaction in Hybrid Learning

Hoch and Dougher (2011) conducted a case study to better understand student perceptions of hybrid vs. traditional face-to-face courses at Montana State University. They used identification of a plant for this study with only in-class component being a weekly lab. Being the first online learning experience for more than 2/3 of the participating students when the course was offered in 2009, 81.8% of students preferred a traditional face-to-face format to the hybrid one that was offered. In 2010, however, student preference for an in-class format dropped to 32%. Though big difference was observed in student attitude to the hybrid format, reasons pointed out for course preference remained the same! Majority of students who favored traditional format didn't like "the reduced instructor contact of a hybrid course." On the other hand, the 76.5% of students who preferred hybrid format "favored the greater independence of this format." Hoch and Dougher's (2011) findings showed the utility of the hybrid format for the course they used the study for and demonstrated how students' attitudes towards online learning were affected by perceived learning skills and previous online and in-class experiences.

Parker and Martin (2010) compared the perceptions of 57 undergraduate students who used the virtual classroom in a fully online and a blended education course using Horizon Wimba's Virtual Classroom package. The features of Horizon Wimba's Virtual Classroom are grouped into three categories based on their application: (1) discussion and interaction are facilitated by breakout rooms, emoticons, chats, videos, presentations, polls, quizzes, and surveys; (2) instruction and reinforcement are implemented through the electronic whiteboard, application sharing, and the content area; (3) classroom management tools include the ability to upload and store documents, an auto-populated participant list, usage details, and archive options (Wimba, 2009a).

The purpose of their study was to examine student perceptions of the virtual classroom in online and blended classes. The questions were:

1. Do students' perceptions of virtual classroom features differ based on course delivery (online vs. blended?

2. Do students' perceptions of interactivity, synchrony, usefulness and ease of use, and sense of community differ based on course delivery (online vs. blended)?

This study was conducted at a Southeastern university in the United States. In the fall of 2008, 101 undergraduates enrolled in an instructional technology course were asked to complete a questionnaire. Fifty-seven students participated, which resulted in a 56% response rate.

Participating students were of different age groups. One percent were 18 years of age and younger, 73.7% of the students were between19-24 years, 14% were 25-31 years old, and 10.5% were 32 or older. Ninety-one percent of participating students were female and 9% were male. Information on race/ethnicity was not collected due to the limited number of minorities enrolled in the course.

Students in five sections of an instructional technology course were involved in this study. Two of the sections were fully online and three sections were blended. In the online format, the entire course was delivered completely over the internet; students did not meet face-to-face. In the blended format, students met predominately face-to-face and met online on specified dates. In both the online and blended courses, students used the Wimba virtual classroom four times during the semester for similar content.

The instructional technology sections were taught by three different instructors (one instructor taught two blended sections, another instructor taught two online sections, and one instructor taught an online section). Each instructor received the same training on how to use Wimba. They conversed prior to the study to ensure the same features were used within the virtual classroom. The characteristics of the virtual classroom were the same across sections.

There were 22 students enrolled in the fully online course and 35 students in the blended course. Seventy-four percent of the students used the virtual classroom for the first time, 19.3% used the virtual classroom for 2-4 semesters, 5.3% had never used it before, and 1.8% used it for 5 or more semesters.

Analysis of collected data showed that online students rated the feature “Viewing archived virtual classroom sessions” as the most beneficial. Ability to raise their hands and use the polling feature to respond to questions was rated as the second highest. The blended students rated the feature “Viewing desktop shared by my instructor and other participants" and "Viewing presentations posted by the instructor" as the most beneficial feature.

Students in the fully online course rated all of the virtual classroom features higher than students in the blended course. For example, online students rated the use of breakout rooms higher compared to students in blended courses. Similarly, online students rated the polling feature more positive than students in the blended course. There were statistically significant differences between the groups for 9 out of the 16 features that were investigated.

These results suggest that online courses may provide the best form of course delivery for instructors who use the virtual classroom. In this study the online students' comfort level on the use of technology seems higher than the students in the blended courses. This was evident in the results wherein online students rated the virtual classroom features higher than the students in the blended courses. In conclusion, Parker and Martin (2010) suggested that students in the online course perceived the virtual classroom more favorably than the other students, which may underscore the power of this innovative technology to transform course delivery.

Rajendran et al. (2010) argue that of the following four popular methods of learning, the auditory learning (learning by hearing), visual learning (learning by seeing), Reading /writing (learning by processing contents), and Kinesthetic learning or practical (learning by experimenting things), the fourth learning style, the kinesthetic learning, learning by doing, helps the students to develop logical reasoning. Some simple experiments can be done as laboratory exercises, but complex experiments cannot be done in labs. In such conditions, virtual labs come to the rescue.

Virtual Labs are online labs that provide an opportunity to 'learn by doing'. They also provide access to systems which are otherwise inaccessible for reasons such as safety, cost and size. Users can explore a variety of what if scenarios by changing the input and observing the effect on the output. Thus, virtual labs have lots of advantages. Rajendran et al. (2010) study aims to identify the effectiveness of these virtual labs in E-learning suite and the increase in learning skills and understanding level of concepts among school students in Chennai. The study also focuses on identifying whether the virtual lab helps the students to increase their self-paced learning.

Rajendran et al. (2010) used a survey and experts' interview. In their study, the samples were students studying in eleventh grade. The questionnaire method was used for collecting the data from participating students. Fifty students of age group of 16 to 17 years old were selected, 35 boys and 15 girls. Students were taken from 11th grade in a school in Chennai that has exposed its students to computer-based tutorials. Unstructured face-to-face interviews were used to collect needed information from the selected students.

The study showed that 35% of the students' surf internet for games and only 25% of them surf for improving their knowledge. The remaining 40% of students use internet for both education and entertainment. The 92% of students who were aware of virtual labs were interested in doing experiments virtually. They felt they need not worry about the damage caused due to wrong results and they can work in the lab as and when they wanted. There was not any restriction in the lab timings.

Almost 90% of the students recommended using computer-based tutorial with virtual labs incorporated with them instead of textbooks. Nearly 62% of them felt they require a faculty for guidance all the time and 22% of them felt they don't require any guidance, whereas 16% of the students felt they require guidance for certain topics. All students responded that they would use the Computer Based Trainings (CBTs) with virtual labs in it in future for the subjects available which shows students' enthusiasm in using the virtual labs. They felt by using these virtual labs, they are learning through fun.

Salamonson and Lantz (2005) studied nursing students' satisfaction with a hybrid course delivery format. The idea evolved from a need to implement in a final year pathophysiology course of a nursing program an alternative teaching strategy that would be less reliant on the traditional lecturer-directed classroom format. As with the biological sciences, nursing students often perceive pathophysiology to be difficult compared to other nursing courses in the nursing program (Elberson et al., 2001). Typically, when pathophysiology is taught using a lecture format, it disadvantages students who are unable to assimilate new and difficult information quickly (Lowry and Johnson, 1999). Unlike the social sciences, students need to remember factual information, as well as understand a series of complex physiological relationships and pathophysiological processes in order to practice safely in the clinical setting. It is therefore essential that teaching strategies are flexible to address the wide range of student abilities within groups. Web-based learning is one strategy that allows students who have difficulty with certain topics to spend more time on them.

Students Learning Outcomes in Hybrid Learning

Abdullahi (2011) investigated students' performances in a "web-enhanced traditional and hybrid allied health biology course" at Bronx Community College of City

University of New York. The author argues that research (Diaz & Cartnal, 1999, Meyer, 2003) shows for students to be successful in distance learning (both hybrid and fully online) they need to have “independent self-paced” study skills as there is less interaction with peers and teachers compared to traditional face-to-face classes. Students need to be active adult learners to benefit from the student focused learning environment. Alternately, students enrolling in hybrid courses just for the convenience of it may not be as successful if they are not prepared for self-directed learning.

Lloyd-Smith (2010) has studied the benefits of blended instruction at community colleges and technical schools. The study found that students who took all or part of their instructions online performed better, on average, than did those taking the same course through face-to-face instruction. Furthermore, those who took “blended” courses were found to do best among all three modes of instruction delivery, the fully on line, blended and face-to-face.

It is evident that blended course instruction offers both more choices for content delivery and may be more effective than courses that are either fully online or fully face-to-face (Singh, 2003). In addition, as not all students learn in the same way, Young (2002) suggests that presenting materials in a variety of formats helps maximize student engagement. “The community college instructor should try to offer learning activities that will appeal to the widest variety of learning styles possible.” (Stewart 2008). In 2002, Garnham & Kaleta suggested that students learn more in blended courses than they do in comparable traditional class sections. Also, studies of Chris Dede (2011) of the Harvard University’s Graduate School of Education suggest that many people are able to find their voice in distance media via an increased level of interaction, both among fellow classmates and with their instructors, in a way that they cannot in a typical classroom.

Several factors affect students’ expectations on e-learning in community colleges. To better understand these factors, Kilic-Cakmak et al. (2009) conducted a study focused on examining the expectations of first year students enrolled in an e-learning program with respect to teaching-learning, instructor, assessment and evaluation, communication, and technical support. They conducted the study in the beginning of 2007-2008 fall semester at a 2-year vocational postsecondary education program in Turkey, equivalent to a community college in the United States. Participants were first year students majoring in computer programming and business administration. The number of registered students during the semester was 511. Of these, 250 students were studying computer programming and 261 were in the business administration program. Though all students were given questionnaire, only 138 of them were returned, a response rate of 27%.

Movahedzadeh (2012) has studied performance of students who were not science major in an introductory science course (Biology 114) at Harold Washington College. The biology class, specifically developed for these students, was offered in hybrid format. The class met once a week with 60% of the class onsite which included lectures, discussions, exams, and laboratories. The remaining 40% or the time the class met online and included reading the lecture/lab materials, conducting virtual labs as practice and preparation for actual labs on campus, taking quizzes, and group research projects.

The success of this hybrid course was assessed by: teaching the same course content in both hybrid and traditional formats, conducting concept-based pre- and post-tests, surveying the students in both the hybrid and the traditional course of Biology 114 at the end of the semester, and, the overall grades of students in both the hybrid and the traditional classes. It should be noted that students' Class Evaluation was administrated by the college in both the hybrid and the traditional sections.

The author's findings indicated that hybrid instruction is at least as good as the traditional teaching. Furthermore, the study confirms three major benefits of hybrid teaching: (1) providing flexibility to working students, (2) helping the institution with space constraints via reducing class time, and (3) enhance "faculty learning community" via developing high quality digital contents and sharing it with other faculty. To investigate the effect of "flipped" model, Scholey et al designed the iBioseminars in Cell and Molecular Biology for senior level undergraduate students in (i) biochemistry and molecular biology, (ii) cell biology and (iii) genetics majors. In a "flipped" model class lectures are mainly provided as homework, and class time is used to promote higher order thinking skills, such as analytical skills, critical thinking skills and problem-solving skills. Students, therefore, used homework time to memorize key concepts in biology and reflect on key scientific questions, but used class time to challenge their understanding of these important concepts, and to defend their perspectives of key scientific problems. In addition, they received direct feedback from their instructor on their ideas, allowing them to correct misconceptions and strengthen their scientific knowledge. They also had the opportunity to have direct discussions with the experts in their field twice during the semester.

Each week, students watched an assigned iBioseminar delivered by a leading research scientist on a topic in modern cell and molecular biology in their own time and answered assigned homework questions that were designed to ensure that they had indeed watched and understood the seminars. iBioSeminars are 30 minute to 1 hour-long, pre-recorded scientific seminar in cell and molecular biology given by some of the experts in the field. The seminars and other materials were posted on the Smartsite page and the entire set of seminars was also available on the iBioSeminars website, a free, open-access resource funded by the National Science Foundation, the National Institute of General Medicine and Howard Hughes Medical Institute and sponsored by UCSF and the American Society for Cell Biology. Assignments included 10-12 multiple-choice questions designed to (a) point students to the most important concepts in the iBioSeminar; (b) provoke reflection on some of the key concepts brought forth by the speaker; (c) encourage students to use these concepts by applying their understanding to a realistic situation. In addition, each week, students were presented with a discussion question before they watched the lecture. This question was often open-ended and encouraged students to develop higher order thinking skills.

All students who attended the first class returned to class the next week but one (17 out of 18) and stayed throughout the semester, unusual for this type of course. In addition, students expressed satisfaction with the group discussion and instructor-led discussion questions as early as week 3. In the final course evaluations, some students indicated that the group discussions helped them understand course materials and they had enjoyed interacting with scientists, either directly or through Skype.

Based on this experience, and students recommendations, Scholey et al. have suggested few modifications to instructors in future teaching of the course including: extend the in-class sessions to 2 hours to allow increase instructor-led in-class discussions, which were sometimes rushed at the end; record an iBioseminar-format introductory lecture to replace the first in-class session; and assign the class to one or more of the targeted majors as a required (or required elective) class so that the enrollment is increased.

In his paper “Online Versus in the Classroom: Student Success in a Hands-On Lab Class” Reuter (2009) compares learning success of online and on-campus students in a general education soil science course with lab and field components. The author argues that academic programs have been reluctant to develop such courses in a distance format due to the uncertainty regarding effective delivery of field-based content in a distance format. The objective of his study was to determine if there is a difference in student learning success between similar online and on-campus hands-on, lab-based science courses. Sustainable Ecosystems is a lab-based class that satisfies both the physical and biological science general education requirement for Oregon State University. The study was conducted during the spring 2007 and 2008 terms at Oregon State University, Cascades Campus/Central Oregon Community College and Oregon State University Ecampus.

Lab methods were outlined in detail and accompanied by photographs and digital video. Each student had to complete each lab independently and photo-document their work. Lecture materials for online students were delivered via Blackboard as PDF files which included graphics and notes. Quizzes and exams were online, open-book, and timed. Three online discussion boards were required, and additional discussion boards were provided for general questions and review. A final report on the lab lessons, including a soil profile description and land-use capability analysis, was required.

Students from two terms of this course completed standardized pre- and post-assessments designed to test knowledge and skills from the lecture and lab content of the course. Student success was evaluated in several ways, including overall course grade, improvement between pre- and post-assessment, total correct questions, improvement per question, reversals in correct answers from pre- to post assessment, and overall course grade.

Test data from 97 students were used in the comparison analysis. Between the two course formats, a total of 78 students completed the demographic surveys (80% return rate). Survey returns were greater for year two (96%) compared with year one (58%) and provided a better representation of student demographics. The reason for the higher return could be the fact that in year two the survey return was counted as an extra credit assignment.

Mean age of students was different between the two groups. The average age for the online class was 34 and 25 for the on-campus class. Student success in both the overall course and for the post assessment was tested for correlation with age using all seventy-eight surveys and also using only surveys returned in year two. Some of the variability in the overall grade results is explained by the age of the student but the correlation is not very strong. Comparing age with post assessment score yielded similar results.

There was no difference in overall grades or lab assignment grades between the two course formats. However, online students outperformed on-campus students on the pre-assessment in the first term and on the post assessment in the second term; the two populations scored similarly for the other assessments. Online students showed a 42% grade improvement from pre- to post assessment; on-campus students had a 21% improvement. Online students also showed better learning success in lab-related knowledge and skills based on individual assessment questions.

Somenarian et al. (2010) studied the student perceptions and learning outcomes in a Medical Terminology course, a non-laboratory course, in the Biology Department of Bronx Community College in New York. The paper presents data from a two-semester study of the effects of distance learning on student achievements as well as their perceptions and attitudes towards online education. Three formats of the course were selected for this study: an asynchronous course, a synchronous course and a traditional course (control group). Course content was the same for all three sections and a different instructor taught each course.

The control group (N=40) received instruction in a traditional lecture, question-answer, small group activity format. Instruction was delivered during fourteen two-hour periods for each semester. Both online formats used a Blackboard platform. The asynchronous course was designed using a course cartridge by Marjorie Willis and the synchronous course was designed by the instructor that taught the course. The asynchronous group (N=38) attended no classes except for a one-hour orientation at the beginning of the semester and for a comprehensive final exam at the end of the semester. They were also required to take a timed weekly quiz for the chapter covered.

Additionally, topics were posted weekly on a discussion board by the instructor for each student to respond; students can also respond to each other. The synchronous group (N=39) attended classes for one-hour a week for group discussions and the second hour was online. They were also required to take a timed weekly quiz and a comprehensive final exam.

Grading in both online formats weighed the same, quizzes 67% and final exam 33%. Students in the two internet-based sections were surveyed at the beginning and at the end of each semester.

Student surveys administered at the beginning of the semester (N=117) showed: males 24%, females 76%, average age was 29 ranging from 18-41 years old, students majors were: Nursing 34%, Nuclear Medicine 33%, Medical Assistant 20%, Radiologic Technology 8%, Biology 5%, International students on visa 10%, students taking their first online course 93%, students with a computer at home 95%, students that use e-mail regularly 99%, working students 76%, students with a previous biology course 67%, students living in the Bronx and neighboring boroughs 93% with 7% living in Westchester county.

To assess student perceptions of the course a survey was conducted at the end of each semester for the two online courses (N=77). To assess student achievement in the course, the final grade points (GP) for each student was used. This study revealed several interesting findings. First, there was no significant difference in student satisfaction of their online learning experience in both online groups. Although 93% of the students were first time online users, overall students showed a very positive feeling about their experience in both online groups. Second, there was no significant difference in course grades when comparing the two online groups to the control group. Although the online groups showed a slightly higher-grade average, most studies done on distant learning environments have demonstrated similar results (Loomis 2000). Somenarian et al. (2010) believe that these results are compelling, and they support the evidence that distant education is achieving the goal of providing quality learning experiences.

As the use of computer-generated three dimensional (3-D) anatomical models to teach anatomy has flourished, Nicholson et al. (2006) have studied the educational effectiveness of such models using a computer-generated 3-D model of the middle and inner ear. They reconstructed a fully interactive model of the middle and inner ear from a magnetic resonance imaging scan of a human cadaver ear.

Working with two groups of students from the first-year medical-school class at McGill University (Montreal, Quebec), Nicholson et al. (2006) conducted a randomized controlled study in which 28 medical students completed a Web-based tutorial on ear anatomy that included the interactive model using a VRML viewer plug-in (Cosmo Player) and, a control group of 29 students who took the tutorial without exposure to the model. To analyze the participants' responses concerning their prior experience with 3-D games, they conducted different tests to ensure that the groups were comparable with respect to gender, previous exposure to ear anatomy and experience in visual arts. At the end of the tutorials, both groups were asked a series of 15 quiz questions to evaluate their knowledge of 3-D relationships within the ear, the intervention group's mean score on the quiz was 83%, while that of the control group was 65%which resulted in a significant difference in means of the two groups when compared to other studies reported earlier by Garg et al. (2002) on carpal bones model and Hariri et al. (2004) on shoulder model study. Authors argue that the negative or equivocal results of previous studies may, in part, be the result of study design. For example, the equivocal results found by Hariri et al. (2004) may be due to low statistical power (their sample size was only 29 students). The authors concluded by indicating that given their positive results, they believe that further research is warranted concerning the educational effectiveness of computer-generated anatomical models.

Pereira et al. (2007) studied the results of implementing blended teaching in human anatomy and analyzed both the impact of it on academic performance of participating students and the degree of user satisfaction. The study was carried out among first year students in biology major at Pompeu Fabra University, Barcelona, Spain. Two groups of students were selected from those having fairly high scores in the national university admissions examination. Students repeating a class were excluded from results analysis.

Students in the first group (traditional teaching [TT]) received a total of 30 hours of theoretical and 15 hours of practical classes. In the second group (blended learning [BL]), 13 hours of theory, devoted to study of the muscles, were replaced by non-attendance-based hours using purpose-designed computerized materials with relevant supervision, both online as well as at 3 seminars which students had to attend for support and problem solving activities. This part of the course was replaced by the blended learning approach due to difficulties in learning detected in previous years (Pereira et al., 2007). Both groups had free, unrestricted access to their respective teaching materials via the virtual campus.

Pereira et al. (2007) evaluated both groups at the end of the teaching period through 3 tests: a 30-question, 5-answer multiple-choice test (MCT); a 15-question, short-answer written examination (WE); and, a 10-question practical examination (PE) based on recognition of structures. The final grade for the TT group was calculated by applying the following percentages: MCT 60%, AT 25%, PE 15%.

During the study period of the non-attendance-based lessons, students in the BL group took 3 MCTs (10 questions, 5 answers, only 1 correct, for each test) as continuous assessment (CA) of the specific knowledge that they had acquired about muscles. The final mark for this group was calculated as follows: CA 30%, MCT 35%, WE 20%, PE 15%. The examination questions, especially in the non-attendance-based section, were designed to evaluate the same items according to different principles.

Students in the BL group received specific surveys as to the development of their learning, the number of hours dedicated to studying and the uses made of the different types of materials. At the end of the teaching and prior to the final evaluation, both groups were administered with a standardized survey to assess their level of satisfaction with the teaching they had received.

Of the 69 students registered for the blended learning course, 65 participated in CA. All participating students passed the CA tests, obtaining an average score of 8 points (scale 0-10). Specific satisfaction surveys of the BL group on non-attendance lessons showed a high degree of satisfaction with their learning (mean 7.6 points) and with the teaching materials (mean 7.7).

Use of the materials available via the web, evaluated by assessing the number of times the subject was accessed, was clearly greater in the semi-attendance-based teaching group, in which 88% increased access (BL 1043 versus TT 555) was detected. This increase in the use of teaching materials was among the aims of this study.

Pereira et al. (2007) observed significant differences favoring the group receiving semi-attendance-based teaching when comparing the results obtained in the final evaluation by both groups in the study. Regarding both quantitative qualifications (TT 5.078 versus BL 6.3) and the percentage of students who passed the examinations at the first attempt (BL 87.9% versus TT 71.4%); the TT group tended to equalize at the second examination attempt. Likewise, they saw that a higher percentage of students from the BL group sat the first call to evaluation. When authors compared both groups taking into account only the marks obtained at the final test stage, and excluding scores obtained in CA by students in the BL group, the differences maintained their significance, both quantitatively (TT 5.0 versus BL 6.1) and as a percentage of passing the subject (TT 71.4% versus BL 85%).

This study reveals a clear improvement in the academic performance of students who were taught the anatomy of the locomotor apparatus via blended learning, both in terms of their grades and the number of students who passed the assessment test in their first attempts. A potential limitation of this study that arises from the fact that the examinations administered to the 2 groups contained different questions was overcome by the evaluation of identical concepts.

Pereira et al. (2007) point out that the implementation of blended learning is extremely demanding of teaching staff, especially in terms of organization of the course and clear definition of its rules. It requires prior reflection that takes into account the students' status as learners, the nature of course content, and the course objectives.

Thus, materials can be designed to respond to student expectations, increase student motivation, allow for participation, anticipate problems that may arise during the course, and sufficiently emphasize the subject's key points. At the same time, the materials must offer tools for the realization of exercises and activities, for self-assessment and for allowing teaching staff to follow up students' individual and collective progress as the course evolves.

Paulsen et al. (2010) studied the advantages of introducing virtual microscopy in histology instruction and have presented their ideas on introducing the subject into the teaching of microscopic anatomy as well as being made available to the user as freely accessible supplementary educational material. A sound knowledge in microscopic anatomy and histopathology is of fundamental importance in medical training. Reviewing how teaching the subject has evolved since the middle of the 19th century when light microscope was used to teach the subject, authors argue that 1990s desktop computers had enough computational power to acquire a digital facsimile of the majority of the information on a glass slide, so that virtual slide acquisition technology using digital tiles was improved upon and commercialized.

Discussing the benefits of converting to virtual microscopy, Paulsen et al. (2010) argue that a teaching concept using virtual microscopy allows for the presentation of cytological and microscopic specimens in an interactive form since the observer can examine the specimen with a conventional microscope in sharp focus up to a magnification of 100× for binocular observation. In particular, the system can be integrated into various media data banks as, for example, in the AVMZ (Audiovisual Media Center of the TU Dresden) of interest.

Paulsena et al. (2010) indicate that the use of virtual sections offers numerous innovations including: an unlimited number of users can examine specimens with a virtual microscope at the same time, access to virtual microscopy independent from time (opening hours) and place (institute), references and explanations (annotations) could be superimposed hence, the specimen offers immediate feedback to the student, different strains can be shown parallel to or overlying one another, so-called merging, immediate access to archived cases is possible, microscopy paths can be replayed, and using adequate software will allow 3 dimensional reconstruction or visualization of the specimens, etc. Indicating few problems with implementing the concept, Paulsen et al. (2010) point out the financing issues.

Doiron (2009) studied pros and cons of online biology labs and provided insight into the effectiveness of online labs, use of online biology lab classes, and that how students and instructors of a community college in Virginia perceived their online biology lab experience. To collect data, Doiron (2009) performed standardized open-ended interviews with students and faculty teaching the course using a predetermined set of questions. The author also conducted two types of observations: first observing the instructor and students in chat sessions and second observing the course activities by enrolling in the online biology lab class. The students' and instructor's activities were observed and recorded. A review of documents including the syllabus, textbook, website for the course, tests, assignments, projects, and email print outs provided another source of data.

When asked for the reason of taking online biology lab class, 100% of the students interviewed indicated that time convenience as the main reason that they chose to take the online biology lab class. In addition to scheduling conflict with job and travelling, 71% of respondents raised childcare as the main reason for enrolling in online lab class. While majority agreed on the flexibility being the positive of online biology lab, 71%, of students responded that "the worst thing about the class was the lack of having an instructor right there to immediately answer questions."

With reference to Summers et al. (2005) that 'Those students who may not have developed appropriate strategies for self-regulation may find that online education courses do not meet their needs and those students may subsequently drop the course; as a consequence, online courses have been associated with much higher rates of attrition than traditional face-to-face courses', Zacharis (2011) compared an online group of freshmen computer science majors with an equivalent on-campus group to find if their individual learning styles play a role in the selection of course delivery mode (online or face-to-face) and in their academic achievement.

In fact, some researchers offer the possibility that there may be only certain types of students who can successfully learn via the online format (Aragon, Johnson & Shaik, 2002; Boyd, 2004; Meyer, 2003). With that, Zacharis (2011) made the purpose of his study as (1) to determine if learning style is a predictor of students' preference for online versus face-to-face delivery format, and (2) to compare students' achievement (on course grades) in two different learning environments—online instruction and on-campus/face-to-face instruction—based on their individual learning styles.

Available studies provide inconsistent empirical evidence on the relationship between student learning style, preference for online instruction, and learning achievement. Therefore, using data from an introductory programming course that had both an online and a traditional section, Zacharis (2011) examined the following research questions: Is there a relationship between a student's learning style and the selection of course delivery format (online or face to face)? Is there a difference between the course grades of students based upon the course delivery format? Is there a difference between the course grades of students based upon their learning style? And, is there an interaction between learning style and course delivery format based upon the course grades?

Using as subjects 161 first-year computer science majors, 77 (29 males and 48 females) of which were enrolled in the online section while the remaining 84 (33 males and 51 females) were enrolled in the face-to-face section of Introduction to Programming Using Java—COMP120, 2008 fall semester. Both courses, online and face-to-face groups, were taught by the same instructor, used the same online resources, covered the same lecture material, submitted the same homework and project assignments, and took the same exams as their on-campus counterparts. The only extra facility they had in their disposal was one instructor-led online session every 2nd week via Centra Live web-conference system, in which they could see and hear the instructor commenting on their code and answering questions.

Based on his findings, Zacharis (2011) suggested that learning style does not impact students' choice for online or face-to-face instruction or their ability to successfully complete a course in any of these two instructional environments. These findings, however, should be further investigated using larger sample sizes, different courses of study, and possibly students randomly assigned to online and on-campus sections.

There has been an increasing presence of technology in all aspects of our lives, including educational system, in recent years. While researchers have studied the growing impacts technology has had in teaching and learning, more needs to be done to understand how to use it so that the best interests of both, students and academic institutions, are accomplished. This study aims to further investigate the role new technological tools can play in teaching science courses in community college settings so that both, students and institutions benefit from it.

CHAPTER III

METHODS

Design

This study employed a retrospective study design shown in Figure 2.

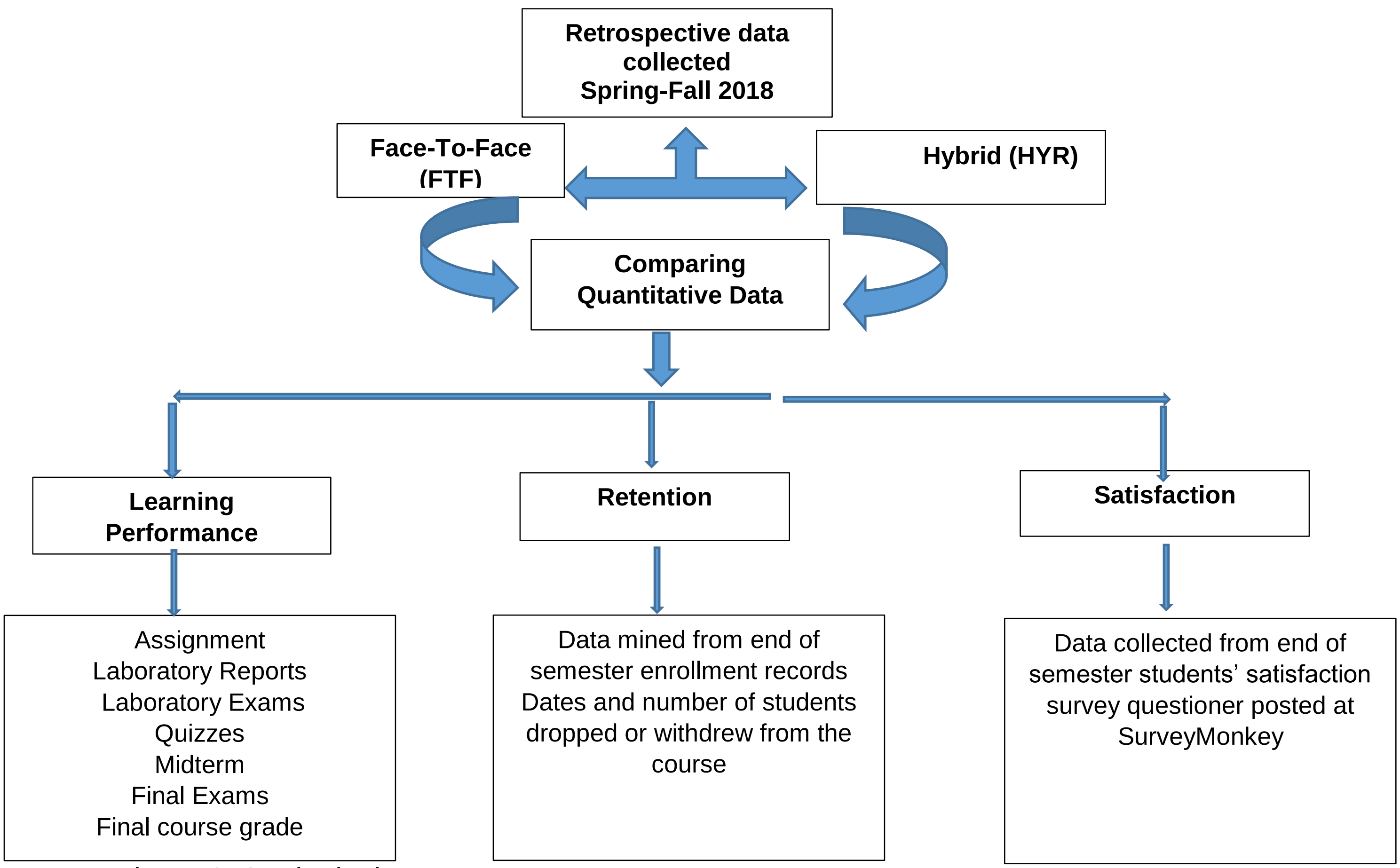


Figure 2. Study design

Quantitative data was mined from data files for a hybrid and face-to-face (FTF) science course (Principles of Biology I, BIO 115) taught at Hudson County Community College (HCCC) during the spring and fall semesters, 2018. Data included scores from assignments, lab exams, lab reports, quizzes, midterm exam, final exam and final course grades. Student retention rate was calculated from student attendance record (in the learning management system CANVAS) by identifying students who dropped or withdrew dates from the courses. Student satisfaction was mined from end of semester student survey data **(SurveyMonky.com).**

Variables

Independent variables (IV):

The independent variable (Figure 3) in this study was the method of course instruction for Principles of Biology I which was either hybrid mode of teaching (HYR) or face-to-face mode of teaching (FTF).

Dependent variables (DV):

The dependent variables (Figure 3) in this study were the students' learning outcomes as measured by points they earn in their assignments, laboratory reports, laboratory exams, quizzes, midterm exam, final exam, and overall course grades. Furthermore, students' satisfaction (mined from the end of semester survey monkey survey administered at the end of each semester) and student retention (completion/withdrawal) rate in the course was minded from student's enrollment records at the college faculty portal in the learning management system CANVAS

(Crawford et al. 2014). Course completion was also noted and defined as successfully earning credit for it (Shanna Jaggar, 2011; Abdullahi, 2011).

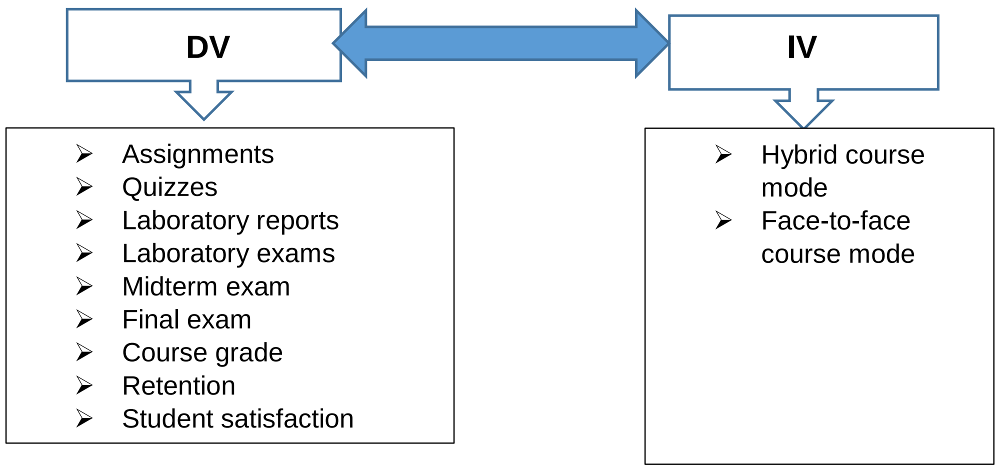


Figure 3. Dependent and independent variables

Setting:

The study data was mined (collected) by the PI from the Hudson County Community College (HCCC) learning management system CANVAS. HCCC is an urban community college that serves Hudson County and the surrounding areas. HCCC maintains a very diverse student's body of approximately 9000 students enrolled in approximately 50 Associates degree programs.

Sample

A sample of convenience was utilized data was minded from all students at Hudson County Community College (HCCC) enrolled in the Principles of Biology I (BIO 115 & BIO 115HYR) during the spring and fall 2018 semester. The PI minded data from HCCC portal and CANVAS platforms which included 85 HCCC students enrolled in the two 15-weeks Principles of Biology I course. There were 44 students enrolled in tradition al face- to-face (FTF) and 41 students enrolled in the hybrid (HYR) sections. At the time of course registration, students self-selected the instructional mode of delivery that best suited their needs. Table 1 shows enrollment numbers for each section of BIO 115 for spring and fall 2018 semesters.

Table 1 –

BIO 115 enrollment traditional and hybrid spring /fall 2018.

Semester	Face-to-face (BIO 115) N	Hybrid (BIO 115 HYR) N
Spring 2018	23	23
Fall 2018	21	18

Inclusion/Exclusion Criteria

Data for this retrospective study was mined from all students enrolled in Principles of Biology I course at HCCC during spring and fall 2018 semesters, regardless of enrollment section. There were no other inclusion criteria or exclusion criteria.

Procedure

Upon obtaining approval from the IRB at Seton Hall University and Hudson County Community College (Appendix A), data was minded from the learning management system CANVAS for students' scores/points on the assignments, laboratory reports, laboratory exams, quizzes, midterm exam, final exam and course grade. Students enrolled in both, hybrid and traditional face-to-face, sections of Principles of Biology I were provided with a course syllabus on the first day of classes. Both syllabi provided students with course descriptions and course objectives. Each course was divided into modules. The PI was the instructor for both sections, the hybrid and the face-to-face.

The traditional and hybrid classes only differ from one another in terms of presentation and contact time spent with students. The traditional face-to-face section met twice a week each for 2:45 hours. One of the meetings was a lecture meeting in which the lecture and discussions were facilitated by the instructor. Exams and other assignment activities were conducted during this meeting. The second meeting took place in the laboratory during which an experiment or practical exam was conducted, as indicated in the course syllabus.

For the Hybrid section, lecture materials, assignments/discussions and quizzes were all online. Students engaged in only one on campus meeting every week in the laboratory to conduct the scheduled experiment or practical exam as indicated in the course syllabus. Both sections had midterm and final exams that were the same in content and were conducted in the 8th and 15th weeks of the semester (Abdallahi, 2011).

The first module for both sections provided an orientation about the course activities conducted by the instructor. For the assignments, students were required to answer a question in an 800-word essay using APA style, which was then submitted online during the module week. Unit quizzes were done fully online. Students had only one chance to complete the quizzes which were timed for a 75-minute period and contained 20 multiple choice questions. Laboratory experiments were conducted every week at the Biology Department laboratory for both sections and students submitted their laboratory reports online during the unit week. Laboratory exams, midterm and final exams were taken in the laboratory or classroom at the designated times by the instructor.

The syllabi noted that the student performance would be evaluated by the weighted percent of total points students accumulated on the different aspects of the course. Total percent point was noted to be 100. Points earned by each student related to a letter grade and was consistent on both syllabi. To determine retention rates, the PI obtained data on students' withdrawal dates and the total number of withdrawals for each section were mined from the HCCC faculty portal. In order to secure student satisfaction for those students who completed the course requirements, they were asked to complete a University developed survey. The link to the survey (housed on Survey Monkey) was provided to the students at the end of semester by the course instructor via the class distribution email available in CANVAS learning management system. To ensure confidentiality of students answering the questioner, the Likert Scale questioner has five choices strongly agree, agree, neither agree nor disagree, disagree, strongly disagree. Student's responses to the survey questions was minded from Survey Monkey at the end of each semester.

Data Collection

At the end of each semester, a research assistant downloaded students' scores specific to the DVs: assignments, threaded discussions, laboratory reports, laboratory practical exams, quizzes, midterm exam, and final exam as excel file from CANVAS Grade book (Table 2).

The research assistant assigned a code name (a number between 1 and 24) to each student and converted their total points to a percent and the corresponding letter grade as noted on the syllabus. Also, the research assistant collected students' attendance record which indicated add/drop and withdrawal(s). All of these data was submitted to the PI. (Martin, 2012).

Table 2.

Weighted percentages of course activities

Final exam	**25%**
Midterm exam	**15%**
Quizzes	**20%**
Laboratory exams	**20%**
Laboratory reports	**10%**
Assignments/discussion	**10%**

Students' evaluations of the course for both sections, hybrid and the traditional face-to-face, were used to evaluate levels of students' satisfaction in the course. For this purpose, researchers have developed questionnaire addressing students satisfaction with the course format (C.Rivera., M. Rice, 2002). Participants' responses were collected from a Likert-type scale survey that was located on Survey Monkey.

Student response to each question ranged from 1-5, with 1 being strongly disagree and 5 being strongly agree.

Data Analysis

Quantitative data was analyzed using SPSS 24 software to calculate means, standard deviations, and conduct tests of inference (Abdallahi, 2011). Frequency tables and descriptive statistics were constructed to display results with respect to each of the research questions. The sample Independent t-test was used for data analysis to see if there is significant difference in students' learning outcomes between the groups (Chen and Chiou, 2014). 95% significance and the p value of 0.05 were used (Abdallahi, 2011). For the survey questions analysis and the retention rate, the Mann-Whitney U test was used because the numbers were lower than 50.

Research Questions & Hypotheses

In order to compare student learning outcomes, retention rate and student satisfaction in the hybrid and traditional face-to-face courses the following research questions were developed and used.

RQ1: Is there a difference between hybrid and traditional face-to-face community college science course **outcomes** as measured by students' grades on assignments, laboratory: reports and exams, quizzes, midterm & final exams and course grades?

A- Class assignments

Ho1A: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in assignments, when compared to the equivalent traditional face-to-face science course.

Ha1A: There is a difference between hybrid science course students' knowledge acquisition as determined by their scores in assignments, when compared to the equivalent traditional face-to-face science course.

B- Laboratory reports

Ho1B: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in laboratory reports, when compared to the equivalent traditional face-to-face science course.

Ha1B: There is a difference between hybrid science course students' knowledge acquisition as determined by their scores in laboratory reports, when compared to the equivalent traditional face-to-face science course.

C- Laboratory exams

Ho1C: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in laboratory exams, when compared to the equivalent traditional face-to-face science course.

Ha1C: There is a difference between hybrid science course students' knowledge acquisition as determined by their scores in laboratory exams, when compared to the equivalent traditional face-to-face science course.

D- Quizzes

Ho1D: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in quizzes, when compared to the equivalent traditional face-to-face science course.

Ha1D: There is a difference between hybrid science course students' knowledge acquisition as determined by their scores in quizzes, when compared to the equivalent traditional face-to-face science course.

E- Midterm

Ho1E: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in midterm exam, when compared to the equivalent traditional face-to-face science course.

Ha1E: There is a difference between hybrid science course students' knowledge acquisition as determined by their scores in midterm exam, when compared to the equivalent traditional face-to-face science course.

F- Final exam

Ho1F: There is no difference between hybrid science course students' knowledge acquisition as determined by their scores in final exam, when compared to the equivalent traditional face-to-face science course.

Ha1F: There is a difference between hybrid science course students' knowledge acquisition as determined by their scores in final exam, when compared to the equivalent traditional face-to-face science course.

G- Final course grades

Ho1G: There is no difference between hybrid science course students' knowledge acquisition as determined by their course grades, when compared to the equivalent traditional face-to-face science course.

Ha1G: There is a difference between hybrid science course students' knowledge acquisition as determined by their scores in course grades, when compared to the equivalent traditional face-to-face science course.

RQ2: Is there a difference between hybrid and traditional face-to-face science course in community college student **satisfactions** as measured by data collected from the end of semester survey?

Ho2: Community college student satisfactions in hybrid science course is equivalent to traditional face-to-face course as measured by data collected from end of semester survey.

Ha2: Community college student satisfactions in hybrid science course is not equivalent to traditional face-to-face course as measured by data collected from end of semester survey.

RQ3: Is there a difference between hybrid and traditional face-to-face science course **retention rates** as measured by examining students that dropped or withdrew from the courses?

Ho3: Retention rate in hybrid science course is equivalent to traditional face-to-face science course in community college as measured by examining students that dropped or withdrew from courses.

Ha3: Retention rate in hybrid science course is not equivalent to traditional face-to-face science course in community college as measured by examining students that dropped or withdrew from either course.

CHAPTER IV

RESULTS

The purpose of this study was to compare students' learning outcome in the two modes of instructional delivery, traditional face-to-face (FTF) and hybrid (HYR), in a lab-science course (Principles of Biology I) at an urban community college, Hudson County Community College (HCCC), to determine if there is a significant difference in the learning outcomes, retention and student's satisfaction based upon instructional delivery model.

The quantitative analysis of nonparametric statistics of means, standard deviations (SD), and the independent t-test were used. All statistical analyses were performed using an alpha of 0.05 with a power of 0.80. A prior review analysis was not conducted, however a Post hoc analysis, G* Power Test (Figure 4), was conducted with HYR N=41 and FTF N=44. The only demographic information secured was the students' self- selected enrollment in either Principles of Biology I course section (HYR or FTF). The statistical analysis of data was performed using SPSS software version 24.

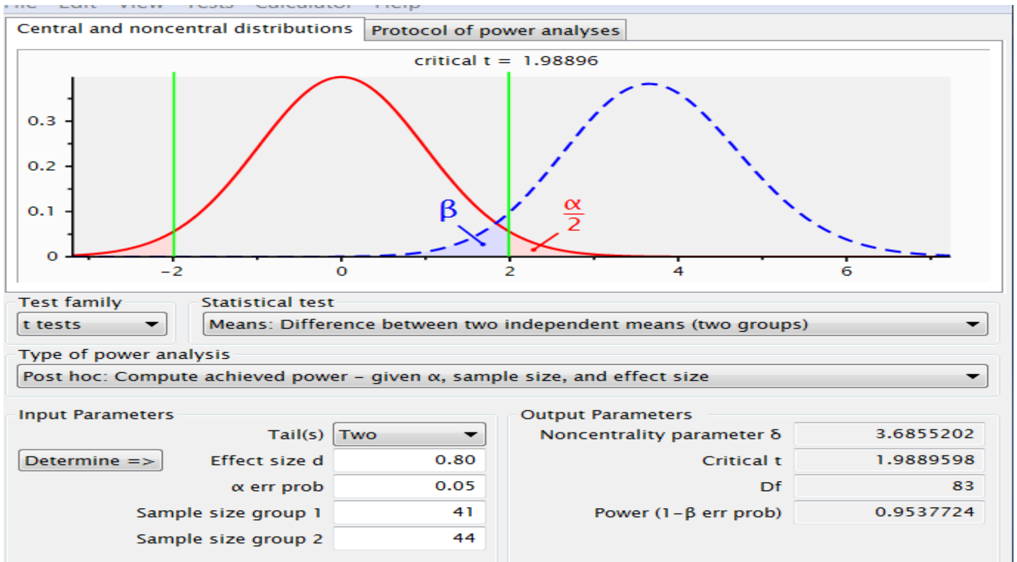


Figure 4. Post hoc analysis, G* Power

Quantitative Findings: Descriptive Statistics

Characteristics of Sample

A total of 85 students enrolled in Principles of Biology I in both, face to face (FTF) and hybrid (HYR), modes of delivery during spring and fall semesters 2018 were included in this retrospective study. The breakdown of enrollments was as follows. In spring 2018 there were 23 students in FTF (N= 23) and 23 students in HYR (N=23). In fall 2018, 21 students were enrolled in FTF (N=21) and 18 in HYR (N=18).

Following data was collected in response to research question 1.

RQ1: Is there a difference between hybrid and traditional face-to-face community college science course **outcomes** as measured by students' grades on assignments, laboratory: reports and exams, quizzes, midterm & final exams and course grades?

Data were analyzed using SPSS 24 with 95% confidence interval and significance level of $p \leq 0.05$.

Assignments

As shown in Table 3, a difference of approximately 1 in the means of the two groups is observed. The overall assignments mean (10% of total grade) for hybrid sections is M=5.69 with SD = 3.49 and for FTF section is M=6.78 with SD = 3.14. An Independent sample t test (Table 4) indicated no significant difference between the groups in the overall assignments scores (t (83) = -1.508, p = 0.135 >0.05). These results suggest that the two groups did not differ significantly in overall assignment scores. Figure 5 presents the Box-plot of assignment score for HYR and FTF.

Table 3.

Assignment Group Statistics

	Course type	N	Mean	Std. Deviation	Std. Error Mean
Assignments	Hybrid	41	5.6944	3.49256	.54545
	FTF	44	6.7800	3.14259	.47376

Table 4

Independent samples t-Test

Levene's Test for Equality of Variances		t-test for Equality of Means					
F	Sig.	t	df	Sig. (2-tailed	Mean Difference	Std. Error Differ	95% Confidence Interval of the Difference

						)		ence		
									Lower	Upper
Assignments	Equal variances assumed	1.184	.280	-1.5	83	.135	-1.086	.7198	-2.517	.34596
	Equal variances not assumed			-1.5	80.	.137	-1.086	.7225	-2.523	.35201

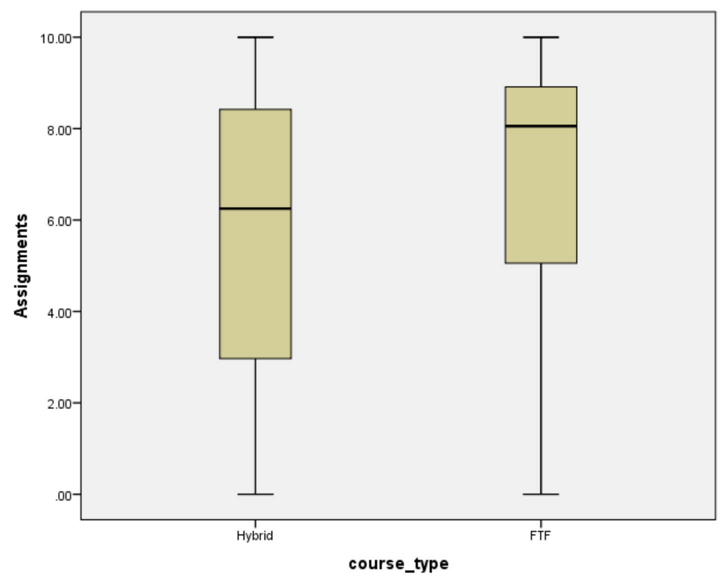


Figure 5. Boxplot of assignments scores for HYR and FTF.

Laboratory reports

Laboratory reports count for 10% of overall grade in both sections of BIO 115. As presented in Table 5 hybrid sections mean (M= 5.90, SD= 3.31) is lower than FTF sections mean (M= 8.34, SD= 3.09) by about 3 points. According to the results of an Independent sample t test (t (83) = -3.50, p=.001 < .05), the two groups did differ significantly in overall laboratory report scores with the FTF section scoring on average higher (Table 6). Figure 6 represents the Box-plot of laboratory report scores for HYR and FTF.

Table 5

Laboratory reports Group Statistics

	Course type	N	Mean	Std. Deviation	Std. Error Mean
Lab report	Hybrid	41	5.9093	3.31455	.51765
	FTF	44	8.3452	3.09017	.46586

Table 6

Lab Reports Independent Samples t Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Lab report	Equal variances assumed	3.170	.079	-3.5	83	.001	-2.436	.69467	-3.818	-1.05429
	Equal variances not assumed			-3.5	81.4	.001	-2.436	.69641	-3.822	-1.05042

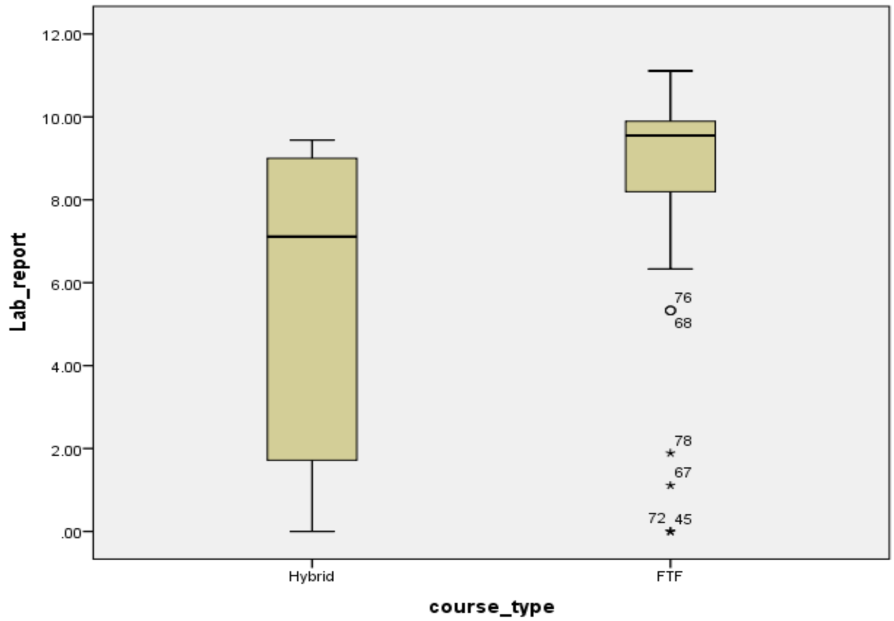


Figure 6. Boxplot of Lab reports scores for HYR and FTF.

Laboratory exams

When looking at the laboratory exams which make up 20% of final grade a mean difference of almost 1 is noted, hybrid (M= 12.93, SD= 20.14) and FTF (M= 14.17, SD= 5.31), as listed in Table 7. However, the independent sample t test (Table 8) presents no significant difference between the groups in their laboratory exam scores (t (83) = -3.94, p=0.695 > .05). Figure 7 represent the Box-plot of laboratory exam scores for HYR and FTF.

Table 7

Laboratory Exams Group Statistics

	Coursetype	N	Mean	Std. Deviation	Std. Error Mean
Lab exams	Hybrid	41	12.9376	20.14192	3.14564

FTF	44	14.1773	5.31683	.80154

Table 8

Lab Exam Independent Samples t Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Lab exams	Equal variances assumed	1.340	.250	-.39	83	.695	-1.240	3.1468	-7.499	5.0191
	Equal variances not assumed			-.38	45.2	.704	-1.240	3.2462	-7.777	5.2976

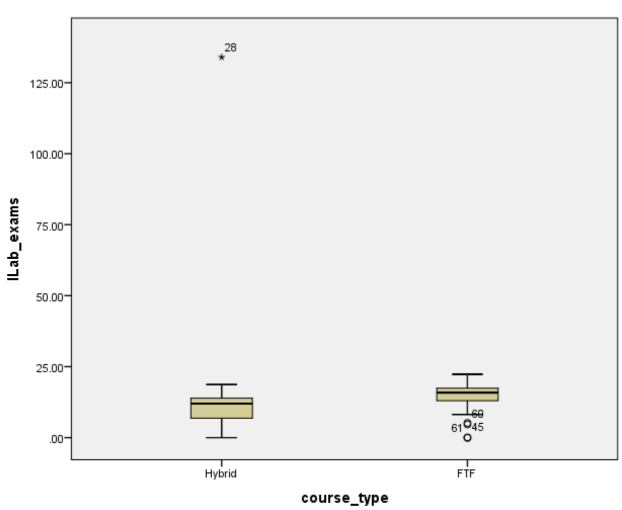


Figure 7. Boxplot of Lab exams score for HYR and FTF

Quizzes

Table 9 lists the mean score of quizzes which makes up 20% of final grade for both the hybrid (M=15.053, SD=5.615) and the FTF (M=12.027, SD=4.351) sections. Independent sample t test (Table 10) indicated no significant difference between the groups (t (83) = 2.78, p=.007 < .05). The results suggest that the two groups differ significantly in overall quiz scores with the hybrid section scoring higher. Figure 8 represent the Box plot of quiz scores for HYR and FTF.

Table 9

Quizzes Group Statistics

	Course type	N	Mean	Std. Deviation	Std. Error Mean
Quizzes	Hybrid	41	15.0539	5.61586	.87705
	FTF	44	12.0270	4.35168	.65604

Table 10

Quizzes Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper

Quizzes	Equal variances assumed	3.410	.068	2.79	83	.007	3.0269	1.0855	.86776	5.1859
	Equal variances not assumed			2.76	75.3	.007	3.0269	1.0953	.84514	5.2086

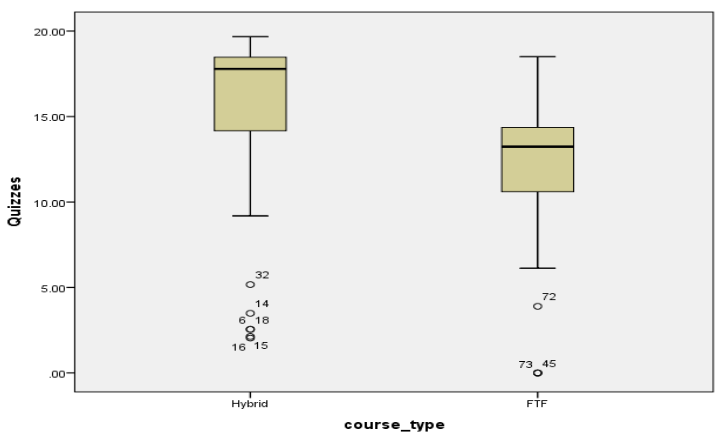


Figure 8. Boxplot of quiz scores for the HYR and FTF.

Midterm exam

Table 11 lists the overall mean and SD for the midterm exam scores which accounted for 15% of the overall final grade, hybrid sections M= 8.72, SD= 4.94 and for FTF, M= 10.37, SD= 4.09. An Independent sample t test (Table 12) indicated that there was no significant difference between the groups in the overall midterm scores (t (83) = -1.680, p=0.097 > 0.05). The results suggest that the two groups do not differ significantly in overall midterm exam scores. Figure 9 presents the Box-plot of midterm exam scores for HYR and FTF.

Table 11

Midterm Exam Scores Group Statistics

	Course type	N	Mean	Std. Deviation	Std. Error Mean
Midterm	Hybrid	41	8.7246	4.94949	.77298
	FTF	44	10.3761	4.09794	.61779

Table 12

Midterm exam scores Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Midterm	Equal variances assumed	3.252	.075	-1.7	83	.097	-1.652	.98295	-3.607	.30355
	Equal variances not assumed			-1.7	77.9	.099	-1.652	.98953	-3.622	.31854

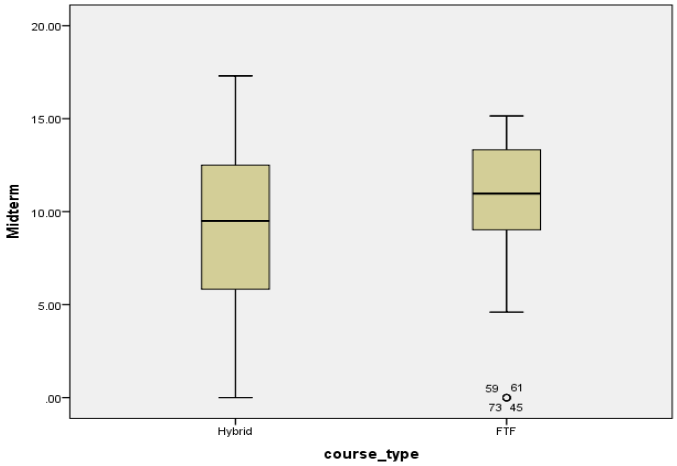


Figure 9. Boxplot of Midterm exam scores for HYR and FTF.

Final exam

The final exam counted for 25% of the total grade. Table 13 lists the mean and standard deviation for the hybrid (M= 10.069, SD= 6.81) and FTF (M= 16.90, SD= 6.56) sections. An Independent sample t test (t (83) = -4.70, p=.000 < .05) suggests that the two groups differ significantly in overall final exam scores with the FTF section scoring higher (Table 14). Figure 10 illustrates the Box plot of midterm exam scores for HYR and FTF.

Table 13

Final Exam Group Statistics

	Course type	N	Mean	Std. Deviation	Std. Error Mean
Final exam	Hybrid	41	10.0695	6.81503	1.06433
	FTF	44	16.9023	6.56695	.99001

Table 14

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Final exam	Equal variances assumed	.566	.454	-4.7	83	.000	-6.833	1.4517	-9.720	-3.945
	Equal variances not assumed			-4.7	82.0	.000	-6.833	1.4536	-9.724	-3.941

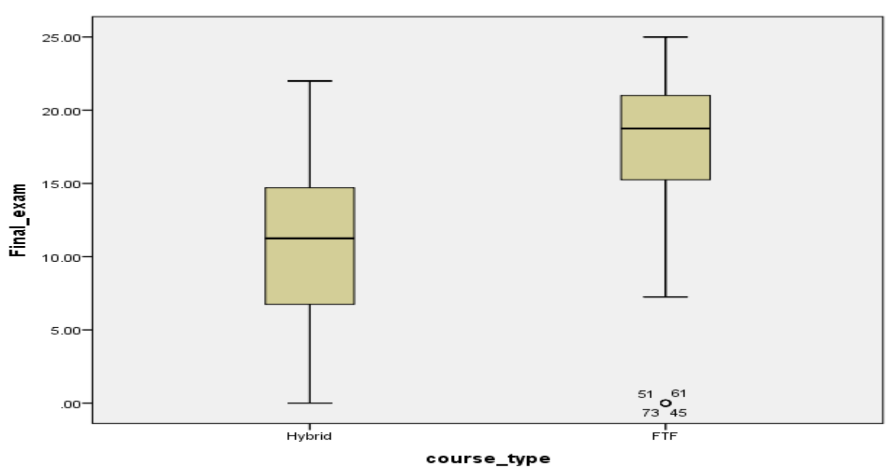


Figure 10. Boxplot of final exam scores for HYR and FTF.

Course grade

The final course grade for each student represents the summation of the percentages earned for assignments, laboratory reports and exams, homework, quizzes, midterm and final exams (Table 15). Overall, FTF students earned higher grades (A, A-, B+, B-, and C+) compared to those in hybrid sections (Table 16). The Mann Whitney U test distribution of the FTF rank higher than HYR for passing grades, U=0 and p=. 317.This means that the values in one sample are larger than the other, thus, we reject the null hypothesis (Table 17 & 18).

Table 15

Percentage total of course activities for HYR and FTF.

Assignments	10%
Laboratory Reports	10%
Laboratory Exams	20%
Quizzes	20%
Midterm Exam	15%
Final Exam	25%

Table 16

Combined spring and fall 2018 semesters course grade distribution percentages

	FTF	HYR
A	13.9%	4.9%
A-	9.3%	2.4%
B+	9.3%	2.4%
B	11.6%	14%
B-	9.5%	5%
C+	16.2%	7.3%
C	11.6%	21%
D	9.3%	16%
F	9.3%	27%

Table 17

Course Type Rank

Ranks

	Course_Type	N	Mean Rank	Sum of Ranks
A	HYR	1	1.00	1.00
	FTF	1	2.00	2.00
	Total	2		
A_MINUS	HYR	1	1.00	1.00
	FTF	1	2.00	2.00
	Total	2		
B_BLUS	HYR	1	1.00	1.00
	FTF	1	2.00	2.00
	Total	2		
B	HYR	1	2.00	2.00
	FTF	1	1.00	1.00
	Total	2		
B_MINUS	HYR	1	1.00	1.00
	FTF	1	2.00	2.00
	Total	2		
c_BLUS	HYR	1	1.00	1.00
	FTF	1	2.00	2.00
	Total	2		
C	HYR	1	2.00	2.00
	FTF	1	1.00	1.00
	Total	2		
D	HYR	1	2.00	2.00
	FTF	1	1.00	1.00
	Total	2		
F	HYR	1	2.00	2.00
	FTF	1	1.00	1.00
	Total	2		

Table 18

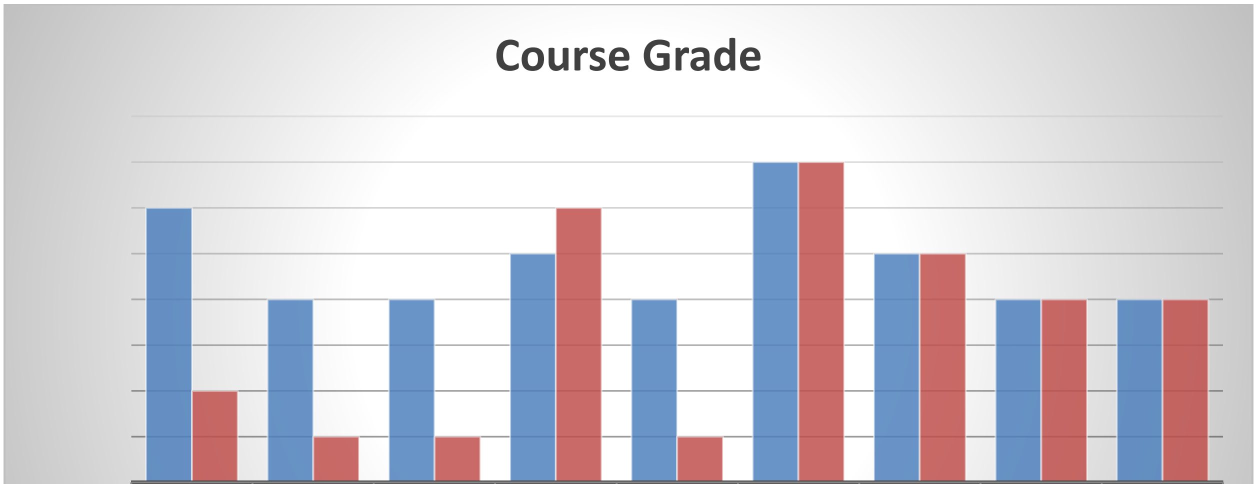
Mann-Whitney U course grade.

Test Statistics[a]

	A	A_MINUS	B_BLUS	B	B_MINUS	c_BLUS	C	D	F
Mann-Whitney U	.000	.000	.000	.000	.000	.000	.000	.000	.000
Wilcoxon W	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Z	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Asymp. Sig. (2-tailed)	.317	.317	.317	.317	.317	.317	.317	.317	.317
Exact Sig. [2*(1-tailed Sig.)]	1.000[b]	1.000[b]	1.000[b]	1.000[b]	1.000[b]	1.000[b]	1.000[b]	1.000[b]	1.000[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.



	A	A-	B+	B	B-	C+	C	D	F
FTF	6	4	4	5	4	7	5	4	4
HYR	2	1	1	6	1	7	5	4	4

Figure 11. Course grade percentages for the FTF and HYR sections.

Data from students' satisfaction survey were used to address: `

RQ2: Is there a difference between hybrid and traditional face-to-face science course in community college student satisfaction as measured by data collected from the end of semester survey?

The overall response to the Principles of Biology I student survey was minded at the end of each semester. The survey was posted at Survey Monkey, of 85 students in the HYR and FTF sections, only 47 students returned the survey, 23 from HYR and 24 from FTF sections, making a total return rate of 48%. The survey included 11 questions, listed in Table 19, addressing students' satisfaction with the course delivery mode HYR versus FTF in the Principles Biology I (BIO 115) at HCCC. These questions were in three main categories, learning the content and delivery, course management, and overall student satisfaction. A scale of strongly agree, agree, neither agree or disagree, disagree, and strongly disagree was used. The summary of the findings is presented in two formats: the percentage of students' replies to each question and, the statistical calculations with graphs.

Table 19

End of semester survey questions (SQ) on students' satisfaction

SQ5. The lessons/lecture notes used in this class facilitated my learning.
SQ6. The assignments/projects in this course facilitated my learning.
SQ8. In this course the laboratory activities were counted appropriately in relation to the overall course grade.
SQ9. I am satisfied with the grade distribution in this course.
SQ10. I am satisfied with how this course was administered.
SQ11. This course met my expectations.
SQ12. I feel the format of this course was very conducive to learning.
SQ13. I am satisfied with the amount of peer interactions available in this course.
SQ14. The syllabus clearly communicated what was expected in the course.
SQ15. I am satisfied with the percentage breakdown across the course activities that made up the final grade.
SQ16. Given the option, I would choose this course format again in the future.

Data was minded from the students' satisfaction survey and questions were analyzed by SPSS through Group Statistic Test and Mann-Whitney U test

1. **Learning the content and delivery satisfaction:** This was presented in survey questions 5, 6, and 12. Students responded as following:

   SQ5. The lessons/lecture notes used in this class facilitated my learning.

Twelve students who responded to this statement from FTF sections agreed or strongly agreed with the statement, six neither agreed nor disagreed, and one student disagreed. Nine students from HYR sections who responded to this statement agreed or strongly agreed, 5 neither agreed nor disagreed and 3 students disagreed. The descriptive data is shown in Table 20, the Mann-Whitney U = 138.5, and p = 0.407> .05, therefore no difference is assumed. Figure 12 shows the percentages of the answers.

Table 20

Mann-Whitney U for survey question 5

Test Statistics[a]

	Satisafction
Mann-Whitney U	138.500
Wilcoxon W	328.500
Z	-.829
Asymp. Sig. (2-tailed)	.407
Exact Sig. [2*(1-tailed Sig.)]	.471[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.

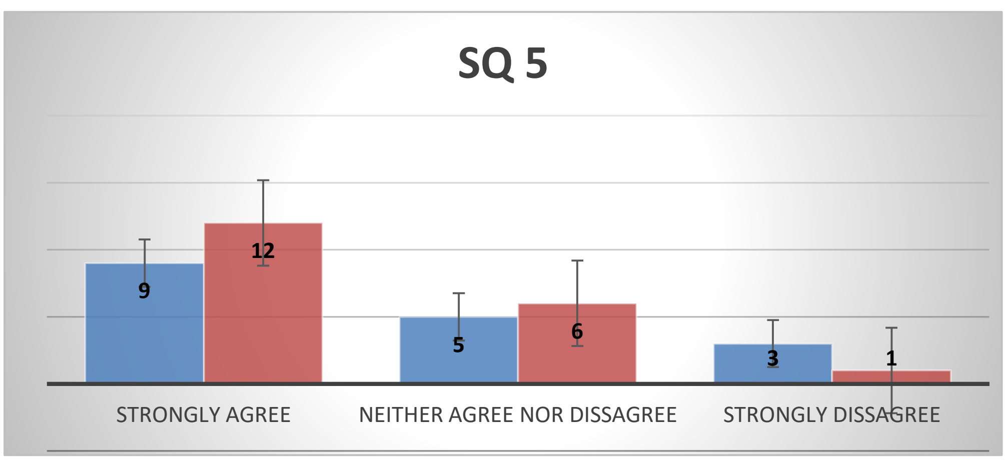


Figure 12. Percentages of student responses to SQ5 for the FTF and HYR sections.

SQ6. The assignments/projects in this course facilitated my learning.

Fifteen student respondents from FTF sections agreed or strongly agreed with the statement, 4 neither agreed nor disagreed, and 2 disagreed. From HYR sections, 11 student respondents agreed or strongly agreed, 3 neither agreed nor disagreed, and 3 disagreed. The Mann-Whitney U is shown in Table 21, U = 163.5 and p= .591> .05, hence there is no significant difference between the two groups. Figure 13 represents student responses to SQ6 for the FTF and HYR sections.

Table 21

The Mann-Whitney U for survey question 6

Test Statistics[a]

	Satisafction
Mann-Whitney U	163.500
Wilcoxon W	394.500
Z	-.537
Asymp. Sig. (2-tailed)	.591
Exact Sig. [2*(1-tailed Sig.)]	.663[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.

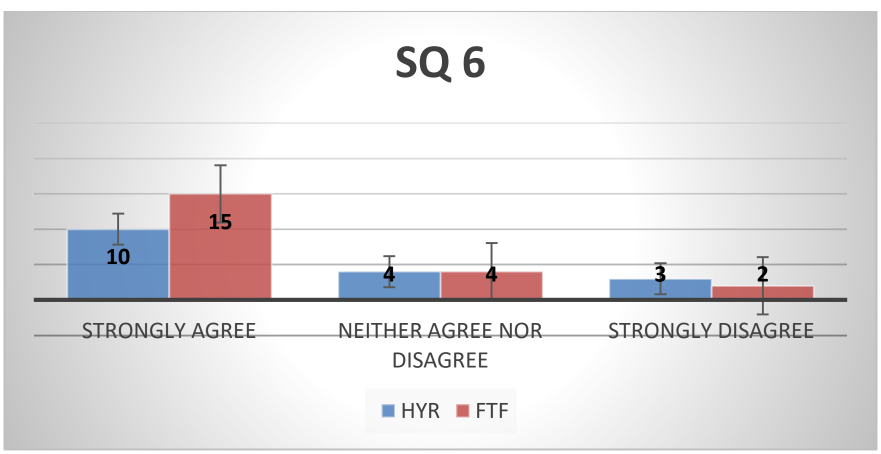


Figure 13. Students response to SQ6 for FTF and HYR sections.

SQ 12. I feel the format of this course was very conducive to learning.

Eighteen respondents from FTF sections agreed or strongly agreed, 2 neither agreed nor disagreed, and 1 disagreed. From the HYR sections, 8 students who responded to the survey agreed or strongly agreed with the statement, 5 neither agreed nor disagreed, and 6 disagreed. The Mann-Whitney U is shown in Table 22, U = 109 and p=.004 < 0.05, indicating that there is no significant difference between the two groups. Figure 14 presents the response percentages to the FTF and HYR sections.

Table 22

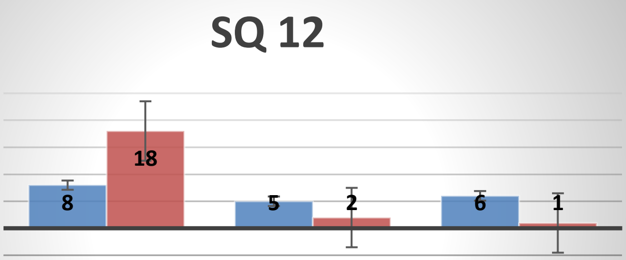
The Mann-Whitney U for SQ12

Test Statistics[a]

	Satisafction
Mann-Whitney U	109.000
Wilcoxon W	340.000
Z	-2.899
Asymp. Sig. (2-tailed)	.004
Exact Sig. [2*(1-tailed Sig.)]	.014[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.



	Strongly Agree	Neither Agree Nor Disagree	Strongly Disagree
HYR	8	5	6
FTF	18	2	1

Figure 14. Student responses to SQ12 for the FTF and HYR sections.

2. **Course delivery & Management satisfaction:** This was presented in survey questions 8, 9, 10, 13, and 15. Students responded as following:

SQ8. In this course the laboratory activities were counted appropriately in relation to the overall course grade.

From FTF sections 18 students agreed or strongly agreed, 2 neither agreed nor disagreed, and 1 disagreed. From the HYR sections respondents to this question 14 students agreed or strongly agreed, 2 neither agreed nor disagreed, and 2 disagreed. The Mann-Whitney U is shown in Table 23 with U = 137 and p= .500 > .05, indicating no significant difference between the two groups. Figure 15 presents the distribution of score for the FTF and HYR sections.

Table 23

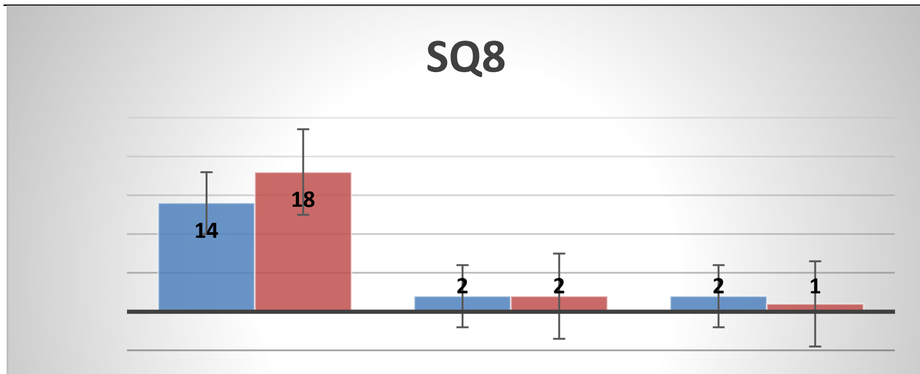
Mann-Whitney U SQ8

Test Statistics[a]

	Satisafction
Mann-Whitney U	173.000
Wilcoxon W	404.000
Z	-.675
Asymp. Sig. (2-tailed)	.500
Exact Sig. [2*(1-tailed Sig.)]	.666[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.



	Strongly Agree	Neither Agree Nor Disagree	Strongly Dissagree
HYR	14	2	2
FTF	18	2	1

Figure 15. Students' responses to SQ8 for FTF and HYR sections.

SQ9. I am satisfied with the grade distribution in this course.

Seventeen students-from FTF sections agreed or strongly agreed, 3 neither agreed nor disagreed, and 1 disagreed. HYR students' responses to this statement were: 11

agreed or strongly agreed, 2 neither agreed nor disagreed, and 5 disagreed. The Mann-Whitney U is shown in Table 24 with U =145 and p = 0.117 >0.05, hence, no significant difference between the two groups. Figure 16 presents students' responses to SQ 9.

Table 24

The Mann-Whitney U for SQ9

Test Statistics[a]

	Satisafction
Mann-Whitney U	145.000
Wilcoxon W	376.000
Z	-1.568
Asymp. Sig. (2-tailed)	.117
Exact Sig. [2*(1-tailed Sig.)]	.223[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.

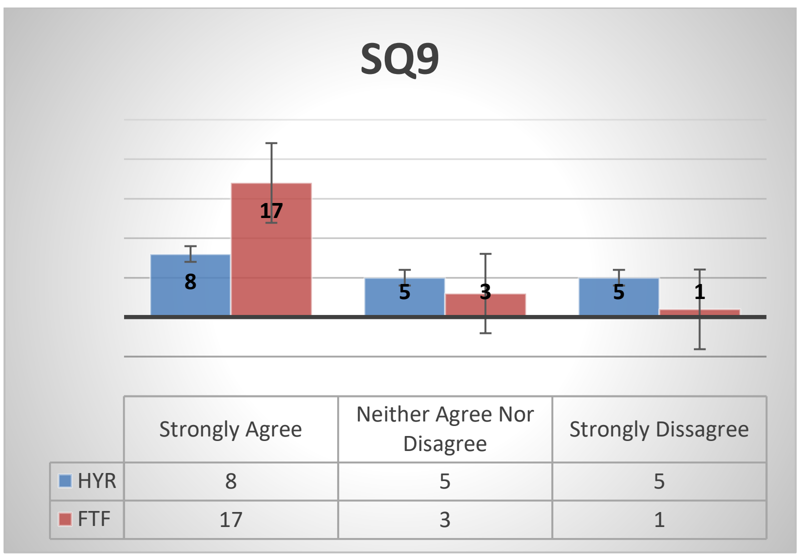


Figure 16. Students' responses to SQ9 for the FTF and HYR sections.

SQ10. I am satisfied with how this course was administered.

Responses from FTF classes: 14 students agreed or strongly agreed, 5 neither agreed nor disagreed, and 2 disagreed. The HYR students responded 10 in agreement or strong agreement, 6 neither agreed nor disagreed, and 3 disagreed. The Mann-Whitney

U is shown in Table 25 with U = 170 and $p = 0.360 > 0.05$ therefore no significant difference between the two groups. Figure 17 presents students responses to the FTF and HYR sections.

Table 25

Mann-Whitney U results for SQ10

Test Statistics[a]

	Satisafction
Mann-Whitney U	170.000
Wilcoxon W	401.000
Z	-.915
Asymp. Sig. (2-tailed)	.360
Exact Sig. [2*(1-tailed Sig.)]	.436[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.

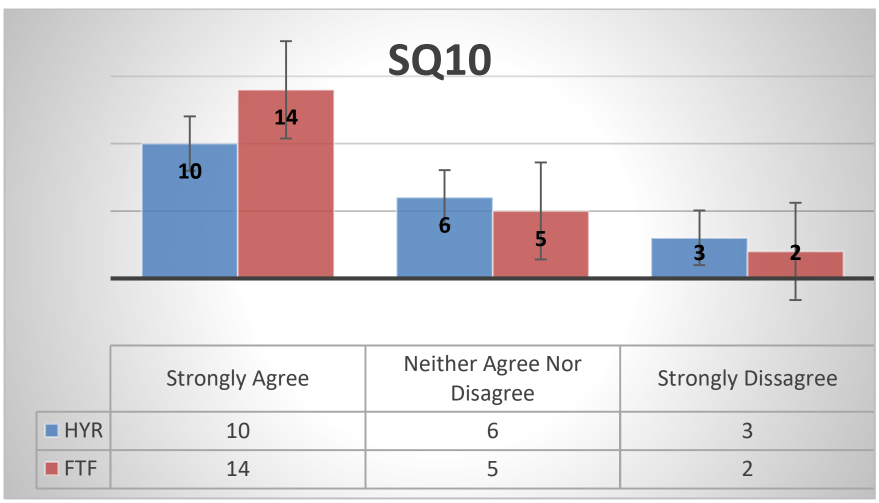


Figure 17. Students responses to SQ10 for the FTF and HYR sections.

SQ13. I am satisfied with the amount of peer interactions available in this course.

Total of 21 students responded to SQ13 from FTF sections. 19 of them agreed or strongly agreed with the statement, 1 neither agreed nor disagreed, and 1 disagreed. 13 of participating HYR students agreed or strongly agreed with the statement, 2 neither agreed nor disagreed, and 2 disagreed. The Mann-Whitney U is shown in Table 26 with U = 170 and p = 0.247 > 0.05, therefore there is no significant difference between the two groups. Figure 18 presents students responses to SQ13 for the FTF and HYR sections.

Table 26

The Mann-Whitney U for SQ13

Test Statistics[a]

	Satisafction
Mann-Whitney U	153.500
Wilcoxon W	384.500
Z	-1.157
Asymp. Sig. (2-tailed)	.247
Exact Sig. [2*(1-tailed Sig.)]	.467[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.

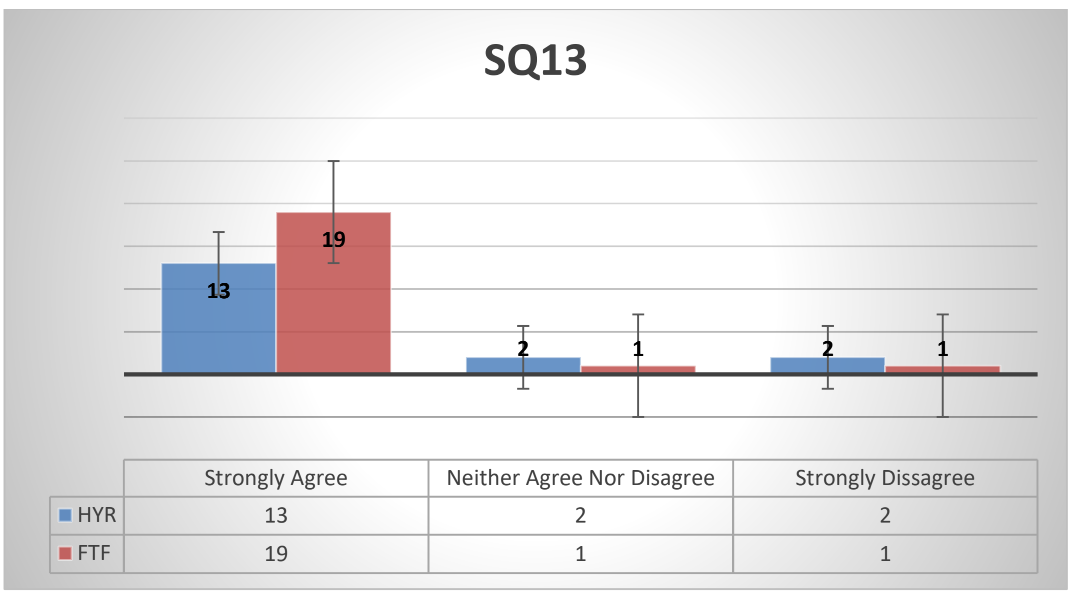


*Figure 18***.** Students' responses to SQ13 for the FTF and HYR sections

SQ15. I am satisfied with the percentage breakdown across the course activities that made up the final grade. Sixteen students from FTF sections agreed or strongly agreed, 4 neither agreed nor disagreed, and 1 disagreed. Of HYR responses to this statement 13 students agreed or strongly agreed, 5 neither agreed nor disagreed, and 2 disagreed. The Mann-Whitney U is shown in Table 27 with U= 138.5 and p= 0.413 >0.05 therefore no significant difference between the two groups. Figure 19 presents students responses to the FTF and HYR sections.

Table 27

Mann-Whitney U for SQ15

Test Statistics[a]

	Satisafction
Mann-Whitney U	185.000
Wilcoxon W	416.000
Z	-.818
Asymp. Sig. (2-tailed)	.413

a. Grouping Variable: Course_Type

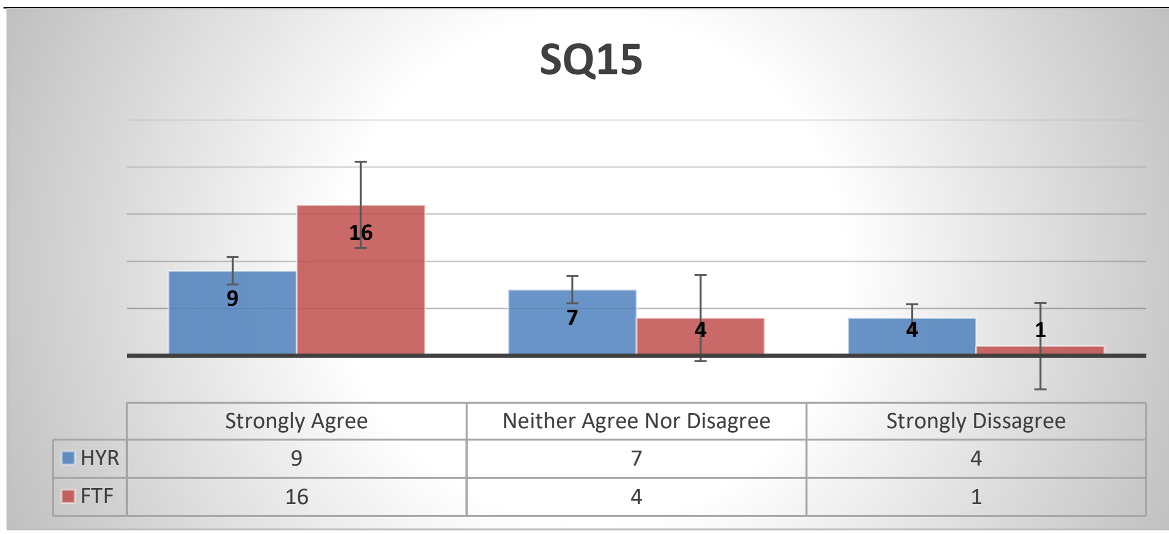


Figure 19. Students' responses to SQ15 for the FTF and HYR sections

3. **Overall satisfaction**: This was presented in survey questions 11 and 16.

   Students responded to these questions as following:

SQ11. This course met my expectations.

Sixteen students from FTF sections agreed or strongly agreed, 3 neither agreed nor disagreed, and 2 students disagreed. On the other hand, 8 of HYR students agreed or strongly agreed, 6 neither agreed nor disagreed, and 6 disagreed. The Mann-Whitney U is shown in Table 28 with U = 131 and p = 0.02 < 0.05, indicating that there is a significant difference between the two groups. Figure 20 presents students responses to SQ 11.

Table 28

Mann-Whitney U results for SQ11

Test Statistics[a]

	Satisafction
Mann-Whitney U	131.000
Wilcoxon W	362.000
Z	-2.330
Asymp. Sig. (2-tailed)	.020

a. Grouping Variable: Course_Type

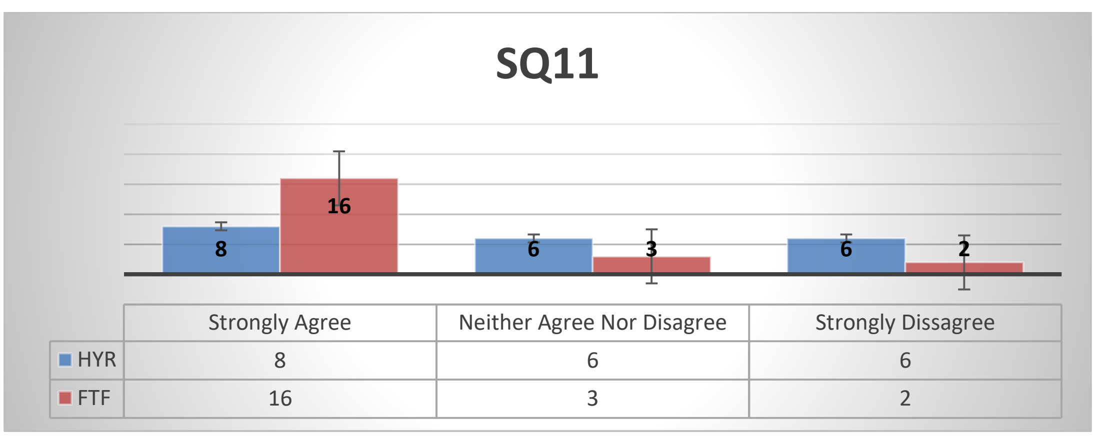


Figure 20. Results of students' responses to SQ11 for the FTF and HYR sections

SQ16. Given the option, I would choose this course format again in the future.

Response from FTF students included 16 agreed or strongly agreed, 1 neither agreed nor disagreed, and 2 disagreed. The HYR students' responses to this question were 8 agreed or strongly agreed, 3 neither agreed nor disagreed, and 6 disagreed. The Mann-Whitney U test results is shown in Table 29 with U = 97.500 and p = 0.029 < 0.05, indicating that there is significant differences between the two groups. Figure 21 presents students responses to SQ16 for the FTF and HYR sections.

Table 29

Mann-Whitney U test for SQ16

Test Statistics[a]

	Satisafction
Mann-Whitney U	97.500
Wilcoxon W	268.500
Z	-2.184
Asymp. Sig. (2-tailed)	.029
Exact Sig. [2*(1-tailed Sig.)]	.067[b]

a. Grouping Variable: Course_Type

b. Not corrected for ties.

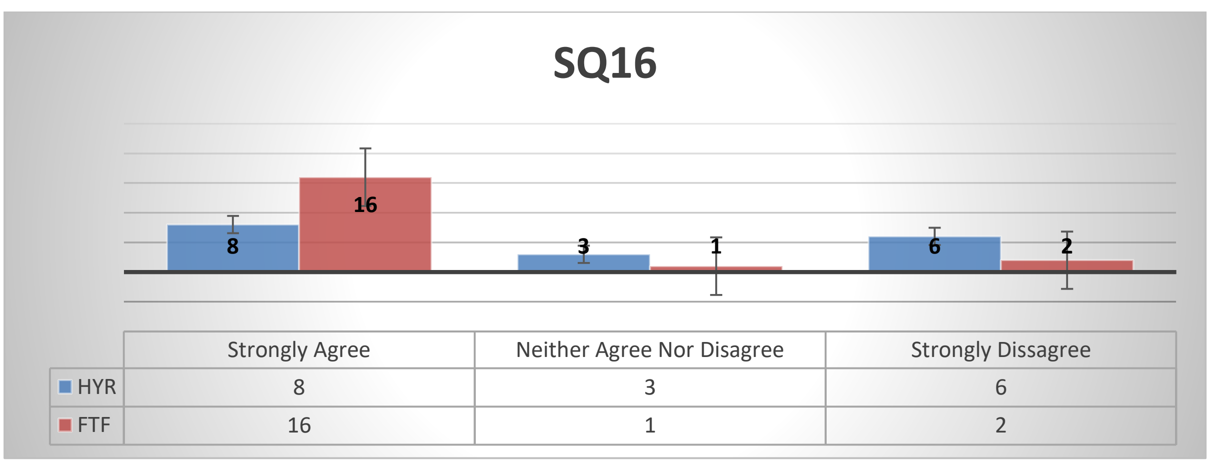


Figure 21. Independent Samples t-Test results of SQ16 for the FTF and HYR sections.

Data collected from the survey present differences in satisfaction for survey questions 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, and 16. The mean positive satisfaction was higher for the FTF with mean = 15.18 whereas the HYR mean= 12.16 (Figure 22). The Mann-Whitney U is (Table 30) U= 5.000 with P=.000< .05 indicating no difference between groups. Responses on neutral satisfaction between the two groups, Figure 23, were about the same, FTF mean= 3.54 and HYR mean= 3.54 with the Mann-Whitney U of (Table 31) U=48.00 and P= .403 >.05 hence no evidence to support difference between the groups. The negative overall satisfaction with type of the course, Figure 24, show that FTF mean= 1.90 and the HYR mean= 2.40, slightly higher than FTF, with the Mann-Whitney U of (Table 32) U= 8.000 and P=.000 <.05 indicative of difference between the groups. This shows less satisfaction among hybrid students-compared to those in face-to-face classes.

Table 30

Mann-Whitney U for positive Satisfaction SQ5-16

Test Statistics[a]

	Positive_Satisfaction
Mann-Whitney U	5.000
Wilcoxon W	71.000
Z	-3.663
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

a. Grouping Variable: Cours_type

b. Not corrected for ties.

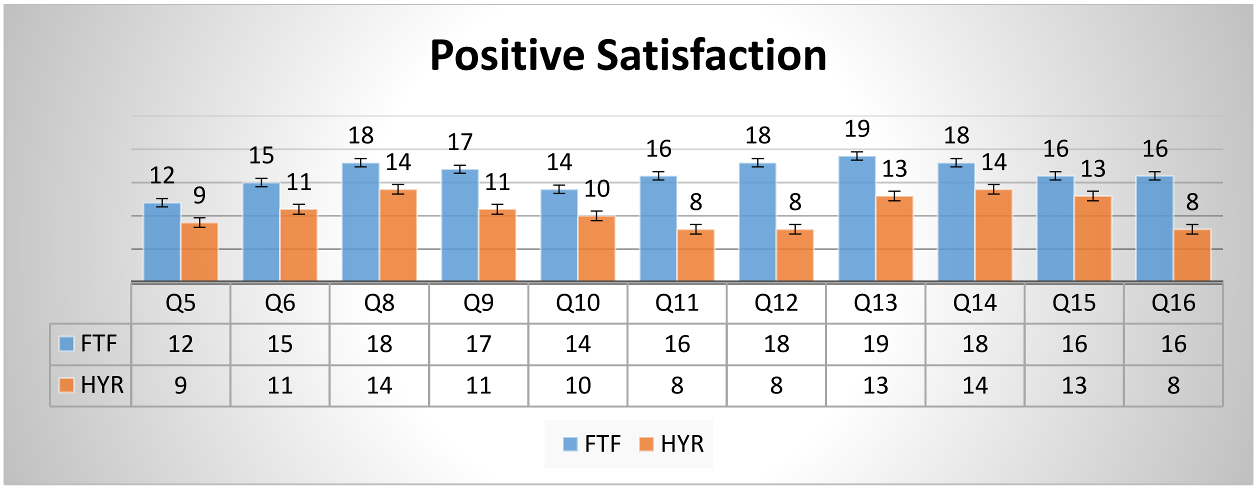


Figure 22. Students positive satisfaction for SQ5-SQ16.

Table 31

Mann-Whitney for neutral satisfactions score SQ5-16

Test Statistics[a]

	Netural_Satisfaction
Mann-Whitney U	48.000
Wilcoxon W	114.000
Z	-.836
Asymp. Sig. (2-tailed)	.403
Exact Sig. [2*(1-tailed Sig.)]	.438[b]

a. Grouping Variable: Cours_type

b. Not corrected for ties.

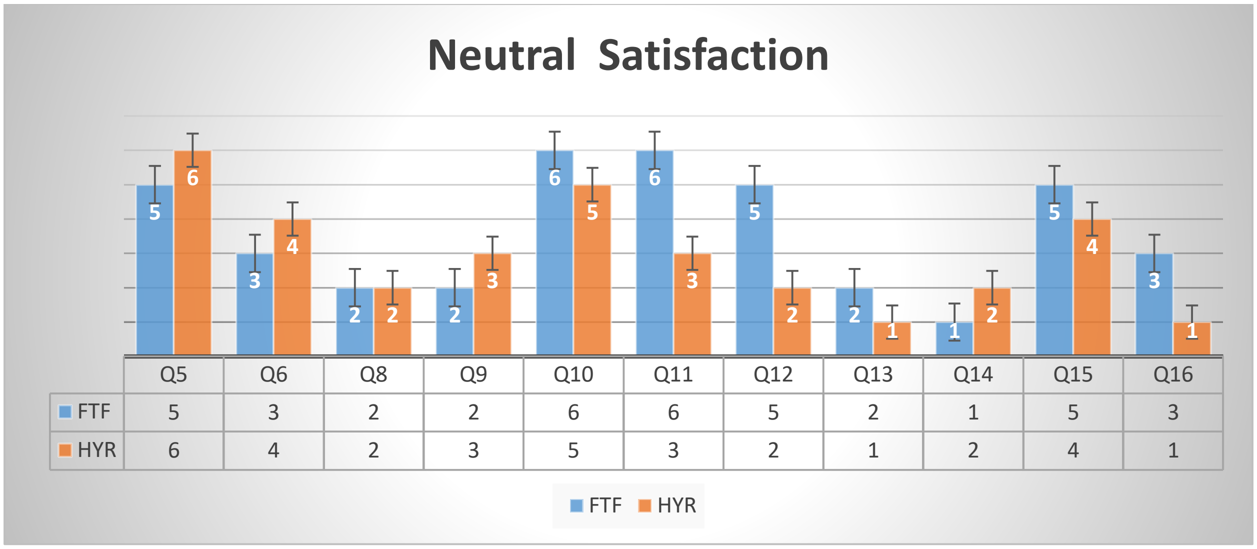


Figure 23. Students neutral satisfaction for SQ5-SQ16.

Table 32

Mann-Whitney U negative satisfaction SQ5-16

Test Statistics[a]

	Netural_Satisfaction
Mann-Whitney U	48.000
Wilcoxon W	114.000
Z	-.836
Asymp. Sig. (2-tailed)	.403
Exact Sig. [2*(1-tailed Sig.)]	.438[b]

a. Grouping Variable: Cours_type

b. Not corrected for ties.

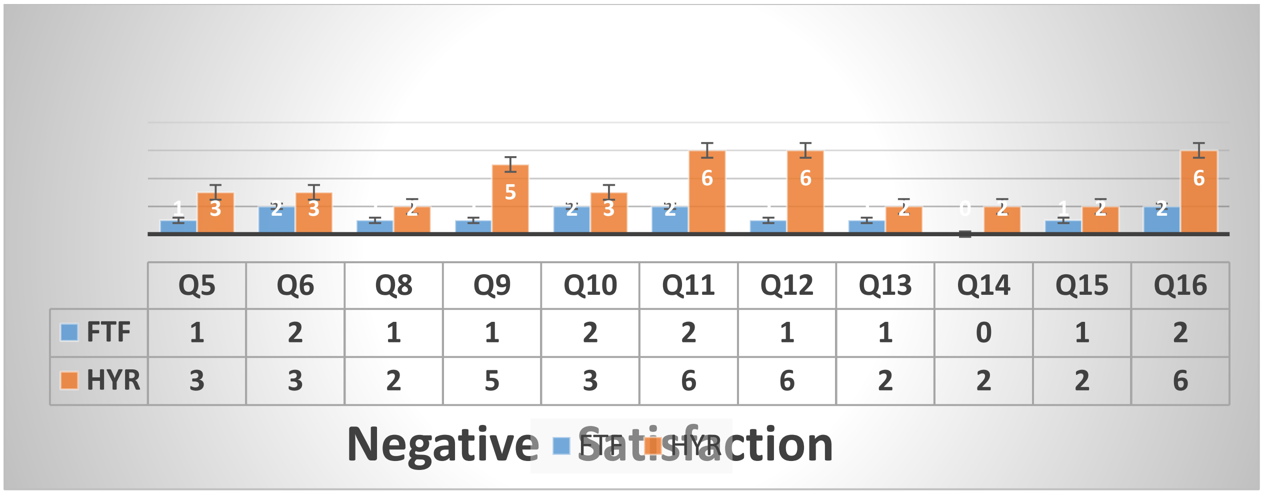


Figure 24. Students negative satisfaction for SQ5-SQ16.

Retention

The third research question compared the retention of students in the two modes of course delivery, hybrid and face-to-face.

RQ3: Is there a difference between hybrid and traditional face-to-face science course retention as measured by examining students that dropped or withdrew from the course?

Data was minded from the HCCC portal to obtain list of students at the beginning and end of each semester. From this data the number of students who dropped from the course can be identified. Students can drop a course during the first two weeks of the semester with no penalty in their record. However, if they withdraw from a course after first two weeks of the semester but before the end of 12th week, a 'W' will be registered for the course in their transcripts. As listed in Table 33, only two students dropped from FTF class in spring 2018 and none in the fall. However, 3 students dropped from the HYR class in the spring and 10 in the fall 2018. The independent t-Test (Table 34) presents t (99) =2.879 and p = 0.005<0.05. This presents significant difference between the groups.

Table 33.

Enrollment data for Principles of Biology I at HCCC during spring and fall semesters of 2018

Semester	FTF			HYR		
Spring 2018	Starting	Ending	Dropped	Starting	Ending	Dropped
	25	23	2	26	23	3
Fall 2018	21	21	0	28	18	10

Table 34

Independent t-test for retention rate between the FTF and HYR

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Retetion	Equal variances assumed	47.167	.000	2.879	99	.005	.19819	.06883	.06162	.33476
	Equal variances not assumed			3.010	77.806	.004	.19819	.06584	.06711	.32926

Figure 25. Student Retention

CHAPTER V

Discussion

There have been many studies exploring online and hybrid teaching formats in recent years, Carnevale (2000), Rivera (2002), Young (2002), Gould (2003), Meyer (2003), Singh (2003), Hodges (2004), Bhattie et al (2005), Saade and Kira (2009), Lloyd-Smith (2010), Jaggors (2011), Abdaulahi (2011), Brain (2012), and Movahedzadeh (2012), just to name a few. This study added to this body of knowledge by specifically focusing on the use of hybrid online teaching of a science course (Principals of Biology I) in an urban community college in which most students enrolled were adult learners. The study was conducted by a biology instructor with more than 15 years of experience in teaching both face to face and hybrid courses. The study spanned over two semesters in which the same instructor, following the same syllabus executed the same science courses via both a hybrid and face to face format.

Driving this study was the ever-growing physical constraints for teaching space encountered by community colleges and the increased demand for, and enrollment in, science courses, biology in particular, in community colleges. Further driving this study was the fact that urban community colleges must cater to a diverse student population with different academic and cultural backgrounds. In the urban community college, it is important that the faculty engage students at their level of academic abilities and advance them while also respecting their cultural differences. However, as academicians we must ensure that, the rigor and quality of the course material is not compromised as we seek to, provide flexible learning situations for our growing diverse student populations and that we optimize the use of campus space. Based upon the findings from this study faculty members and college administrators can gain insight into how to best serve students diverse needs in the urban community college and maintain the integrity of the course content explored.

This study proposed three research questions for both modes of delivery, face to face and hybrid. These questions aimed to study: students' learning outcomes, students' satisfaction, and student retention in these two modes of teaching. To minimize variability based upon instructor style of teaching and content knowledge the same instructor taught both sections and the same course syllabus and grading scale were used. An independent research assistant reviewed all student questionnaire responses in order to ensure that the course instructor had not inadvertently imposed bias when reviewing student responses.

The descriptive data included a total of 85 students enrolled in both modes of delivery of the course in the spring and fall 2018 academic semesters. There were 23 students in each section in spring 2018 and there were 21 students in traditional face-to-face and 18 in hybrid in the fall. Post hoc G* Power was calculated for alpha=0.05 and effect size of 0.80.

The first research question assessed, students' learning outcome, utilized standard assessment tools, such as assignments, laboratory reports, laboratory exams, quizzes, midterm and final exams. These scores were processed by the statistical software SPSS to obtain mean, standard deviations, and results of independent t-test. No significant difference in scores between the two modes were noted for assignments, laboratory exams, and midterm exams. However, a significant difference was observed in the laboratory reports, with the traditional face-to-face students scoring higher than the hybrid students. This may be because traditional students spent more time in class with the instructor and could have benefited from an in person one on one explanation. On the other hand, the students in hybrid mode did better in quizzes than students in face to face. This can be attributed to the time allocated to take the quiz. Students enrolled in hybrid course could choose the day and time to work on the quiz in the given week even though the timeframe set for the actual exam was consistent across modes. The third difference was observed in final exam scores where face-to-face students scored higher than hybrid students. As for the final course grade 80% of traditional face-to-face students scored higher than C where only 60% of hybrid class scored C or higher. In summary, these findings presented a significant difference in learning outcomes, as measured by common assessment tools.

The second research question assessed students' satisfaction via a questionnaire (Survey Monkey). Questions regarding satisfaction were designed in three categories, namely learning and content, course management and delivery, and overall satisfaction. Traditional students revealed a higher positive satisfaction with their course where hybrid students presented more neutral and negative satisfaction.

The third research question assessed students' retention. Data minded from the College portal using the management system-canvas at the end of each semester revealed that traditional face-to-face students' retention was higher (46 started and 44 finished) than students enrolled in the hybrid sections (54 started and 41 finished).

As we look at the study findings and seek to secure insights that can help to inform academicians and administrators in the urban community college meet the needs of the diverse ever-growing population, we can infer the following. Traditional face-to-face learning offers interaction with instructor that has been in practice for centuries and thus learners are more familiar with its procedures and might gravitate towards it. Online learning which can be asynchronous can offer students a more flexible schedule to balance their life, work, and education schedules. For adult learners that work or have family responsibilities or, have been away from school for years, flexibility in their education scheduling is of the utmost importance. The hybrid online mode can provide adult learners with the flexibility to learn the content and interact with their instructors and fellow classmates. However, the learning outcomes from this study support that students in the hybrid online mode of learning must be more self-reliant and disciplined, thus truly adult learners to benefit from this model of learning delivery.

Not surprising, student satisfaction data support that, students are still somewhat more inclined with traditional classroom setting as that is what they have been indoctrinated to expect from an educational environment. This finding suggests that educators and administrators must better prepare students in the community college with the resources needed to successfully adapt to diverse learning modes.

Student retention was in coherence with the other two research questions, namely familiarity with the educational setting and self-dependence. More students in hybrid classes withdrew from their course compared to the traditional face-to-face courses. One reason could be because they were not able to study on their own and fell behind in submitting assignments, labs and quizzes on time.

Overall, the findings from this research study support that benefits do exist in both face to face and online hybrid modes of delivering learning in the community college specifically for science coursework. Students should be given the opportunity to enroll in the course mode of delivery that best meets their learning style and life work balance. However, students must be prepared to meet the adult learning principles proposed by the theory of andragogy in order to maximize their learning.

Therefore, it is recommended that colleges, in particular urban community colleges that educate students from diverse academic and cultural backgrounds, offer courses in both modes of instructional delivery but better prepare the students and faculty to successfully meet the expectations of the modes of delivery. Hybrid courses in the sciences can offer students with a more convenient schedule time and assist community colleges with limited space and facilities to accommodate the continuous increase in student enrollment but, the degree of student independence, discipline, and motivation must be understood by the student so they can make a more informed decision prior to selecting hybrid courses.

Study Limitations

As with all studies, this study has several limitations which must be noted. First, major versus nonmajor, when comparing learning outcome in this study we should note that the course can be taken by students majoring in Biology and taking it as their core course versus students taking it as science elective. This can affect their work on the course and eventually their satisfaction and retention. Second, student may have had external forces such as course close out, work schedules, etc, determining their class schedules and thus did not self-select to enroll into the hybrid or face-to-face.

Future research

Comparing the findings of this study and prior ones indicates that future work is needed to further explore the impact and effectiveness of divers teaching modes at urban community colleges with open enrollment policy as the population of students in this study. As this group of students may have not been adequately prepared to benefit from the adult learning principles (Andragogy) supported by the hybrid learning, they should be prepared for such journey in high school or prior to attending an academic semester, such as a summer workshop on hybrid learning. Future work must also explore student learning mode preferences (face to face or hybrid) for different type of courses (science, humanities, etc.) In addition, educator's experience in teaching hybrid courses would impact the effectiveness of diverse modes of teaching and learning.

Conclusion

This study provides an understanding of differences between hybrid and face-to-face in one science course at one urban community college. The study present significant difference in learning outcomes where students enrolled in traditional face-to-face classes have better learning outcomes compared to those enrolled in hybrid. The findings of this study, however, are different from what is reported in the literature which present mostly similar or in some studies better learning outcomes for hybrid versus traditional. This difference could be related to the type of institutions, urban community college versus four-year colleges or universities in which the studies were conducted. This can also be because community colleges have open door policy and because of that they admit all applicants of whom some may not be college ready unlike universities that screen their applicants and have admission requirements. Thus, further research is needed to evaluate the effectiveness of hybrid learning in urban community colleges.

Educators using a hybrid / online learning environment, must embrace and infuse the principles of adult learning theory into their curse design and assignment expectations in order to meet the needs of today's adult learner, and explore the literature surrounding learning communities to aid students development. In July 2012, MDRC and the National Center for Postsecondary Research released two reports on the effectiveness of learning communities, strategy that places small cohorts of students together in two or more thematically linked courses, usually for a single semester, with added support, such as extra advising or tutoring. The theory behind learning communities is: they give students a chance to form stronger relationships with each other and their instructors, engage more deeply with the integrated content of the courses, and access extra support.

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APPENDICES

APPENDIX A

Seton Hall University IRB Approval

SETON HALL UNIVERSITY
1 8 5 6

August 28, 2018

Abdallah Matari

Dear Mr. Matari,

This letter is a formal statement that your study, "Hybrid and Face-to-Face Enrollment and Performance of Community College Students in Science Course" does not fall under the purview of the IRB. This is because, as you describe it in your IRB Application, the study is a nongeneralizable case study on teaching methods in two of your classes at Hudson County Community College.

Please remove the reference to the IRB office and myself in the Informed Consent document before you give it to the participants.

Sincerely,

Mary F. Ruzicka, Ph.D.
Professor
Director, Institutional Review Board

cc: Dr, Genevieve Zipp

APPENDIX B

HCCC IRB LETTER

HUDSON COUNTY
COMMUNITY
COLLEGE

March 5, 2018

Re: Hybrid and Face-to-Face Enrollment and Performance of Community College Students in Science Class

Dear Abdallah,

Thank you for giving us the opportunity to consider your research proposal. As part of Hudson County Community College's commitment to developing best research practices, the Institutional Review Board (IRB) requires the application of formalized investigative procedures and welldocumented proposals.

Your application has been approved under the criteria associated with the expedited review procedures established by Department of Health and Human Services - Office for Human Research Protections and incorporated into the review procedures established the HCCC Institutional Review Board.

The IRB approval extends from 03/01/2018 through 12/14/2018; please note the following guideline:

> Responsibilities of the Principal Investigator: Any additions or changes in procedures in the protocol will be submitted to the IRB for written approval prior to these changes being put into practice. Any problems connected with the use of human subjects once the project has begun, must be brought to the attention of the IRB Chair. The principal investigator and his or her designee are responsible for retaining Informed Consent Documents for a period of three years after completion of the project.

The IRB Committee appreciates your interest in conducting research at Hudson County Community College.

hank you,

Thank you,

Gerardo Trombella, Ph.D.
Dean of Institutional Research and Planning Hudson
County Community College

cc: Pamela Bandyopadhyay, Ph.D.
Nancy Booth, Ed.D.
Jery Lamb, Ed.D.
Jeannette Lim