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THE IMPACT OF USING AN ONLINE LEARNING MANAGEMENT SYSTEM ON STUDENT BIOLOGY ACHIEVEMENT IN A HISPANIC RURAL HIGH SCHOOL

A Dissertation

by

BRENT J. BURKOTT

Submitted to the Graduate College of
The University of Texas Rio Grande Valley
In partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

July 2021

Major Subject: Curriculum and Instruction

THE IMPACT OF USING AN ONLINE LEARNING MANAGEMENT SYSTEM ON STUDENT BIOLOGY ACHIEVEMENT IN A HISPANIC RURAL HIGH SCHOOL

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by
BRENT J. BURKOTT

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July 2021

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ABSTRACT

Burkott, Brent J., The Impact of Using an Online Learning Management System on Student Biology Achievement in a Hispanic Rural High School. Doctor of Education (EdD), July, 2021, 53 pp., 5 tables, 4 figures, 68 references.

The purpose for this study was to determine the effect of using online Learning Management Systems with a Blended Learning pedagogy on state assessment achievement of high school biology students with interactions analyzed based on teaching method (Face-to-Face/Blended Learning), course type (Honors/Regular) biological sex (Male/Female), risk factor (At-Risk/Not At-Risk), and socioeconomic status (High/Low). The research questions were: (1) What is the difference in achievement scores between students taught in a Blended Learning environment with a Learning Management System verses a traditional Face-to-Face learning environment, and (2) What differences in achievement exist on the Texas assessment based on teaching method, course type, biological sex, risk factor, and socio-economic background.

This expo-facto study used univariate analysis of variance of data for school years 2016 to 2019 from a predominantly Hispanic rural high school located along the US-Mexico border, as part of a doctoral program with the University of Texas Rio Grande Valley. Data was retrieved from the school district's secure data management system, TANGO©. Significant differences in scores on the Texas state assessment for biology were identified with course type ($P<0.001$), biological sex ($P=0.027$) and Risk Factor ($P<0.001$). Honors students outperformed regular students (mean scaled scores = 4531/4162), males outperformed females, (mean scaled scores = 4400/4284) and Not At-Risk students outperformed At-Risk students (mean scaled scores = 4489/4182). There was not significant difference found in scores based on teaching method or socioeconomic status. Only a minimal, yet statistically significant difference (P=) was found in the interaction effect between teaching method and Risk Factor.

At-risk students in this study were the lowest performing group on the Texas biology state assessment. Although there was a significant interaction effect (P=0.037) between risk factor and teaching method, with a slightly negative effect when at-risk students were in a blended learning class utilizing a learning management system, the practical effect was minimal with low power (0.55) and a low Eta squared (0.005).

Key Words: biology, online education, socioeconomic status, Hispanic education, at-risk.

DEDICATION

A special thanks to my family who have supported me with inspiration, love and patience. My wife, Michelle Burkott, my daughters Brittany Burkott and Madison Burkott, my mother, Carol Burkott and my father Joseph Burkott who all provided me with the encouragement that I needed to stay focused and complete my study. Thank you for your tolerance and support.

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CHAPTER I

INTRODUCTION

Project 2061, launched by the American Association for the Advancement of Science (AAAS), called for reforms in science education in the United States by the year 2061. This is a long-term science educational reform initiative. The AAAS in 1989 published *Science for All Americans*, which defined science literacy and laid the groundwork for the National Science Education Standards (NSES). *Science for All Americans* "provided the groundwork for national science-education standards by outlining what students should know and be able to do in science by high school graduation" (Jackson & Ash, 2012, p. 724).

The Hispanic student population in the United States has doubled over the past 20 years. There is a science achievement gap between students of various ethnic and socioeconomic groups (Jackson & Ash, 2012). The U.S. Department of Education (USDE) in 2009 reported declining test scores and widening achievement gaps for children in the United States. However, that report did not give educators useful guidance for improving instructional practices (Carnoy & Rothstein, 2015). Since then, closing the achievement gap between ethnic groups has been a priority in the U.S. education system (Jackson & Ash, 2012). As a result, legislation resulting in revisions and adoptions of educational standards occurred throughout the U.S. By 2015, the USDE reported that after investing over 1.5 billion dollars on early childhood education, graduation rates from high school had reached the highest levels in US history (USDE, 2015).

The development of The National Science Education Standards (NSES) in 1996 and then revised in 2013, and The Next Generation Science Standards (2013) were specifically designed to improve science education curriculum experiences. Not all states in the U.S. adopted the national standards for science education. In Texas, the Texas Essential Knowledge and Skills (TEKS) mandate standards for teaching science, including biology, rather than the National standards. The directives addressed in the TEKS, outline the minimal expectations for students upon completion of high school biology courses in Texas. Despite clear mandates to raise rigor and student outcomes on state exams in Texas, there is still ambiguity on specific changes in pedagogical approaches to assist teachers to accommodate students' in meeting those standards. Today's U.S. science teachers "find themselves in a tug-of-war between high-stakes, standards-based education and the expectation that all students will succeed in science regardless of their cultural, linguistic, or socioeconomic background" (Johnson, Yerrick, & Kearney, 2014, p. 23).

In the United States, factors such as student's socioeconomic status (Tucker-Drob, Cheung, & Briley, 2014; Sirin, 2005), English proficiency and/or cultural differences (Johnson, Yerrick, & Kearney, 2014) may negatively influence student achievement in science and require special attention in science education. Males score higher in math and science education than females and that gender gap has an important sway on the public's overall understanding of science issues (Reilly, Neumann, & Andrews, 2015). Teachers', schools' and school districts' conceptual/theoretical framework which they base their curriculum upon must be well planned and thoroughly researched before taking actions that affect the students they are intended to serve (Facer & Selwyn, 2013), such as level of success on the biology End-of Course (EOC) exam. Online curriculum in public education through distance learning programs, recently observed in response to the outbreak of the COVID-19 pandemic, is likely to cause loss of student's skills, and result in greater educational inequalities for students at-risk and coming from low socioeconomic households (Douglas, Katikireddi, Taulbut, Mckee, & Mccartney, 2020).

Prior to the onset of COVID-19, the challenge to increase rigor and success on biology student's state exam scores led to the search for effective changes in teaching science that resulted in the emergence of new pedagogical strategies, especially in recent years (Bidarra & Rusman, 2017). Some pedagogical approaches adopted by public education institutions, both at the secondary level and in higher education, incorporate online learning in a variety of ways. Methods incorporated by some institutions have provided asynchronous courses as 100% online, while others remain primarily face-to-face. There is a wide variety of varying levels of mixing the two methods into new courses (Glogowska, Young, Lockyer, & Moule, 2011; Tseng & Walsh, 2016).

One pedagogical approach that has been gaining attention by educators is Blended Learning (BL). The pedagogy of combining face-to-face (FTF) teaching, the traditional method of teacher-led lectures and discussions in a formal classroom setting, combined with strictly asynchronous online learning have been converging, leading to an increased use of BL as a result of improvements in information and communications technology (Bidarra & Rusman, 2017; Alkıs & Temizel, 2018). Classrooms implementing BL with use of a Learning Management System (LMS) utilize aspects of traditional face-to-face (FTF) teaching with lectures on a set curriculum in a classroom at a specific time, combined with student self-directed online learning using online resources provided on the LMS, with flexibility in student time management.

The use of LMS and BL first surfaced in higher education. A correlational study by Cheng & Chau (2016) found a statistically significant positive relationship between achievement and student satisfaction. Bolsen, Evans, & McCaghren Fleming (2016) compared FTF and BL courses and concluded that BL courses in higher education are as effective as traditional face-to-face courses for student learning, as measured by increases in the content knowledge of the course. Similar studies prompted the acceptance and viability of online courses in higher education (Tseng & Walsh, 2016). Molnar et al. (2019) claimed that beliefs that online learning and blended learning institutions would increase student performance has overwhelmingly shown otherwise. The lack of clarity on when it is appropriate and then how to adjust pedagogy has left many educational institutions, including public high schools, unwilling to risk possible negative outcomes on students' state exam results by trying new teaching strategies (Bidarra & Rusman, 2017).

Jackson and Ash (2012) conducted a 3-year study at a Texas elementary school with a high number of students coming from low SES households, focusing on science instruction. They found that the combination of purposeful planning, academic vocabulary development, and inquiry-based science improved learning outcomes for science expeditiously. There is limited evidence about whether a BL environment employing online LMS in secondary education biology enhances student learning more than a traditional FTF pedagogy (Taplin, Kerr & Brown, 2017).

Liu and Cavanaugh (2011) examined student's achievement on an end of course test from a Midwestern high school biology course taught in 2007-08 using a LMS. The purpose of their study included examining the effects of student demographics and use of LMS on science classes (K-12) that included online curriculum. In their study, they used a random analysis of variance (ANOVA) and found that in biology, "students from different schools are not much different from each other with respect to their academic achievement" (p. 48). They also found that students who were receiving free lunch (low SES) were significantly impacted for the first half of biology, but found no significant effect in the second half. Additionally, students who spent more time using the LMS scored significantly higher in biology.

Statement of the Problem

The need for teachers to systematically predict, design, and understand how learning occurs in new learning environments, like BL utilizing LMS, is important for educators (Bidarra & Rusman, 2017), and has the potential to increase student engagement in and foster self-directed learning (Alkıs & Temizel, 2018; Bidarra & Rusman, 2017; Cheng & Chau, 2016). Although online curricula use in higher education has shown to be as effective as traditional courses, similar research conducted at the secondary level is scarce to non-existent (D'Agostino & Kowalski, 2018), especially with biology courses. Very few studies have examined the impact of learning science, especially biology, through blended learning using a LMS on student achievement.

Liu and Cavanaugh (2011), in a random ANOVA, found variance between-schools to be small when compared with within-school variance, especially for biology. The results also suggested that the amount of time students spent using a LMS had a significantly positive effect on the biology test score. Mixed results were found when it came to the number of logins students made and test scores. They also found that students of low SES showed a significant negative effect in this course using LMS in regards to final test scores. They based their method of identifying students of low SES was on eligibility for free school lunches. "This finding could lend relevance to the development of online courses that integrate components targeting improved academic performance for students with lower family SES" (p. 50).

Comparison of biology classes taught with BL verses FTF found no significant differences in course grades; however, females significantly scored higher than males in both learning environments in a 2010-11 Turkish study (Kazua & Demirkol, 2014). Akbarov, Gonen, and Aydogan (2018), recommended future investigations in education should examine gender, student preferences, and attitudes toward blended verses traditional courses. Utami (2018) found BL to improve student learning in a Basic Network Class, and suggested a need for future research in other subject areas. This study contributes to the limited current body of knowledge regarding blended learning with use of LMS in high school biology courses.

Purpose of the Study

There are two purposes for this study: (1) to determine the effect of using an online LMS, Schoology, with a BL pedagogy on achievement of high school biology students on the Texas Biology End of Course Exam, and (2) to determine differences in achievement on that exam based on course level, biological sex, at-risk status, and socioeconomic status.

Research Questions

(1) What is the difference in achievement scores on the state biology accountability exam between students taught in a BL environment with the LMS Schoology verses a traditional FTF learning environment, without the use of a LMS in regular and Honors classes?

(2) What differences in achievement exist on achievement scores of students taught with BL and LMS based on course type (regular/honors), biological sex (M/F), at-risk status (at risk/not at risk), and/or socio-economic background (high/low)?

Operational Definitions

For the purposes of this study, the following operational definitions apply:

Blended Learning

The "thoughtful fusion of face-to-face and online learning experiences" (Garrison & Vaughan, 2008, p. 5).

Learning Management System

"Learning Management Systems (LMS) are web-based systems allowing instructors and/or students to share materials and interact online" (Lonn, Teasley & Krumm, 2011, p. 642).

At-Risk

"AT-RISK-INDICATOR-CODE indicates whether a student is currently identified as at-risk of dropping out of school using state-defined criteria only" (Texas Education Agency, 2019a, p. 1).

Low-Socioeconomic Status

Students eligible for free lunch are from homes of low-socioeconomic status. Status is based on household income adjusted annually and is effective July 1 through June 30 each year. "These guidelines are used by schools, institutions, and facilities participating in the National School Lunch Program (and USDA Foods in Schools), School Breakfast Program, Special Milk Program for Children, Child and Adult Care Food Program and Summer Food Service Program. The annual adjustments are required by section 9 of the National School Lunch Act" (US Department of Agriculture, 2020).

Delimitations and Limitations

As a biology teacher in this same school for over fifteen years and the Principal Investigator (PI) in this study, I have expertise in the content as well as pedagogy in this predominantly Hispanic school district. I am familiar with the students' struggles as well as successes. I have experience in guiding students to success despite inequities that may exist. Thus, I possess the expertise needed to conduct this research to identify strengths and weaknesses of the pedagogies used in the attempt to increase student performance on the Texas state assessment in Biology (EOC).

Data collected for this study included quantitative data only from the school district during the identified school semesters between Spring of 2016 to Spring of 2019. This study did not include qualitative data and the PI can be considered an outsider since the PI is neither affective, has a behavioral impact, nor interconnected cognitively with the data collection. Some may still consider the PI an insider because the PI is a teacher whose quantitative data is included, but there really is not a concise dichotomy but rather a continuum somewhere in-between outsider and insider (Hendrickson Christensen & Dahl, 1997). The data for this study was collected from the Texas Education Agency directly by TANGO© and, the PI does not have control of data for manipulation in any way on the TANGO© database other than to view data as selected groups. The researcher's role was limited to transfer of data from TANGO© into SPSSv26 for ANOVA and interpretation.

CHAPTER II

REVIEW OF LITERATURE

Theoretical Framework

New Literacy Theory (NLT), also called New Literacy Studies (NLS), is deictic, meaning the definition changes rapidly, as what it means today may be different from what it means tomorrow (Leu, Kinzer, Coiro, Castek, & Henry, 2017). Gee (2000) described NLS as methods which include context infused with technology. A deixis arises as new technologies are replaced with even newer technologies that may have not been invented or become available yet. NLT/NLS focus on the development of higher-order thinking practices with online reading (Bussert-Webb & Henry, 2016).

Student literacy will change to meet newer technology, social practices and new discourses to meet the demands of the new technology (Leu, Kinzer, Coiro, Castek, & Henry, 2017). NLT/NLS replaces the historical view of literacy as written language with literacy of new digital technological (Gee, 2015). New Literacy theory is beneficial in addressing the continuously changing literacy and technology and theory building. NLT has its origin in the 1980's with influential founding works from Scollon and Scollon in 1981, Heath in 1983, and Street in 1984 (Gee, 2015).

The framework of New Literacies theory in educational research occurred in response to rapid changes in the educational world in the 21st century (Gee, 2004; Hall 1996; Sang, 2017).

New Literacy theory is distinguishable from other literacy theories because it focuses on rapid changes in technology used in everyday life and culture (Coiro, Knobel, Lankshear, & Leu, 2008). It does not limit the concept of literacy to simply written or printed materials, but also includes digital technology and educational practices (Sang, 2017). Lankshear and Knobel (2007) defined *new* to include technological innovations and ethos, and is the definition accepted by most educational researchers.

Although use of technology in classrooms has existed since the 20th century, the rapidly increasing capabilities of devices today go far beyond that of radio, film, and even computers in *old* technology (Sang, 2017). New technology in classrooms today, such as with BL, is a hybridization of older technology with interactive and creative forms of use and production (Lankshear & Knobel, 2007), including high speed internet access in and out of schools on students' mobile devices (Sang, 2017). The pedagogical approach of BL with an LMS like Schoology meets the definition of New Literacy Theory.

There is considerable research in recent years on the impact BL has with higher education students as it relates to course achievements in a variety of subjects. Success in finding ways to make effective changes in pedagogy with high school biology courses are not easy to find, and results are not easily compared nationally due to variability in some states adopting NGSS, or individual state requirements like those found in the TEKS. Comparisons of students' science performance between states is also difficult due to different ways states measure success, with many focusing more on math, English and graduation rates (Molnar et al., 2019).

Pedagogical Approaches

With expectations rising because of increased rigor in the TEKS and state exams, public educators in state-tested areas like biology have begun to look for ways to make effective changes in pedagogy. When making changes, combining new technological advancements into higher education courses has shown to be both flexible and innovative for delivering content to students (Taplin, Kerr & Brown, 2017). When developing and implementing new pedagogies that create new learning environments (New Literacies), it is important that students get access to integrated educational tools that are coherent with content-based curriculum; allowing teachers to design, predict and understand how learning occurs in their classes (Bidarra & Rusman, 2017). Application of these principles associated with New Literacies and BL at the secondary level should show similar findings to those in higher education, but little formal research to demonstrate this is available.

Education through use of online resources and learning has shown to increase students' educational choices while also improving efficiency in public education (Molnar et al., 2019); increases students' flexibility in time management of school, work and family; and potentially take advantage of different learning styles (Glogowska, Young, Lockyer, & Moule, 2011). However, research evidence thus far does not substantiate claims that the use of online curriculum is a viable means to improve student achievement in science when compared to traditional science teaching, even though it may increase self-directed learning (Molnar et al., 2019). Some notable disadvantages include a large diversity in student's computer literacy skills (Moule et al., 2010) and availability of study time and computer access from outside of school institutions (McVeigh, 2009). The following sections will explain the instructional platforms.

Learning Management Systems

There is a new complexity in U.S. higher education environments with multiple modes of content delivery including BL, fully online, and face-to-face (Bonk, Kim, & Zeng, 2006). Use of LMS has increased in a variety of educational settings, especially higher education (Cheng &

Chau, 2016). Course-management systems (e.g., WebCT, Blackboard), in addition to recent advances in digital educational media, are readily used in higher education to supplement traditional course materials. This method of dispersing course material permits faculty to distribute resources and increase communication between students and instructors (Biktimirov & Klassen, 2008).

Advancements in digital resources include improved access to online textbooks in English and Spanish, high-quality online videos, interactive lab activities, online manipulatives, and almost limitless opportunities for self-education and self-paced learning through use of a variety of resources using LMS. Some school districts in Texas have converted to 100% online biology instruction with only one or two faculty members overseeing the entire biology curriculum and LMS instructional platform. Other districts use both traditional FTF instruction for biology by some teachers and BL instruction with the LMS Schoology by other teachers. Regardless of the push to include more online learning with LMS like Blackboard, Google Classroom, and Schoology, there are conflicting findings on the effectiveness of online learning strategies. It is important to consider the risks and impact these changes are having on biology students in Texas schools making these types of pedagogical changes.

Blended Learning

Bidarra & Rusman (2017) defined a framework with BL using "innovative tools, new pedagogies and formative assessment methods for teaching science, integrating formal and non-formal learning contexts" (p. 8) designed for upper secondary students and new university students. BL integrates aspects of traditional face-to-face (FTF) teaching with lecture on a set curriculum in a classroom at a specific time, combined with students' self-directed learning with use of technology-driven instruction and online resources through LMS both in and out of school

(Clark, Kaw, & Besterfield-Sacre, 2016). This approach combines on and off campus learning experiences and is part of a widespread change currently observed in secondary and higher education (Azeiteiro, Bacelar-Nicolau, Caetano, & Caeiro, 2015; Coelho, Teixeira, Bacelar-Nicolau, Caeiro, & Rocio, 2015). This allows for flexibility in learning styles and pace.

BL in higher education provides high quality, engaging, experiences for students, and aims to incorporate optimal face-to-face teaching with technology online (Garrison & Vaughan, 2008; Bourne, Harris, & Mayadas, 2005). BL, with its combination of online paperless and traditional FTF components, is a probable better pedagogy than strictly traditional classes with younger generations (Akbarov, Gonen, & Aydogan, 2018). It increases student motivation and interest, builds language skills, and promotes deeper understanding of the subject (Abdelhak, 2015).

Data in higher education (Al-Shaer, 2013) and vocational high school (Lin, Tseng, & Chiang, 2017) suggest that BL is an appropriate alternative teaching strategy to a traditional face-to-face (FTF) method. These studies showed that BL had a significant positive effect on student learning. Utami (2018) also found that high school courses taught with BL had higher student achievement scores than those not taught with BL. In their study, Bidarra & Rusman (2017) used interactive and participatory approaches with computer-based tools that included on and off campus study in higher education. They found that this BL approach allowed students to benefit from environments that encouraged students' independence and stimulated autonomous learning in a variety of educational environments. Abdelhak (2015) listed benefits for using a BL pedagogy and reported benefits including generating higher student interest in the class, enhancement of language skills, deeper learning, increased motivation and inspiration, active learning, and more involvement in use of technology. Korkmaz & Karakus (2009) found that high school geography students in Turkey prefer this type of learning environment to traditional FTF methods, and that BL enhances these students' critical thinking skills while enhancing students' interest in a school subject or course.

Tseng & Walsh (2016) reported that BL helps students develop self-regulation skills at a higher degree than traditional FTF learning environments, and allows more efficient use of students' time by engaging in content and completing coursework when not on-campus. Additionally, using videos and internet websites with English classes in the U.S has proven to help Hispanic students with comprehension in not only English, but also science and math. It also improves auditory skills as they incorporate the use of visual cues and sounds (Castillo, Holland, Kelsey, & Mata-Caflin, 2015). When students use libraries, computer labs, and computers in classrooms, it has shown to improve enthusiasm for learning, captures students' attention, and increases vocabulary and writing (Chantoem, & Rattanavich, 2016; Chen, 2015; Ohwojero, 2015).

Cheng & Chau (2016) reported significant associations between student participation in different types of online activities and learning achievement. They specifically identified use of online networking ($p < 0.1$) and participation in developing material ($p < 0.1$) as most influential on course achievement. There is a significant positive correlation between self-efficacy and course grades in BL courses (Lynch & Dembo, 2004). Online activity and higher grades may relate to increased student efforts that causes online activity and grades to change (Biktimirov & Klassen, 2008) along with higher motivation. Tseng & Walsh (2016) identified significant differences in student motivation, satisfaction and confidence in BL courses verses FTF courses, but there was not a significant difference in final course grades.

Some research suggests that online learning experiences are beneficial because they are more accessible to all populations by offering fewer barriers and more choices in what and where students can learn (Corry & Carlson-Bancroft, 2014). There is some evidence that higher achieving students preferred blended courses to traditional face-to-face, but low achievers might not cope as well with blended learning because they need the structure that comes from regular face-to-face classes (Owston, York, & Murtha, 2013). Using computers as substitutions for teachers and using stricly FTF instructional models that stress repitition as a means for learning, has not produced increased success for all students (Darling-Hammond, Zielezinski, & Goldman, 2014; Weis et al., 2015).

Student Demographic Groups

As children from different cultural and socioeconomic backgrounds enter public education, they bring with them digital skill experiences that may affect their achievement in school, especially if those experiences primarily involve social media, entertainment, and information searches (Bussert-Webb & Henry, 2016). Cultural and socioeconomic differences of students may place them at an advantage if they are from the dominant class or a disadvantage if from the lower socioeconomic classes (Lamont & Lareau, 1988; Glogowska, Young, Lockyer, & Moule, 2011). Student’s from disadvantaged groups experience a higher rate of issues related to internet access, online services, and device capabilities than those students from advantaged groups (Gonzales, 2016).

Bussert-Webb and Diaz (2012) found that students from low SES backgrounds were less aware of how to get broken electronic devices serviced and were less likely to get broken devices repaired or replaced. This digital divide is a driving force in today’s achievement gap, as many disadvantaged students experience disruptions in Internet availability, resulting from financial issues, equipment malfunctions, and limitations of public access (Gonzales, 2016). A BL pedagogy that provides class-time for accessing online materials, as in this study, may help reduce the gap in availability of technology and help students of low SES gain valuable experience using technology in an educational setting.

School districts can and should consider cultural and socioeconomic backgrounds of their students when implementing new literacies with online educational plans, especially when they require student work online from home such as with BL. Ritzhaupt, Liu, Dawson, and Barron (2013) studied 6,000 Florida middle school students from thirteen school districts. They determined that knowledge and use of information and communication technology (ICT) by whites vs. non-whites and males vs. females demonstrated that there was clearly a digital skill inequity. They found significant differences in access to digital resources based on SES, gender, and ethnicity, with the highest achieving students being high-SES white females.

Gorski and Clark (2003) found inequalities against students of low socio-economic status based on schools, student abilities, device capabilities, teachers' knowledge, and teacher use of technology. More recently, Park and Lee (2015) declared that the access and use of smart phones is the main factor influencing digital access to technology today. Only the high-end phones have unlimited access to high bandwidth downloads and uploads. Additionally, minority communities have a lagging of service in populations of low SES. Although fixed services such as home Wi-Fi has improved at a steady pace in recent years, the mobile broadband is still growing rapidly. Hispanics have fewer home broadband services than other ethnic groups (Prieger, 2015).

CHAPTER III

METHODS

Participants

This study examined data for 928 students who took the Texas biology End-of-course state assessment (paper) for their first time in 2016 = 167, 2017 = 286, 2018 = 196, and 2019 = 279 (see Table 1 for demographics). This includes 55% males, 25% at-risk, 73% of low SES, 44% in Honors/PreAP, and 59% taught with the blended learning pedagogy. Data from 2016 to 2019 were analyzed from the school district's secure online assessment system. The high school is rural, located along the US-Mexico border. The school population in 2018-2019 consisted of 96% Hispanic, 3% white, and less than 1% for each of the other ethnicities (Texas Education Agency, 2019b), which is consistent for the other testing years for the district. Students in 9th grade biology are between the ages of 14 to 16.

Table 1

Student Characteristics 2016 to 2019 for Spring Assessments

Demographic	2016-19 Totals
Teaching Method	
Face to Face	381
Blended Learning	547
Course Type	
Regular	523
Honors	405
Biological Sex	
Male	508
Female	420
At-Risk	
Yes	232
No	696
Low Socioeconomic Status	
Yes	674
No	254

Background and Intervention

During the Spring of 2016, all classes taught by all teachers in this study used a typical FTF pedagogy, except for one trial PreAP class with 29 students taught by one of the teachers. Due to the positive results of that trial class, that teacher switched all classes to BL with the LMS Schoology the following school year, while others continued with FTF. Positive results followed for the Spring 2017 assessment, and then in 2017-2018, a second teacher switched completely to BL with Schoology. Finally, in 2019-2020 (not included in this study due to COVID 19 cancelation of the state exam) a third teacher switched to BL with Schoology, leaving only one of the four teachers using a FTF pedagogy.

Course Types

There are three course types offered at this district: honors biology, regular biology and extended biology. The students in honors and regular biology classes attend either 90-minutes classes for 18 weeks or a 45-minute class for 36 weeks. Students in the extended biology attend a 90-minute class for 36 weeks and use a different curriculum guide, scope, and sequence. Data for the participants in this study only came from honors and regular courses, which do share the same curriculum, scope, and sequence.

Curriculum

In 2012, a team of school district staff consisting of three teachers and one district administrator from the district where this study takes place, developed a curriculum for Honors and Regular biology courses based on the TEKS provided by the Texas Education Agency (§112.34. Biology, 2012 and then updated in 2017). The curriculum, scope and sequence emphasized TEKS identified by the State of Texas Education Agency as "readiness" standards, but also included a lesser amount of time devoted to "supporting" TEKS. The district's curriculum development team chose to spend more time and emphasis on readiness standards due to the higher probability that these topics are on the EOC test administration when compared with the supporting standards. The limited time during the school semester before EOC testing, along with the depth of knowledge required to properly teach biology concepts, was felt by the team to be justification to devote more time and effort on the readiness standards. The developed scope and sequence included twelve broad units, each containing both readiness and supporting standards:

Unit 1 - Levels of Organization and Biomolecules;

Unit 2 - Cells and Cell Processes;

Unit 3 - Plants, Photosynthesis, and Cellular Respiration;

Unit 4 - Cell Cycle and Cell Differentiation;

Unit 5 - DNA, Replication, and Protein Synthesis;

Unit 6 - Mendelian Genetics;

Unit 7 - Non-Mendelian Genetics;

Unit 8 - Evolution;

Unit 9 - Taxonomy/Classification;

Unit 10 - Immunity and Viruses;

Unit 11 – Ecology; and

Unit 12 - Body Systems

Pedagogy Development

After implementing the new curriculum, scope and sequence developed for the Regular and Honors biology courses beginning in Fall of 2012, student success on the EOC demonstrated excellent results. The number of students in this district using the newly developed curriculum passing the state assessment was over 95%. However, students reaching the advanced/mastery level, which are students who score 83-86% or higher on the Texas state assessment (depending on the testing year), remained relatively low (<20% of Honors students). In Fall semester of 2016, the campus Principal where this study takes place challenged biology teachers to find a way to get 30% or more of all students in Honors biology to the advanced/mastery level. In an effort to meet this new goal set by the principal and teaching staff, several teachers adopted BL with the Schoology LMS as the platform for student access to curriculum, as an alternative to the traditional FTF pedagogy that had been previously implemented by teachers in the district.

Blended learning with LMS. The units/modules from the existing FTF curriculum were input into the LMS, along with additional resources such as video clips, reading materials, online book access and activities like Quizlett. Paper assignments used in the FTF courses were also uploaded into Schoology in a digital format. Additional online quizzes and self-checks were created using Schoology directly. In the BL classroom, online assignments combined with shorter concise lectures in class, focused on the areas students typically struggled with for each unit/module. Class time was not used to teach the entire biology concepts, allowing for teachers and students to concentrate efforts in class to correct misconceptions. Both formative and summative unit assignments and exams were given through the LMS, accompanied with teacher oversight using computer software program (LanSchool). A lockdown browser was not available from the district.

Use of BL with LMS provided students with the ability to access all resources and assignments from any location with access to the Internet, with the same scope and sequence as developed by the curriculum team for FTF, but allowed students flexibility in when, how, and where to complete learning and work. One advantage of using a BL pedagogy is that students can repeatedly access resources and can discuss and communicate with teachers and other students outside of normal class time (Utami, 2018).

Students had access to all assignments and resources on the first day of each unit/module. Students could complete assignments at their own pace, as long as they submitted work through the Schoology LMS before the teacher designated due date and time. This is one of the biggest differences when compared to FTF, which often had work that was due at the end of class or the following day if assigned as homework. A typical instructional unit was 7 to 10 days. Upon completion of a brief teacher-led discussion (15 to 30 minutes) on the subject of the day, students were given time and opportunity to work individually or in small groups. Some students chose to work independently while others did group study. Students were also provided with school-owned laptops, or they could use their own personal devices. All students were provided with access to school Wi-Fi while on or in close proximity to campus. Student scores on classwork, homework, and assessments were available instantly online upon completion. Student online reports identified which questions were correct and which were incorrect, but the correct answer choices were not revealed until after the assignment due dates for all students had passed.

Face-to-face. Teachers choosing the traditional face-to-face pedagogical approach at this campus, followed the same scope and sequence as those in the BL with LMS. These teachers offered teacher-led instruction to students primarily through presentations (Power Point, Slides, Prezi, etc.) during class time with the aid of a laptop computer and a projector. The computer presentations were projected onto a large dropdown screen for all students to view simultaneously, rather than self-paced, student-led learning like in the BL with LMS. Large whiteboards were also used to add additional hand drawings and to respond to student questions after the computer presentations were concluded.

Students were given access to the textbook either online or by checking out a hard copy from the school office. Paper assignments were given to students as the main means of formative assessment, but some online assignments were occasionally given via commercial websites, such as the district purchased online textbook (My HRW), Edpuzzle, STEMScopes, etc. Students were given opportunities, as time permitted to work on assignments in class. Some assignments were given as classwork and were due before the bell rang, but the bulk of the schoolwork was given as take-home assignments, homework to be turned within the next day or two. Summative unit assessments were given by FTF teachers as a paper exam, with the use of bubble Scantron or handwritten responses. Student scores on classwork, homework, and assessments would be graded by the teacher and reported to the students within a day or two of the assignments' completion.

Data Collection & Analysis

Data Collection

Archival data (expo-facto) was collected through the school district's licensed TANGO© software. TANGO© is a database that stores results from the End-Of-Course (EOC) examine for each student and provides all demographic information needed for analysis. TANGO© also provides aggregated data from the state accountability exam by course type, socioeconomic status, biological gender, risk factor, and other demographics not considered in this study. Students' EOC scores and demographic data were available online from this secure online database with scores from Fall of 2014 to present. Data collected from TANGO© was limited to *regular* and *honors* classes as independent variables with respective demographic data.

Access to TANGO© data is by a secure teacher-of-record or district administrator online login. The district provides additional data security, along with TANGO's built-in security features, via Bitdefender Endpoint Security Tools (version 6.6.17.249). There is also a district Information Technology (IT) department that continuously monitors for potential security issues. The data collected was analyzed using IBM SPSS Statistics version 26 (SPSSv26). Reporting of student scores is anonymous.

Data Analysis

Analysis of variance. Analysis of Variance (ANOVA) was conducted with descriptive statistics. The data used for the ANOVA consisted of EOC scores for the school terms of Spring 2016, Spring 2017, Spring 2018, and Spring 2019. Data for the school year 2019-20 are not available due to student exemption for the EOC tests by Governor Greg Abbott due to the COVID-19 pandemic. Final scores for students' performance on the Texas STAAR Biology EOC exam were used as the dependent variable for ANOVA. There are no data for the EOC exams in Spring 2020 due to the Texas assessment cancelation resulting from the COVID19 pandemic.

"The statistical procedure for testing variation among the means of more than two groups is called analysis of variance" (Aron, Coups, & Aron, 2014, p. 315). ANOVA was an acceptable procedure for analyzing data from this study because data from this study came from several different groups: honors students using LMS with BL, honors students without LMS and FTF, regular students using LMS with BL, or regular students without LMS and FTF. Additional comparisons beyond the teaching method and course type were analyzed including biological sex, risk factor and socioeconomic status. For example, male students enrolled in honors biology with LMS verses female students enrolled in honors biology with LMS (see Table 2). Or, Male students enrolled in honors biology with LMS compared to male students enrolled in honors biology without LMS.

Table 2

Analysis Groups and Sub-Groups of Data for Comparison with ANOVA

Populations	Sub-Groups		
Course Type & Teaching Method	Biological Sex	Risk Factor	Socioeconomic Status
Honors biology using a learning management system and blended learning.	Male/Female	Yes/No	High/Low
Honors biology not using a learning management system with face to face.	Male/Female	Yes/No	High/Low
Regular biology using a learning management system and blended learning.	Male/Female	Yes/No	High/Low
Regular biology not using a learning management system with face to face.	Male/Female	Yes/No	High/Low

The intent of the analyses was to determine if there is a significant relationship between academic achievements on the EOC exam based on the study variables, and to produce actionable findings that increase positive improvements in student performance both in class and on the state Biology EOC exam. The dependent variable is Biology EOC scores. Independent variables are 1) teaching format with two levels, students taught in a BL environment with the LMS Schoology and those taught in a traditional FTF course without use of a LMS; 2) Course type (regular/honors); 3) socio-economic background (high/low); 4) biological sex (m/f); and 5) risk factor (at-risk status/not at-risk). This data is already grouped in TANGO© and was accessed by a secure administrative district login.

The descriptive results included in the SPSSv26 ANOVA identify basic trends and findings of the results. Identification of means and standard errors of the dependent variables (Test Scores) is included in this section. Descriptive results include N, mean, minimum, maximum and standard deviations for each of the independent factors. The null hypothesis for ANOVA analysis is that there is no significant difference between the independent variables on the dependent variable, and the results have similar mean scores.

The F ratio. Comparing between-groups and within-groups population variance provides the F ratio. When the ratio of between-groups divided by within-groups variance is equal to one, the null hypothesis is accepted, meaning there is no significant difference in population variance. If that ratio is greater than one, the null hypothesis is rejected, and a treatment effect may be significant. The calculated F ratio when running the ANOVA on SPSSv26 was compared with an F table to determine significance at the 0.05 significance level.

Effect size and power. The power and effect size help understanding of ANOVA results. The proportional variance (R^2) measures the ANOVA effect size. The "R^2 is the proportion of the total variation of scores from the grand mean that is accounted for by the variation between the means of the groups" (Aron, Coups, & Aron, 2014, p. 335).

Eta-squared. The value of Eta-squared relates to the strength of the main effect. It helps determine the amount of variance that can be explained by the independent and dependent variables. Determining the power of the results along with Eta-squared values is important and helps determine usefulness and practicality of results.

CHAPTER IV

FINDINGS

Table 3 presents mean scores from the years 2016 to 2019 on the Spring administrations of the Texas Biology End of Course examination and standard errors. These scores are for first-time testers only. Those in the Face to Face group had a higher mean than the students in the Blended Learning group, although it was not a statistically significant finding.

Table 3

Descriptive Results of ANOVA with the Dependent Variable of EOC Scale Scores

	Group	Mean Score	Std. Error
Teaching Method	Face-To-Face	4379	35.2
	Blended Learning with a LMS use.	4305	32.3
Course Type	Honors Biology	4531	40.6
	Regular Biology	4162	26.2
Biological Sex	Male	4400	30.5
	Female	4284	36.3
Risk Factor	At-Risk	4182	45.3
	Not At-Risk	4489	18.1
Socioeconomic Status	High	4342	38.8
	Low	4339	28.5

Table 4 presents the results of the ANOVA with mean scores broken down and reported by teaching method (FTF or BL with LMS), course type (Honors or Regular), biological sex (Male or Female), and socioeconomic status (High or Low). These data show the F value and significance level, as well as the partial Eta squared and power. The combination of these

ANOVA statistical results help in reporting the importance and usefulness of the findings. Significant differences in groups were found for course type, biological sex, risk factor and for the interaction effect of being at-risk and teaching method, however biological sex and the interaction effect have relatively low power and low Eta squared values.

Table 4

ANOVA Results with Between-Subjects Effects and the Dependent Variable EOC Scale Scores

	df	F	Sig.	Partial Eta Squared	Observed Power
Teaching Method	1	2.25	0.134	0.002	0.32
Course Type	1	46.15	<0.001	0.049	1.00
Biological Sex	1	4.90	0.027	0.005	0.60
At-Risk Factor	1	27.96	<.001	0.030	1.00
Socioeconomic Status	1	0.63	0.428	0.001	0.12
At-Risk x Teaching Method[a]	1	4.37	0.037	0.005	0.55
All other effects			≥0.138		

[a] Note: Significance levels for all other interaction effects ranged from 0.138 to 0.926.

The interaction effect of teaching method and risk factor was the only significant interaction effect observed and is reported in Table 5. These data are used to show an effect on the scaled scores of the Texas Biology EOC exam, based on the two teaching methods (Face to face or Blended Learning with use of a Learning Management System) and the at-risk factor (at-risk or not at risk). A common method for interpreting an interaction effect is to analyze the data graphically (Aron, Coups, & Aron, 2014, p. 345).

Table 5

Interaction Effect of Teaching Method x Risk Factor on Texas Biology EOC Scale Scores

Teaching Method	Risk Factor	Mean Score	Std. Deviation	N
Face-To Face	At-Risk	4074	340.9	121
	Not At-Risk	4420	425.7	261
	Total	4311	431.6	382
Blended learning with LMS use	At- Risk	4029	327.9	111
	Not At-Risk	4549	457.8	436
	Total	4443	482.2	547
Total	At-Risk	4052	334.8	232
	Not At-Risk	4501	450.1	696
	Total	4389	466.4	928

Figure 1 graphically displays the estimated marginal means of the Texas EOC exam scores for at-risk students and not at-risk students in courses taught with the two teaching methods, FTF or BL with LMS. This figure presents comparisons between at-risk and not at-risk students in Face to Face and BL with LMS. Aron, Coups and Aron (2014) wrote: “to look at a main effect, you focus on the marginal means for each grouping variable. To look at the interaction effect, you focus on the pattern of individual cell means” (p. 341). Figure 1 illustrates that there is no interaction effect and that non at-risk students scored higher when receiving instruction in either of the teaching methods.

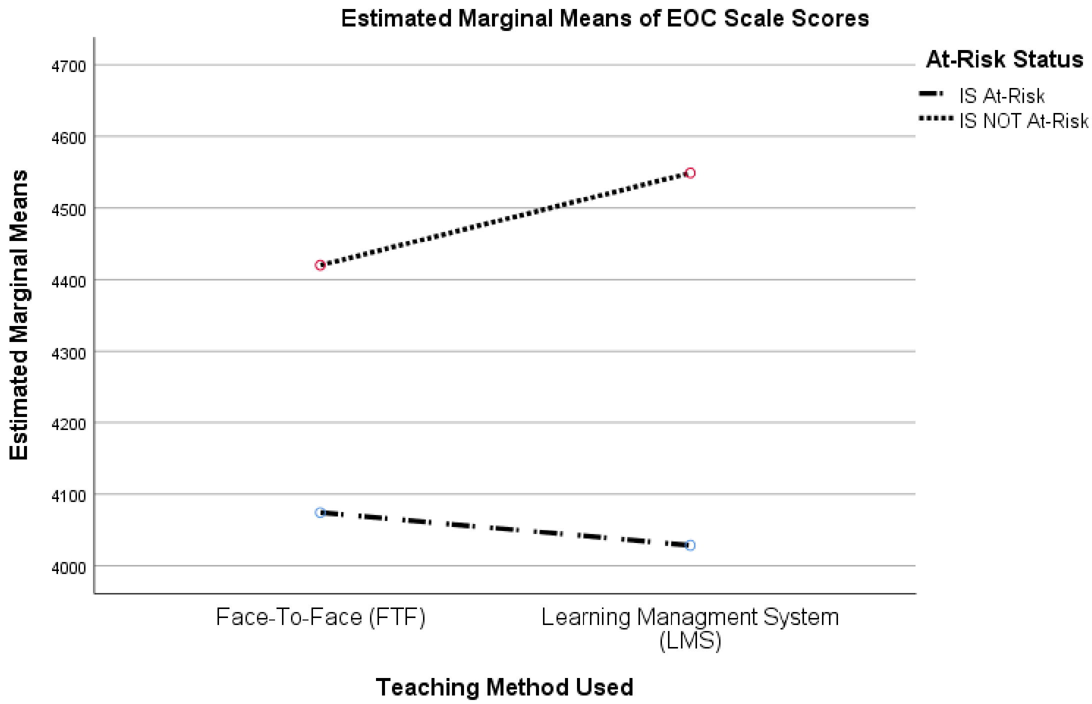

Figure 1. Mean EOC Exam Scores and the Interaction Effect of Risk Factor x Teaching Method.

Figure 2 presents the marginal means for course type (Honors or Regular) at the 95% confidence level, along with the observed grand mean. Honors students scored significantly higher on the Texas Biology EOC examination than those students in regular biology classes. However, effectively all students in both courses passed the exam, even though the higher achievement level was seen in the Honors courses. The observed grand mean lies just under 4400 points on the scaled score.

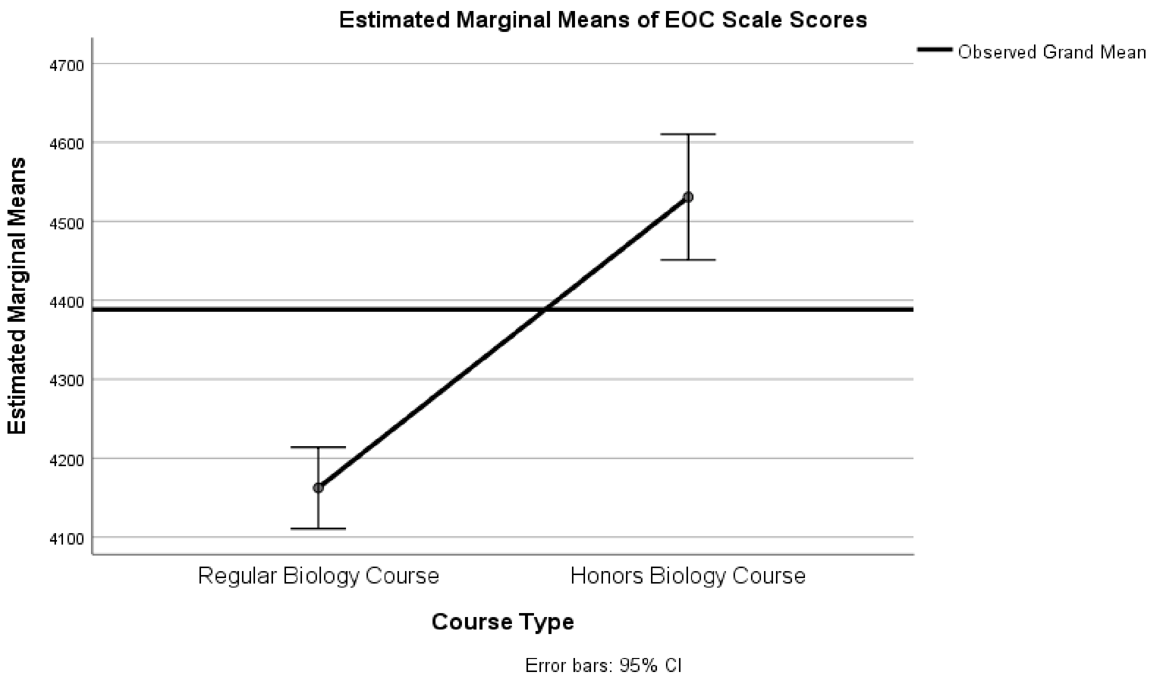

Figure 2. 95% Confidence Intervals of Texas Biology EOC Marginal Means by Course Type.

Figure 3 illustrates marginal means based on biological sex. Female students passed the Biology EOC equivalently to male students, but males statistically scored higher with a low Eta squared and low power. This implies little to no real effect on performance based on the biological sex of males and females. The observed grand mean was in close proximity to the male student's marginal mean score.

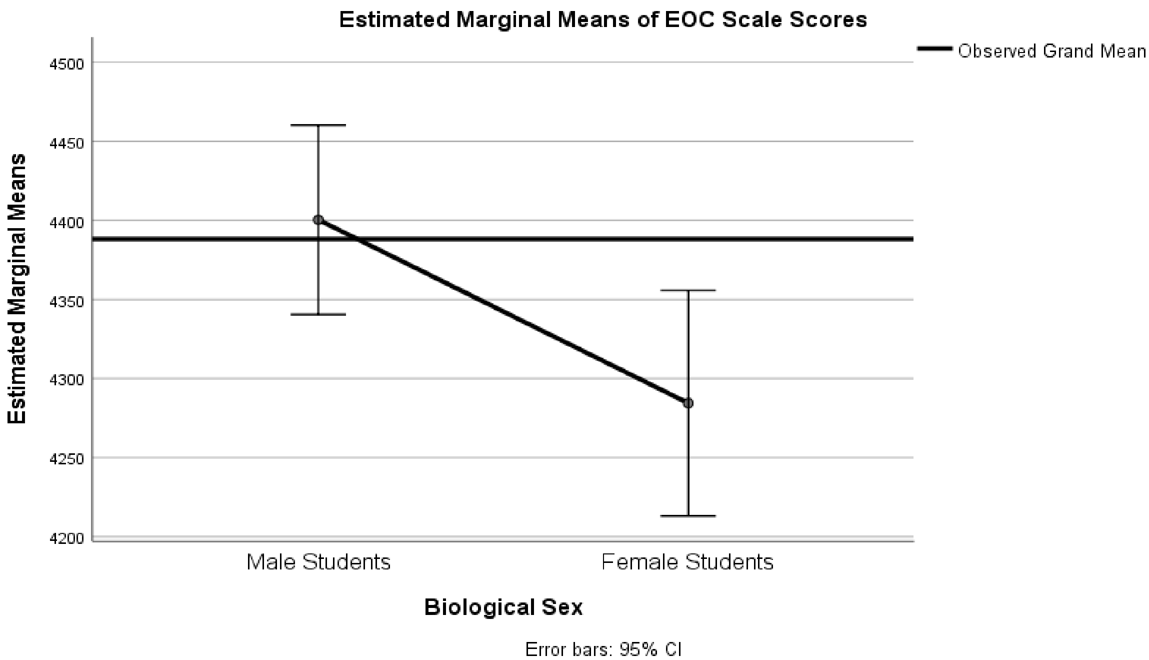

Figure 3. 95% Confidence Intervals of Texas Biology EOC Marginal Means by Biological Sex.

Figure 4 demonstrates the comparison of estimated marginal means based on if students were at-risk or not at-risk. This allows for a visual comparison of the marginal means resulting from the univariate ANOVA along with the observed grand mean. Students who were identified as being at-risk scored significantly lower than students who were not at-risk. See Appendix for requirements for a student to be listed as at-risk.

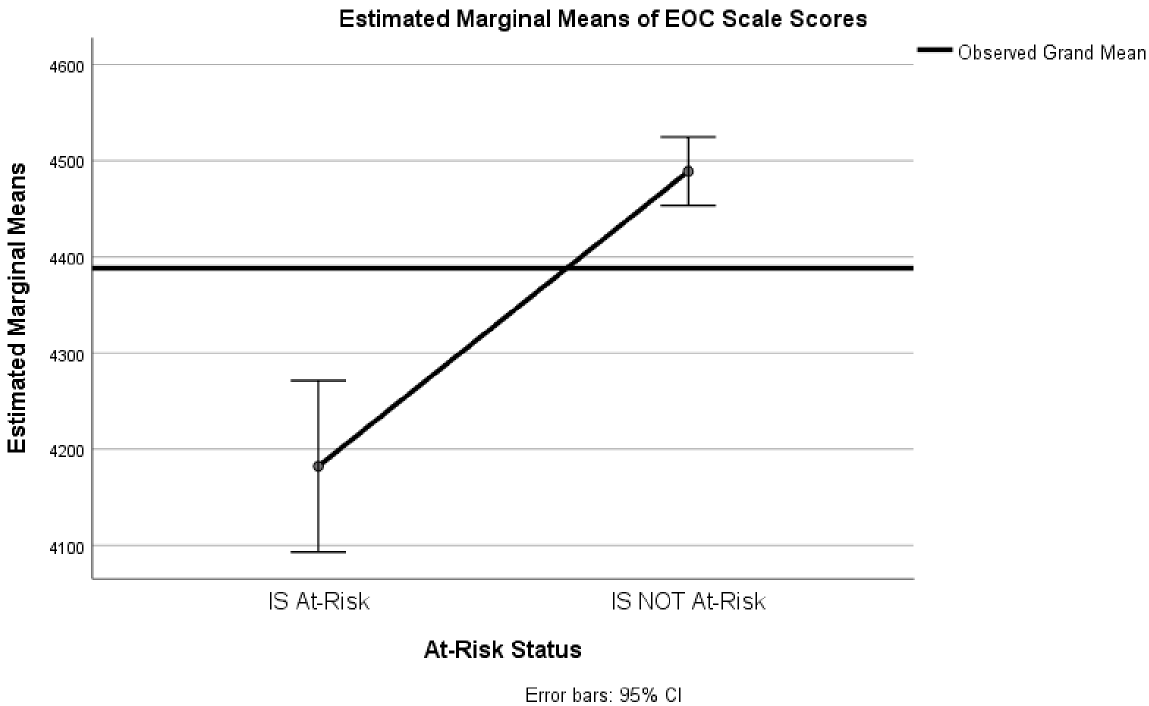

Figure 4. 95% Confidence Intervals of Texas Biology EOC Marginal Means by Risk Factor.

CHAPTER V

DISCUSSION AND CONCLUSION

Discussion

Teaching Method

This analysis found no significant differences in students' EOC scores enrolled in courses taught with the traditional FTF method verses BL. With the exception of a slight negative impact on students at-risk, both teaching methods are for all purposes equally effective for teaching biology and preparing students to successfully pass the Texas Biology EOC. This result suggests that biology students can achieve equally well in both learning environments. This could be explained by the fact that the content in both teaching conditions were primarily the same, just presented in different formats.

Tseng and Walsh (2016) reported similar findings when comparing higher education English courses taught FTF with BL, with no significant differences in final course grades. Baragash and Al-Samarraie (2018) questioned 196 undergraduate students and found that using a LMS, with FTF (essentially BL) positively improved students' scores on the final exam. Cleveland, Olimpo and DeChenne-Peters (2017) found that with these two teaching methods, the students in both groups demonstrated significant gains in content knowledge. Likewise, students in these high school biology courses made equivalent gains in content knowledge, as demonstrated by performance on the Texas Biology EOC.

Utami (2018) concluded that in a vocational high school, using traditional FTF as a control group, students in a BL class significantly scored higher than the control group. Those in a BL class demonstrated higher outcomes in a posttest than those in the FTF class, although both groups showed positive learning results. The findings of this study do not support those of Utami's; however, they add to the confidence that BL is an acceptable alternative to FTF. These mixed results in higher education, combined with the results of this high school biology study, support the idea that BL is at minimum, an acceptable alternative to FTF. Other factors not addressed in this study may influence when BL is an advantage and when it simply offers an alternative pedagogy. Additional studies in high school biology classes with both similar and different student demographics should be conducted to more fully understand the impacts on various student groups with these teaching pedagogies.

Course Type

Students enrolled in the more rigorous Honors biology scored significantly higher on the Texas End-of-Course exam for biology. Students enrolled in a Regular biology course had an average score of 4162, and those in an Honors biology had an average score of 4531. The additional student requirements and rigor for honors students, not imposed on regular students, contributes to the results that the course type, Honors or Regular, had a significant impact on students' Biology EOC scores.

This school district allows all students the opportunity to enroll in Honors level biology courses, if desired. Although enrollment is initially open to all students, at parent discretion, there are strict requirements to stay in the course for the duration of the educational period. Students must maintain satisfactory academic progress and have consistent attendance in order to remain in Honors biology beyond the first three weeks of instruction. Any students not maintaining a course cumulative grade above a 70% after the first three weeks are referred to a review team consisting of an administrator, counselor and the teacher of record. The parents are also invited to participate.

Some students are removed from Honors and placed in an appropriate course level, as determined by the review team. This means students get a schedule change from Honors biology to a Regular biology course. In some rare cases Honors biology students are moved to the extended biology course, not included in this study. Data from these students are included in the appropriate course type at the time of the state test administration, which occurs towards the end of the course. This means data from students initially enrolled in Honors biology, and subsequently removed in the first weeks, are not included in the results for Honors courses.

Biological Sex

Male students in this study scored higher than females on the Texas Biology EOC exam with statistical significance. Although there is a statistical difference, probably related to the relatively large sample size, when considering the moderate observed power and low Eta-squared values the overall finding is that there was not any practical difference between the two groups. The average scaled score for male students was 4400 and for females was 4284. Both these scores are well above the minimum required score to pass the state assessment. The fact that the average male’s score was just above the grand mean, may suggest that a few outlying scores for some females may have negatively obscured the findings for females. Most females scores are probably similar to the male scores than suggested by these statistical results, which is indicated by the grand mean being close to the mean score for males alone.

Reilly, Neumann, and Andrews (2015) studied data obtained from the National Assessment of Educational Progress (NAEP) from grades 4, 8 and 12 in life science, physical science and earth science. Data spanned the years 1996 to 2011. They found that in life sciences, which would include biology, there was not a significant difference in scores of males and females. There were significant differences in physical science and earth science with males outperforming females. These results on life science are not statistically supported by the findings of this ninth-grade biology study with predominantly Hispanic students. However, when looking at the overall practical findings, the results may actually be the same.

Grunspan, Eddy, Brownell, Wiggins, Crowe and Goodreau (2016) also found that males averaged higher course grades than females in undergraduate biology classes they studied. Their findings showed significantly higher scores in one of three classes by male students. They concluded that peers' views of males mastering the STEM courses more than females could influence the confidence of female students, resulting in lower self-confidence, course scores and reduced retention in STEM degrees. This aspect of self-confidence impacting student outcomes was not included in this study, but it is would be valuable information that could be looked at in additional studies to determine if there is a correlation between EOC scores and self-confidence.

Risk Factor

Students identified by Texas criteria for being At-Risk (see appendix) scored overall significantly lower than students not At-Risk. Those students not identified at-risk had an average Texas Biology EOC score of 4489, while at-risk students scored on average 4182 with a grand mean just under 4200. At-risk students at this district are identified to the teacher of record, but the specific reason they are put on that status is not. As a result, teachers in this district must expend extra effort to find ways to modify instruction for at-risk students.

The teachers in this study appeared to meet all of the recommended policies for teaching at-risk students, but did not have any specific training on how to modify instruction for at-risk students. Perhaps a weakness in the curriculum itself not implementing creative learning strategies could account for this difference. Methods may have been more about drilling of knowledge. This might explain the significant negative impact observed with these students on the Texas Biology EOC scores. Incorporating more creative learning experiences for students should close this gap.

Darling-Hammond, Zielezinski, and Goldman (2104) reviewed over seventy studies involving at-risk students and revealed some suggestions for teaching at-risk students using technology for high school students. They acknowledged that within their review of those studies, they found many mixed results some showing that using technology was successful with at-risk students and others not, as implicated by results of this study. They suggested that some of the differences were related to many at-risk students having less than optimal internet access or ownership of adequate devices. Providing each student, whether at-risk or not, adequate time in class with access to school provided laptops and internet access should have reduced this affect with this district; yet, there was still a significant difference in the two groups.

When it comes to effective use of technology with high school at-risk students, pedagogy should not be geared towards simply improving performance on minimal competency tests, like the Texas EOC. Instead, they should focus on three specific skills to promote success with at-risk high school students: use of interactive learning, exploratory learning, rather than drilling of facts, and an appropriate blend of teachers and technology integration, as in BL (Darling-Hammond, Zielezinski, & Goldman, 2104, p. 6). Darling-Hammond, Zielezinski, and Goldman (2104) went on to identify some specific policies that should be followed. They were: 1) one-to-one access to computers, 2) speedy internet connections, 3) high levels of interactive learning, 4) access to curriculum and learning plans to create content as they learn, and 5) use of bended learning with significant support from teachers and other students.

Socioeconomic Status

Despite the fact that there is a gap in ownership of digital equipment and variable internet access for students of low socioeconomic status (Darling-Hammond, Zielezinski, & Goldman, 2104), there were no significant differences observed in students' Biology EOC scores based on socioeconomic status in this study. The results suggest that students of both high and low socioeconomic status can score similarly on the Texas Biology EOC exam in both a FTF and a BL with a LMS pedagogy. Surprisingly, there was not a significant interaction between at-risk status and socioeconomic status.

A more intense look at student scores on the Texas Biology EOC could identify subgroups of at-risk students based on which reason the student obtained that label. Many students meet the at-risk criteria in early elementary education, including pre-k and kindergarten. Once labeled at-risk, they remain so until completing school. Other students are not labeled at-risk until reaching their teenage years, either in middle school or high school. Perhaps there is significant interactions with some of these subgroups of at-risk and socioeconomic status. Future studies might consider identifying students at risk status and socioeconomic status closer.

Interactions

At-risk x teaching method. At-risk students were collectively successful in passing the Texas Biology EOC exam and can benefit from being in either learning environment, but there is a slight negative effect on performance when they are placed in the BL with LMS teaching pedagogy rather than a traditional FTF class. An interaction effect is "a situation where the combination of variable has a special effect" (Aron, Coups, & Aron, 2014, p. 340) on the results. There was a statistically significant interaction between At-Risk students based on the teaching method used for biology. At-Risk students obtained higher scores on the Texas Biology EOC when taught in a FTF class than those taught in a BL with LMS. However, the low Eta square value along with a weak observed power imply little practical interaction between the two methods and risk factor.

When the interaction effect model was condensed to a more limited comparison between just Teaching Method and Risk Factor, the partial Eta square was also low (0.008). This low Eta square is similar to that found on the larger overall model. Together the analysis suggests that there is not much practical significance of interaction between the two variables Teaching Method and Risk Factor. This means even though there is a statistical difference, that effect of teaching method is minimal. This is visualized in Figure 1, where it can be observed that there is not an intercept point between the lines for teaching method and risk factor.

Other interactions. No other interactions tested had significant effects on the dependent variable: EOC scale scores. The levels observed ranged from P=0.138 to P=0.926.

Conclusion

There was no statistical difference in achievement scores between the two teaching methods, face-to-face and blended learning with use of a learning management system. This means that students can perform equally well in either a face-to-face or a blended learning environment. This study did not support the findings of other studies that concluded that students in a BL class outperform those in traditional FTF classes. A more detailed investigation in specific teaching aspects and the role individual teachers play in different BL environments may reveal more information on why there are statistical differences in some study results and no difference in others.

Like with the teaching method, no significant differences were found based on socioeconomic status. This indicates that the technology gap may be closing or has closed already. An interaction effect was expected, but not observed, between SES and risk factor. It was anticipated that at-risk students would frequently be associated with students of low SES, but this was not observed in this study. Additional studies should investigate this further.

However, there still remains a statistically significant difference in performance based on biological sex. Males scored higher than females on the Texas Biology EOC assessment in this predominantly Hispanic school. This finding suggests that the gap is minimal. Future research should exam biological sex impacts on overall course grades, course exams, and other state assessments such as English, Algebra, and U.S. History. There is also a need for additional studies in Texas biology courses.

At-risk students in this study were the lowest performing group on the Texas biology state assessment. Although there was a significant interaction effect between risk factor and teaching method, where at-risk students performed less well than their peers in blended learning environment. At-risk students appear to do slightly better in a FTF learning environment.

Further research could focus on identifying the causes of at-risk students scoring lower on the state Biology EOC exam. Given the results of the current study, it is recommended that professional development programs may be needed to help teachers improve blended learning pedagogy for at-risk students. As a result, the achievement of at-risk students on the state Biology EOC exam may improve and at-risk students would develop deeper understanding of biology concepts. Future studies should include examining the impact of professional development in blended learning pedagogy and achievement for at-risk, Hispanic, high school biology students.

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APPENDIX A

APPENDIX A

E0919 AT RISK INDICATOR CODE

At-Risk-Indicator-code indicates whether a student is currently identified as at-risk of dropping out of school using state-defined criteria only (TEC §29.081, Compensatory and Accelerated Instruction).

A student at-risk of dropping out of school includes each student who is under 21 years of age and who:

1. is in prekindergarten, kindergarten or grade 1, 2, or 3 and did not perform satisfactorily on a readiness test or assessment instrument administered during the current school year;

2. is in grade 7, 8, 9, 10, 11, or 12 and did not maintain an average equivalent to 70 on a scale of 100 in two or more subjects in the foundation curriculum during a semester in the preceding or current school year or is not maintaining such an average in two or more subjects in the foundation curriculum in the current semester;

3. was not advanced from one grade level to the next for one or more school years; (Note: From 2010-2011 forward, TEC 29.081 (d-1) excludes from this criteria prekindergarten

or kindergarten students who were not advanced to the next grade level as a result of a documented request by the student's parent.)

4. did not perform satisfactorily on an assessment instrument administered to the student under TEC Subchapter B, Chapter 39, and who has not in the previous or current school year subsequently performed on that instrument or another appropriate instrument at a level equal to at least 110 percent of the level of satisfactory performance on that instrument;

5. is pregnant or is a parent;

6. has been placed in an alternative education program in accordance with TEC §37.006 during the preceding or current school year;

7. has been expelled in accordance with TEC §37.007 during the preceding or current school year;

8. is currently on parole, probation, deferred prosecution, or other conditional release;

9. was previously reported through the Public Education Information Management System (PEIMS) to have dropped out of school;

10. is a student of limited English proficiency, as defined by TEC §29.052;

11. is in the custody or care of the Department of Protective and Regulatory Services or has, during the current school year, been referred to the department by a school official, officer of the juvenile court, or law enforcement official;

12. is homeless, as defined NCLB, Title X, Part C, Section 725(2), the term “homeless children and youths”, and its subsequent amendments; or

13. resided in the preceding school year or resides in the current school year in a residential placement facility in the district, including a detention facility, substance abuse treatment facility, emergency shelter, psychiatric hospital, halfway house, or foster group home.

Please note that a student with a disability may be considered to be at-risk of dropping out of school if the student meets one or more of the statutory criteria for being in an at-risk situation that is not considered to be part of the student’s disability. A student with a disability is not automatically coded as being in an at-risk situation. Districts should use the student's individualized education program (IEP) and other appropriate information to make the determination.

BIOGRAPHICAL SKETCH

Brent J. Burkott grew up in Rockledge, Florida. After high school he met Ron Harrison, a top executive with Marriott Hotels. Mr. Harrison told him to get a challenging degree in something he loved and when he graduated to come see him about working for Marriott Hotels and Resorts. Brent got a B.S. in Biology with a minor in Chemistry from Brigham Young University Hawaii in 1992. During that time, he met his wife Michelle. Rather than pursue a job with the Marriott Hotels, he decided to attend graduate school at Texas A & M University Corpus Christi, where he received a M.S. in Mariculture in 1995. His life changed with the mentoring of Mr. Harrison, who helped set him on a different path than he was previously on.

Brent worked for the Oceanic Institute (O.I.) in the finfish research department, where he became the first person in the World to successfully design a culture system for spawning Flame Angel Fish in captivity. He later purchased a 50-acre ornamental fish and shrimp farm in Kahuku, Hawaii that he operated for five years before returning to Texas as a shrimp-farm manager and later the director of marketing and sales for a large U.S. shrimp company.

In 2006, he began teaching high school Biology and soon became a fully certified Composite Science Teacher in Texas. He has since taught biology, PreAP biology, Honors biology, AP biology and chemistry. While still teaching, he received a Doctorate of Education with a specialization in science in July of 2021 from The University of Texas Rio Grande Valley. Brent can be contacted by email at Burkott@gmail.com