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Comparison of academic performance with a traditional textbook versus a digital openly-licensed textbook

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Abstract

With the utilization of open educational resources (OER) and digital materials becoming more popular, research is needed to determine if academic outcomes are affected with the increasing shift to digital content. The goal of this research was to analyze the academic performance of students using a traditional physical textbook, as compared to those using an electronic copy of a similar textbook provided free through the campus library. The traditional and digital no-cost textbook comparisons were made between two sections of the same upper division undergraduate course taught at a Hispanic-Serving Institution. The two sections of the course were taught during the Fall 2019 semester, both online, with the same faculty member facilitating both sections. There was no statistical difference in mean discussion grades, $t(62)=-0.714$, $p=0.478$, $d=0.178444$, mean written assignment grades, $t(62)=-1.985$, $p=0.053$, $d=0.49613$, and mean quiz grades, $t(62)=-1.711$, $p=0.092$, $d=0.427858$. However, when looking at the overall total course grade, the mean no-cost course was statistically higher than the traditional textbook course, $t(62)=-2.097$, $p=0.042$, $d=0.524348$. Instructors do not need to be

concerned about student outcomes with the increasing implementation of such materials. Universities providing free digital access to textbooks can help address financial concerns for these students without sacrificing academic performance.

Keywords: digital textbook, openly-licensed resources, traditional textbook, Hispanic-Serving Institution, academic performance

Resumen

Con la popularización del uso de los recursos educativos de acceso libre y materiales digitales, se hace necesario investigar si los resultados académicos se ven afectados por el movimiento creciente hacia el contenido digital. El objetivo de esta investigación fue analizar el desempeño académico de estudiantes que utilizaron libros de texto tradicionales y en soporte físico, en comparación con aquellos que utilizaron una copia electrónica de un libro de texto semejante, que se ofrece gratuitamente en la biblioteca de la universidad. La comparación entre el libro de texto tradicional y el libro de texto digital gratuito se hicieron en dos secciones lectivas del mismo curso de tercer y cuarto año, que se imparte en una Institución de Servicio a Hispanos. Las dos sesiones se impartieron por el mismo profesor de forma virtual (online) durante el semestre de otoño del 2019. No hubo ninguna diferencia estadística entre el promedio de las calificaciones de los debates, $t(62)=-0.714$, $p=0.478$, $d=0.178444$, entre el promedio de las calificaciones de las tareas escritas, $t(62)=-1.985$, $p=0.053$, $d=0.49613$, y entre las medias de las calificaciones de los exámenes, $t(62)=-1.711$, $p=0.092$, $d=0.427858$. Sin embargo, en las calificaciones generales del curso, el promedio en el curso que uso el libro de texto gratis fue más alto estadísticamente que el promedio en el curso de libro de texto tradicional, $t(62)=-2.097$, $p=0.042$, $d=0.524348$. Los profesores no se deben preocupar por los resultados de los estudiantes

con la creciente implementación de estos materiales digitales. Las universidades que facilitan el acceso digital gratuito a libros de textos pueden ayudar a reducir las preocupaciones financieras para estos estudiantes sin sacrificar el desempeño académico.

Palabras claves: libro de texto digital, recursos autorizados abiertos, libro de texto tradicional, Institución de Servicio a Hispanos, desempeño académico

Introduction

Many university libraries have shifted toward providing openly-licensed and digital content to help shield students from the rising cost of course materials (Boling & Kohn, 2019). As the movement toward open educational resources (OER) and digital materials gains more traction, the efficacy of such resources is a common objection by the movement's opponents (Clinton & Khan, 2019; Hilton, 2016). Research is needed to determine if academic outcomes are affected with the increasing shift to digital content.

Having access to free textbooks, while beneficial to all students, can be particularly impactful to historically underserved college students. Hispanic students in particular are more likely to experience increased stress due to financial concerns (Ermis-Demirtas et al., 2018; Montalto et al., 2018). Further, students who identify as Hispanic often have additional family obligations to juggle during their academic journey (Covarrubias et al., 2019; Covarrubias & Fryberg, 2015). The cost of college textbooks has been identified as a redistributive social justice issue that disproportionately impacts historically underrepresented groups (Jenkins et al., 2020). With the proportion of Hispanic college students increasing steadily, a need to identify more cost-effective course materials has never been greater (Rodríguez Amaya et al., 2018).

The goal of this research was to analyze the academic performance of students using a traditional physical textbook, as compared to those using an electronic copy of a similar textbook provided free through the campus library. This study was conducted at a Hispanic-Serving Institution (HSI), making it a particularly well suited to explore issues related to the evaluation of the impact of digital textbooks on this group of students. The research was also unique because it compared two sections of the same course, taught by the same instructor, during the same semester, and using the same modality. Given the university's HSI status and the ideal timing of these two sections of the course, this research set out to compare students' academic performance using the different textbook modalities.

Literature Review

Advantages of No-Cost Materials

Reducing Cost

Perhaps the most compelling argument in favor of adopting no-cost educational materials is their cost savings potential for students. Cost is a primary factor that affects students' ability and willingness to buy required course materials. The average cost of textbooks for a single class is around $150 (Ariyo & Reams-Johnson, 2021); however, this number can rise, especially in core major classes. In fact, the total cost of course materials can be even higher than that of tuition for some students (Fischer et al., 2015). For each of these reasons, a survey of over 22,000 post-secondary students in Florida reported that 64% of participants did not buy their required textbook for a course due to high cost (Hilton, 2016). For students from historically underrepresented groups and/or with a lower socioeconomic status, this can make receiving the education they desire much more difficult and seemingly unattainable. Making no-cost materials

available for multiple majors at colleges and universities across the country would alleviate stress on students that are deeply affected by the ever-rising costs of education.

Technological Advantages

Over the years, technology has continually made space for itself in nearly every aspect of life, and education is certainly not exempt. Most of today's college and university students have been surrounded by technology starting very early in their lives and it has shaped how they communicate, socialize, and learn (Millar & Schrier, 2015; Weisberg, 2011). A common assumption of this generation, usually referred to as "Generation Y," is that they want to obtain all the information they can, and instantly at that (Millar & Schrier, 2015). As a result, many educational institutions feel motivated to make the shift to no-cost digital resources in their classrooms to keep up with their students in terms of how technology is integrated into their everyday lives. Additionally, because many of today's students grew up using technology, they can easily adapt to such implementations.

Increased Accessibility

Many proponents of no-cost digital educational materials agree that such materials are paving the way for ultimate accessibility, something that traditional textbooks do not cater to, given their cost. This is especially important for students of non-traditional age or circumstance that, for example, utilize distance learning and strive to maintain a work-life balance, or have physical disabilities and cannot carry multiple heavy textbooks around a university campus. Aside from its physical attributes, the functional convenience of digital educational materials is one that many students can endorse. In a 2011 study, Weisberg found that students preferred technological devices as their textbook medium because they could use interactive note-taking

functions such as highlighting, searching, saving, and sharing without worry of ruining or losing an expensive textbook. They also found it easier to be able to study in a variety of settings (i.e. on the train, in a park) at their leisure (Weisberg, 2011).

Academic Performance

Several studies report evidence of improved academic performance when using openly-licensed digital content, which may encourage educational institutions to invest in these types of materials for their students. A 2012 study compared the academic success of students taking an introductory psychology course; 690 students used a free digital textbook, and were compared in class success to 370 students that used a traditional textbook in a previous semester (Fischer et al., 2015). Results showed that students who used the digital textbook had better overall grades in the course, had a lower withdrawal rate that semester, and had better scores on the final examination than students in the semester that used traditional textbooks (Fischer et al., 2015). Pawlyshyn and colleagues (2013) implemented open OER into several math courses at Mercy College in the fall semester of 2012. Between Spring 2011 (when only traditional textbooks were used) and Fall 2012 (when OER was implemented), pass rates rose from 48.4% to 68.9%. Another study found that students who used textbooks from Flat World Knowledge, an online source that provides openly-licensed textbooks in a digital format, had better success in class and lower failure and withdrawal rates (Feldstein et al., 2012). While these results are both positive and promising in the discussion of moving toward full implementation of no-cost educational materials and OER, there are also studies revealing disadvantages.

Disadvantages of No-Cost Materials

Limited Viability

Substantial data supports the notion that digital educational resources are simply more effective for soft sciences than hard sciences. Analyses of multiple reports show that no-cost digital materials and OER were most viable in computer science, business, engineering, psychology, and art courses (deNoyelles & Raible, 2017; Millar & Schrier, 2015; Nicholas et al, 2010). Conversely, OER were least popular in economics, humanities, and literature courses (Allen et al., 2015; Millar & Schrier, 2015). Such a phenomenon could exist because the latter subjects require much more close readings than the former, and students of those subjects prefer traditional textbooks as to not have eye strain from looking at a screen (Millar & Schrier, 2015). This is important to acknowledge in this context as reading comprehension is critical to student success.

Reduced Comprehension

While having a textbook available on a computer or tablet screen is certainly convenient, this does not guarantee that readers will comprehend information as well as they would from a paper source. Research indicates that some students comprehend information better when they physically touch the book, highlight important points in the text, and take notes in the margins if they plan to keep the book (Millar & Schrier, 2015). In 2012, researchers in Norway evaluated reading comprehension in 72 students in the 10th grade by giving vocabulary and word-reading pre-tests and subsequently two different kinds of texts to read and be tested on; 25 read on paper, and 47 read from a computer screen (Mangen et al, 2013). Significant results from a multiple regression analysis showed that students who read from a computer screen scored lower on reading comprehension tests than their counterparts ($p=0.025$) (Mangen et al., 2013). A component that affects these results is the ability to scroll through and find specific information

within PDF documents; this function can be convenient and helpful but can hinder the ability to fully comprehend what is being read (Mangen et al., 2013).

Restricted Access

While no-cost digital textbooks and OER can provide education to a wider range of students in terms of funding and convenience, being able to access these resources outside of school may be difficult or not possible for some. For students of lower socioeconomic status, not having access to a stable internet connection, or the resources for acquiring convenient devices such as laptops or tablets, poses a disadvantage to their potential to be successful in school (Chulkov & Vanalstine, 2013). In 2012, a school district with a higher concentration of students with low socioeconomic status attempted to transition fully to digital educational materials (Choppin et al, 2014). While implementing the change, they experienced some large-scale unfortunate setbacks. The books they required were not available on less expensive reading devices like Nooks and Kindles, and more students than expected did not have internet access at home. This resulted in teachers using an entire year's worth of paper in less than two months to print the materials (Choppin et al., 2014). If students who live in a lower socioeconomic status are provided the opportunity to attend a higher education institution, and do not have the resources to access digital textbooks outside of school, and if no other options are available, their institution is not ameliorating the issue at hand by considering the switch to no-cost digital textbooks.

Implementing no-cost digital educational materials into an increasing number of higher education institutions is a topic that is being looked at under the microscope by both the movement's supporters and opponents. While there are many advantages to the concept, there

are disadvantages. Additionally, research on the subject in regard to student success is inconclusive, so there is much more to be done in that respect.

Methods

The traditional and digital no-cost textbook comparisons were made between two sections of the same upper division undergraduate course taught at a four-year public university: Healthcare Program Planning & Evaluation. The two sections of the course were taught during the Fall 2019 semester, both online, with the same faculty member facilitating both sections. The assignments, quizzes, due dates, and feedback turnaround times were identical. The difference being evaluated was the traditional textbook offered in one section and the free electronic textbook offered through the university library.

Setting

The campus these courses were taught at is a regionally accredited public university with a student population of just over 7,000, nearly all being undergraduate students. The campus is a designated Hispanic Serving Institution comprised of 65% female students, 65% racial/ethnic minorities, 49% Federal Pell Grant eligible, and 35% first-generation college students. The campus is located in Southern California.

Course

The course was offered under the Health Sciences undergraduate program. It is an upper-division elective for the major. The course description of Healthcare Program Planning & Evaluation is:

> This course introduces skills and techniques to research and develop health programs at the community, state, and national levels. Students are presented with concepts, processes, and techniques used in health program planning, implementation, and

evaluation. Students will engage in planning, implementation, and evaluation exercises/demonstrations. This course emphasizes the importance of teams and partnerships in developing successful health promotion programs.

Upon completion of the course, students should be able to:

1. Understand and develop logic models.
2. Evaluate programs using both formative and summative methods of evaluation.
3. Make recommendations for program improvements based on findings from evaluation research.
4. Employ appropriate methodologies to evaluate health programs.
5. Assess the validity of existing evaluation research.

The course using a traditional textbook required students to purchase a hardcopy or electronic version of the textbook. The other section provided a free copy of a different textbook with similar content, with login required to the university library, available in an electronic version only. Both courses offered the same supplemental resources to students including research articles, instructor videos, handbooks and guides from professional organizations, slides from textbook publishers, websites, and a second textbook provided electronically in the course material for the final module of the course.

Assessments

The course consisted of both subjective and objective assessments. The subjective assessments included five discussion boards and four written assignments: a needs assessment, program proposal, evaluation plan, and final course project implementing feedback on individual components. The objective assessments include five quizzes, one per module of the course. Extra

credit was offered for completing the survey for this research project; the extra credit score adjustment was not included in the data analysis.

Participants

Subjects were recruited through the online course announcement feature. At the beginning of the semester, students were made aware of the opportunity for completing a research study that would earn them extra credit in the course. One week prior to the end of the course, another announcement was sent out including the link to complete the survey. Two weeks later, an email was sent directly to those who had not yet participated with a reminder of the opportunity.

Each section of the course had 32 students enrolled; both sections had 100% participation in the survey. The demographics of the two sections of classes were similar (Table 1). All but one student was a health science major; the other was a pre-nursing major. All students were juniors or seniors. The majority of students in both sections identified as Hispanic.

Table 1.

Characteristics of student participants.

Characteristic	Digital Textbook	No-Cost Textbook
Gender	90.6% Female	84.4% Female
Race/ethnicity	53.1% Hispanic	75.0% Hispanic
	18.8% White	12.5% White
	12.5% Asian	6.3% Asian
	12.5% Other or mixed	6.3% Other or mixed
Age (mean)	22.8 (19-32)	23.0 (20-34)
GPA (mean)	3.17	3.35

Instrumentation

Student performance was compared using grades from four subjective written assessments, five discussion board activities, five objective assessments administered as online quizzes, and overall course grade. A range of questions was asked on the surveys to determine student preferences for course materials, access to materials, course material costs per semester, and other factors.

Analysis

Statistical analyses were performed using IBM SPSS Statistics 25. Composites of student grades, consisting of discussion grades, assignment grades, and quiz grades were utilized to perform bivariate analyses. Independent samples t-tests were performed to indicate whether there was a significant mean grade difference between the traditional textbook course section and the no-cost materials course section. Cohen's d (d) was calculated to measure the magnitude of the mean grade differences between course sections.

Ethical Standards

The ethical standards of this research were evaluated and approved by the Institutional Review Board at California State University Channel Islands.

Results

Ninety-one percent (90.6%) of students enrolled in the traditional textbook class reported having access to their textbook for the course. Meanwhile, 69.0% of those who had access to the textbook reported purchasing, renting or borrowing a hardcopy, while only 31.0% reported purchasing or renting an electronic copy. On a scale of 1-10 (with 0 being "not once" using the textbook and 10 being using it "every week"), students in the traditional textbook course

reported an average engagement of 5.4. The average engagement reported by students with the digital no-cost textbook was 7.9.

The no-cost digital textbook group numerically outperformed the traditional textbook group in every grading category and overall course performance. The mean grades for the different assignments in the two courses can be seen in Table 2.

Table 2.

Mean grade percentages and differences between two textbook types.

	Digital Textbook	**Traditional Textbook**	**Difference**
Discussion Boards (15 points)	14.1 ± 1.3	13.8 ± 1.9	0.3
Subjective Assignments (56.25 points)	49.6 ± 6.1	45.0 ± 11.5	4.3
Quizzes (30 points)	22.6 ± 3.5	20.7 ± 5.4	1.9
Final Course Grade (overall percentage)	84.8 ± 7.1	78.3 ± 16.1	6.5

There was no statistical difference in mean discussion grades between students in the traditional textbook course and the no-cost digital materials course, t(62)=-0.714, p=0.478, d=0.178444. Likewise, the mean written assignment grades of students in the traditional textbook course and the no-cost materials course were statistically similar, t(62)=-1.985, p=0.053, d=0.49613. The mean quiz grades of students in the traditional textbook course and the no-cost materials course were also not statistically different, t(62)=-1.711, p=0.092, d=0.427858. However, when looking at the overall total course grade, the mean no-cost course was statistically higher than the traditional textbook course, t(62)=-2.097, p=0.042, d=0.524348.

Discussion

The use of OER, digital, and other no-cost resources is becoming increasingly common in higher education. Available research has shown OER to positively impact student performance (Feldstein et al., 2012; Fischer et al., 2015; Pawlyshyn et al., 2013; Winitzky-Stephens & Pickavance, 2017). However, few studies have compared the specific impact of openly-licensed course materials on student performance by comparing two groups of students enrolled in identical courses. This current research did just that.

The students in these two classes completed the same assignments during the same semester and the same university with the same instructor. They had the same supplemental materials and both courses were delivered in an online environment. In the traditional textbook course, the majority of students selected the hardcopy option. Given that the traditional textbook students mostly accessed the text through a hardcopy and the no-cost digital textbooks students accessed only an electronic version, some of the potential drawback with e-textbooks could have affected this study's results. More specifically, the aforementioned concerns over reduced comprehension and restricted access could have had negative repercussions on students using the electronic text (Mangen et al., 2013; Millar & Schrier, 2015; Weisberg, 2011). However, the results of this study do not support these concerns. Even though it was only available in electronic form, students using the no-cost text performed comparably or better by every measure in the course, and were found to engage with the course material more frequently.

One possible explanation for why students in the no-cost digital textbook course outperformed their counterparts is the higher rate of engagement they reported with their textbook. With the digital textbook being (1) provided for free by the campus library and (2)

available to students at the beginning of the semester, students were able to engage in the material immediately. With traditional textbooks, students often wait to purchase the textbook to see if the instructor will use it or not (Jenkins et al., 2021). Previous research also found that simply opening course resources before the first class meeting was a major predictor of success (Baker et al., 2015). Students, particularly those from underrepresented groups, have also reported delaying the purchase of a text because they simply do not have the money to do so (Jenkins et al., 2021). With the known decision-making process of students and the lack of resources to acquire the course materials, providing a free digital copy addressed many of the challenges that Hispanic and other students from underrepresented groups face.

Knowing that digital textbooks provided students with the same – or better – foundation to succeed in a class supports the growing trend of universities providing these though their libraries as a way of addressing rising textbooks costs (Boling & Kohn, 2019). One concern, though, is that Hispanic students and those from other historically underrepresented groups often have troubles with a reliable internet connection (Jenkins et al., 2021). However, Xu and Guo (2018) have offered budget-friendly solutions for universities to provide sufficient internet access on campuses. Though this does not address the lack of reliable internet at home, students would at least have consistent access while they are on campus.

The greatest strength of this study is the near identical situation the two courses were taught under. This is the first known comparison of traditional physical textbooks and digital textbooks under such similar circumstances. While the same size of 32 students in each section is small, this research provides clear evidence that digital textbooks, particularly those provided for free to students, are a wise investment for universities and students alike.

There are some limitations to this study. In order to protect students' privacy, the distributed survey did not collect any identifiable data. Therefore, researchers were unable to link individual student grades to a student's choice of purchasing a hardcopy of the traditional textbook or the digital version. If this link had been possible, the data could have been disaggregated to show a more specific comparison. Nonetheless, since the majority of students in the traditional text section purchased the physical text, there is still merit to the presented comparison. Further, to address the aforementioned small sample size, it would be ideal if this study was repeated with more sections and a larger number of students in each section. Researchers that plan to study the subject should be sure that their methods are sound and that their results are generalizable. Understanding the advantages, disadvantages, and empirical results of no-cost digital materials and OERs through credible research will assist in the guarantee of better access to education, and greater success in the classroom, in the most convenient yet viable ways for students, educators, and institutions alike. Other studies have questionable research methods such as the inability to replicate an experiment or not providing conditions that are exactly the same in a multi-year study (Hilton et al., 2013). The methodology of some studies can be logistically problematic in that the courses being studied vary in difficulty, subject matter, and teaching differences.

Conclusion

Hispanic students and others from historically underrepresented groups are often dealing with multiple obligations and stressors outside of their academic pursuits. Universities providing free digital access to textbooks can help address financial concerns for these students. With the

current research, instructors do not need to be concerned about student outcomes with the increasing implementation of such materials.

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