

Online Microbiology Course Effectiveness Compared to Traditional Courses

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Abstract

As the online science course offerings increase, many educators are concerned with the ability of these online courses to deliver an effective course that includes rigorous content and to deliver an

effective course, especially in biology. An idea to explore when determining the effectiveness of an online biology course is the preparedness of students. Students who had taken a college biology course and/or have received technology training before taking an online microbiology course are variables that could affect student success in an online course. This literature review explores previous research to determine if online microbiology courses have been as effective as a face-to-face microbiology course. The study consisted of various searches of keywords at online journal sources, including UNT library sources such as OVID, PubMed, and, Google Scholar. Multiple studies were identified that contained relevant information to evaluate the effectiveness of student success in an online course, specifically an online microbiology course.

Keywords: traditional course, online course, technology, non-traditional course, traditional student, non-traditional student

Introduction

Obtaining an online education has become a practical option for many students who require the flexibility that online educations can offer (Adams et al., 2015). As the use of technology in the classroom increases and the need for flexibility in course offerings rises, the need to evaluate the effectiveness of technology use in online and hybrid courses is necessary (Biel & Brame, 2016). This is especially accurate when evaluating the effectiveness of online courses in biology such as microbiology, which uses live bacterium during experimentation (Adams et al., 2015). Many instructors and institutions are uncertain that online biology courses are effective in creating a learning environment and preparing students for upper-level biology courses and professional programs (Alhumaid et al., 2019). However, proper technology training before taking an online course is vital for success (Eichelberger & Imler, 2016). Instructors and students that are trained in technology could then devote more attention to learning information rather than troubleshooting technology.

To gain foundational information about the impact of technology training and student academic preparation before college courses, extensive research was conducted. Key terms such as traditional and non-traditional students resulted in the literature comparing the success rate of the two groups within college courses and the obstacles they potentially face (Gonclaves & Trunk, 2014). Adding key terms such as online versus traditional courses to the search engine provided additional information to the study about comparisons of the effectiveness of online and traditional courses. Various studies provided alternate conclusions about the comparison of online and traditional course delivery. Biel and Brame (2016) concluded there was no difference between the two-course delivers while Adams et al. (2015) concluded that non-traditional

courses performed significantly poorer than the traditional course. While the literature review provided foundational information, the phrase well-designed online course can be as effective as a traditional course was a repeated theme among the literature (Biel & Brame, 2016).

The focus of this study is to determine how prior technology training and prior exposure to a college course impacts student success in an online course, such as an online microbiology course, compared to a traditional (face-to-face) course.

Literature Review

Background

As students, traditional and nontraditional, enter college, they have the option to pick their courses (online, hybrid, face-to-face) usually without guidance. Many students are not guided on the correct course sequence and often take harder courses such as biology when they are ill-prepared to handle the course material (Adams et al., 2015). Students are also intrigued about the possibility of completing a course in an online format yet are not equipped with the proper technical training to be successful in an online or hybrid course (Varty, 2016).

With multiple literature reviews and studies of online course effectiveness versus a traditional course, researchers have used varying methodological approaches and concluded opposing results. The inconsistency of the terminology used to describe an online course and the homologous usage of the term traditional course creates difficulty when conducting a literature review on this topic. A literature review by Faulconer and Gruss (2018) introduced the difference in terminology that can lead to inconsistency in comparison to research study results. While the literature provides foundational information, the comparison of online and traditional courses resulted in conflicting results. A research study identified no significant difference between an

online and traditional course yet failed to identify the difference in the types of general biology courses (Biel & Brame, 2016). Another study compared hybrid courses to traditional courses and determined that students in hybrid courses performed poorer than the traditional courses (Adams et al., 2015). This data is beneficial in providing a framework for this literature review and supplying foundational information, yet it did not address online courses and evaluated just one hybrid course. When determining the effectiveness of different modalities of course offerings, the impact on learning, attitudes, and cost must be evaluated (Son et al., 2016).

Technology Awareness and Training

Student success in online or hybrid courses can be influenced by the amount of technology training students have received. Eichelberger and Imler (2016) conducted a study evaluating student proficiency in Microsoft Word, Microsoft PowerPoint, PDFs, Gmail, Windows, and Microsoft Excel. The researcher selected 39 college freshman students from three different institutions. The participants were evaluated by screen recording software and an online exam. It was concluded that traditional-aged students (younger than 24 years old) displayed more confidence in their technology skills yet did not perform better in the skills tests than non-traditional aged students (older than 24 years old). A majority of the traditional-aged students were self-assured with their technology skills and happy with their performance on the skills test yet performed poorly on the skills test.

Grant et al. (2016) conducted a study to evaluate students perceived technology skills to their actual technical ability. The researchers administered a survey and an assessment tool for 200 U.S. college students. The student had been required to complete an introductory computer applications course. The survey was designed to capture student perception of computer skills

and proficiency. The assessment tool evaluated their computer application skills and proficiency. The researchers concluded that there was no difference in students' perception of presentation skills and actual ability, there was some difference in students' perception of word processing skills and their ability, and a significant difference in students' perception and spreadsheet skills ability.

Terminology

One of the biggest obstacles when analyzing studies is the masked meaning of terminologies, such as e-Learning, online, blended, hybrid, and traditional when describing course modality (Biel & Brame, 2015). It is implied that an online course is strictly delivered in an online format. However, Faulconer and Gruss (2018) concluded that the difference in terminology creates a discrepancy in comparing research study data. Various overlapping of terms, such as e-Learning and online, with the same implied meaning, were found throughout multiple journal articles. Developing consistency of the terminology in the literature review allows for accurate analysis of the data acquired within those studies. Biel and Brame (2015) concluded within their study of online versus traditional courses that terminology created additional sorting when conducting a literature review. The study categorized online courses as any course delivered 80% or more in an online format. This included hybrid courses, blended courses, and online courses. This categorization created a barrier to effectively comparing 100% online courses to traditional (face-to-face) courses. Bield and Brame (2015) concluded that a well-designed online or blended course can be as effective as a traditional, on-campus course. Additionally, a virtual lab course was identified as an online course when it was described as a hybrid course (Markansky et al., 2016).

Nontraditional Students

Nontraditional students, ages 24-64 years old, are a large part of the college student population (Slover & Mandernach, 2018). The nontraditional student is also an individual who has family and/or employment obligations, as well as attending college in the nontraditional format of a traditional course (Gonclaves, 2014). Online courses are appealing to nontraditional students due to the added flexibility it provides in accommodating their family and job obligations (Adams et al., 2015). Age, low socioeconomic status, gender, ethnicity, and academic preparation can affect nontraditional student online dropout rates (Wladis et al., 2015). Often institutions do not capture the relationship between age and mode of learning. Slover and Mandernach (2018) conducted research addressing the relationship between the mode of instruction (online versus traditional courses) and age. The researchers analyzed the Peregrine Outcomes Assessment, a cumulative outbound assessment exam, of 1,276 undergraduate business students. A two-way ANOVA was used to analyze the relationship between instructional mode and age. The researchers concluded that nontraditional students performed significantly better in the online course than traditional students. In comparison, nontraditional students do not perform as well in the on-campus course compared to traditional students.

The unique “real world” experiences, such as family obligations, work obligations, and on-job experiences, of the nontraditional student, 24-64 years old as described by Slover and Mandernach (2018), creates a singular focus to achieve the practical application of the course rather than necessarily a high grade. Nontraditional students and their active work experience contribute to their success in an online course. After analyzing the Peregrine Outcome Assessment, Slover and Mandernach (2018) determined that nontraditional students will perform

better on summative assessments than traditional students, regardless of the instruction mode, due to their “real world” experiences, also referred to as on-job experiences.

Wladis et al. (2015) conducted a study to evaluate how characteristics of nontraditional students, gender, and ethnicity attribute to student success in an online and traditional science, technology, engineering, and mathematics (STEM) course. The study consisted of 3,600 community college students enrolled in online and traditional (face-to-face) STEM courses. Analyzing course completion (grade of C- or higher) rates, researchers concluded similar results as Slover and Mandernach (2018) in that nontraditional students perform better in an online learning environment than a traditional (face-to-face) course.

Virtual Lab Course versus Traditional Course

As alternative course offerings in higher education increase, the need to assess the effectiveness of online, hybrid, or blended courses is necessary (Wladis et al., 2015). Identification of different methods used in hybrid courses and the determination of the effectiveness of these alternative instructional tools is useful. Makransky et al. (2016) conducted a study comparing a virtual laboratory simulation (vLAB) course and a traditional lab course. The study blindly assessed the streak plate technique in the physical lab of student participants. Along with the streak plate technique, students were blindly administered a pre and post-test to determine their knowledge of microbiology, intrinsic motivation to study microbiology, and self-efficacy in the field of microbiology before, and after the experiment. Makransky et al. (2016) concluded that there was no difference between the vLAB group and the on-campus group.

Adams et al. (2018) conducted a similar study in the comparison of the effectiveness of an online course. The study looked at one hybrid course and one traditional course that included

identical materials, delivery, and exams. Researchers determined that students in the hybrid course performed significantly worse than the traditional course (Adams et al., 2018). Although the data contradicts that of Markansky et al. (2018), this study only focused on one hybrid course and one traditional course delivery.

Whitworth et al. (2018) conducted a study comparing a computer-simulated lab course to a standard (traditional) lab course. During this study, the researchers converted a standard lab course (E) into a computer-simulated lab course (S) and vice versa. Each group was given the traditional lab protocol when in a standard lab course and a computer-simulated protocol when in the computer-simulated lab course. The same lab protocols were given in each course regardless of the order in which it was administered, S to E or E to S. The researchers identified a significant increase in posttests and attributed the results to an increase in psychomotor learning in response to computer-simulated activities.

Online Biology Course versus Traditional Course

The demand for online biology courses continues to increase (Gonzalez, 2016). There is an increase in online biology course offerings at 2-year community colleges or small colleges compared to 4-year institutions (Varty, 2016). The increase in demand for online courses, and specifically online biology courses, can be attributed to the demographics of a 2-year institution of nontraditional student's active work schedules (Slover and Mandernach, 2018).

Undergraduate biology courses include general biology, microbiology, and anatomy physiology to name a few (Faulconer & Gruss, 2018). Biel and Brame (2016) conducted a literature review of 13 studies that compared the effectiveness of online and face-to-face undergraduate biology courses at various institutions including community colleges. Within the

research, multiple courses at community colleges and larger institutions were observed independently. No significant difference was found between the online and face-to-face format in nine of the studies. Two studies showed that face-to-face courses were more effective than online courses. Two studies found online students outperformed face-to-face students in course design elements with one or more measures. A common theme is that a well-designed online biology course could be as effective as a face-to-face biology course (Biel & Brame, 2016).

The design of an online course can also generate a positive response from students and their involved family (Gonzalez, 2016). Gonzalez (2016) conducted a survey of online students in an Introduction to Biology course to evaluate student perception of various areas of the course. The majority of the students viewed the course as one of understanding and not memorization, concluded the assignments as useful, and founded the course satisfactory overall. This qualitative data was used to determine if the course design was engaging and valuable for the students.

Werhner (2010) conducted a study comparing student performance on identical exams in an online earth science course and a traditional earth science course over four semesters. The researcher concluded that there was not a significant difference in the exam scores between the online and traditional courses. These studies provide valuable data about science courses but fail to provide specific data for a specific course, such as an online microbiology course.

Online Microbiology Course versus Traditional Course

An online microbiology course brings about unique challenges with the use of live bacterium in the laboratory. Adams et al. (2015) conducted a study to determine the effectiveness of hybrid microbiology courses compared to traditional microbiology courses. Researchers selected two courses taught by one instructor (one hybrid and one face-to-face). All assessments were

identical in both courses except for the lecture delivery. Upon completion of the courses, researchers compared final grade success between the courses. Biel et al. (2015) determined that students in the hybrid course performed significantly worse than the traditional course. It was also determined that freshman performed worse in both sections and had the highest enrollment in the hybrid section, which could contribute to the lower final exam scores for the hybrid course compared to the traditional course. Overall, regardless of standing (freshman, sophomore, junior, senior), students performed slightly poorer in the hybrid course. These are notable results yet it only evaluates one hybrid course and one traditional course. A larger sample size comparing more than one hybrid microbiology course and one traditional microbiology course could produce a different conclusion.

Hughes (2008) took twenty-seven traditional microbiology courses and converted them to 17 online microbiology courses. Various lessons were grouped into the following topics: history and principles of microbiology, microbial metabolism, ecology and diversity, biotechnology and food microbiology, and microorganisms and diseases. The lectures for lessons within these topics were converted from the oral form to the written form for the online courses. Within this study, Hughes conducted a two-year retrospective study of three online courses and three traditional courses. Student exam scores and course letter grade was analyzed using quantitative research methods. Laboratory grades were used as the control group since the laboratory session and delivery did not change between the online and traditional courses. Researchers analyzed the student exam scores and laboratory averages using a t-test. The variance data were further analyzed using the SPSS statistical program. An anonymous 18-question Likert survey was given that included a favorable comment free-response and unfavorable free-response questions. Further analysis was conducted using the VassarStats website, a two-tailed Mann Whitney U

test. Hughes concluded, although students in the online microbiology course performed slightly lower on exams and overall course grade, those students expressed positive comments on the student evaluations. Researchers concluded that the online microbiology course as an alternative to a traditional microbiology course is reasonable. They also concluded that further research is needed to determine the reasons the scores were slightly lower.

Discussion

Several factors influence the success of an online course as opposed to a traditional course, such as technology awareness and software training to a particular subject. Identifying the effect of these factors can explain the effectiveness or lack of effectiveness of online courses (Gonclaves & Trunk, 2014 and Slover & Mandernach, 2018). Nontraditional students tend to focus on the applicable aspect of the course and perform better than traditional online students in online courses (Slover & Mandernach, 2018). On the other hand, this population (non-traditional students) tend to not do as well in traditional courses and opt to take an online course because of the demand of an active work schedule (Slover & Mandernanch, 2018). Course design is also a factor that can influence the effectiveness of an online course (Biel & Brame, 2016). It was determined that a well-designed online course can be as effective as a traditional (face-to-face) course (Biel & Brame, 2016). As multiple modalities offerings increase for students, biology majors are less likely to take an online course due to fewer offerings available (Varty, 2016). However, in the sudden transition to remote learning due to COVID-19, all students, including biology majors were forced into the online environment. Skepticism about the effectiveness of online biology courses is a valid question (Biel & Brame, 2016). Werhner (2010) established no significant difference in student performance between the online and traditional courses. Biel

and Brame (2016) and Faulconer and Gruss (2018) determined a well-designed online biology course is as effective as a traditional course. Hughes (2008) determined that students enrolled in an online microbiology course performed slightly lower than traditional microbiology courses.

However, the data acquired will be beneficial to two groups: academic institutions and professional schools. The data shows that nontraditional students are focused and perform better in an online course. Additional research in this particular area could strengthen the basis of accepting online prerequisite coursework by institutions that currently do not accept online prerequisite courses. The data from the aforementioned studies can equip institutions to make an informed decision about the acceptance of online prerequisite courses and provoke future research focused on students who took an online prerequisite course and their success in the nursing or medical program.

The data of these studies can provide information for institutions in their decision of determining if online prerequisite courses or online degrees are effective in preparing students for their academic or professional program. According to Liberman (2019), many professional programs, such as medical and nursing school, do not accept prerequisite courses that are hybrid, online, or in a modified semester. Stanford Medicine along with John Hopkins Medicine, are just a few medical schools that do not accept online degrees or online prerequisite courses (Liberman 2019). However, according to Liberman (2019), other institutions such as Duke University and the University of Washington will consider online courses on a case-to-case basis.

Additionally, information acquired from this study review can educate the academic institutions on the need for proper training of educators and the importance of course design when developing an online course (Gonzalez, 2016). Higher education institutional resource

investment in faculty training, along with technological support is required to create an effective online course (Varty, 2016). Further research is necessary to identify how these factors directly affect an online microbiology course.

Conclusion

After extensive review, not enough data comparing student success in an online microbiology course compared to a traditional course was acquired to formulate a conclusion. Additional research of literature comparing online microbiology course to a traditional microbiology course and independent studies is required to determine student success in an online microbiology course. The aforementioned studies provide a foundation to build research studies to address this topic. However, it can be concluded that a well-designed online biology course can be as effective as a traditional biology course.

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