Open versus Traditional Textbooks: A Comparison of Student Engagement and Performance

Isabelle Chang
Temple University

This study compared student engagement and performance in both open educational resources (OER) (n[open textbook users fall 2018] = 72) and traditional textbook (n[traditional textbook users fall 2017] = 66) classes. Data were drawn from the Learning Management System (LMS). Results show (1) final grades in the OER class were on a par with the traditional textbook class, and (2) OER equalize student engagement and performance by narrowing the dispersions of page views, on-time assignment submissions (OTAS), attendance, and final grades. (3) OER increased attendance and lessened excessive dependence on LMS course materials recorded in the traditional class. (4) The indirect effect of attendance on final grades was stronger than the direct effect of OTAS in the OER class. Attendance provided the opportunity for the instructor and students to be on the "same page," which helps students better assimilate course content and comprehend lectures. (5) The availability of textbooks appears to be a factor influencing student course success. However, it remains unknown how much of the variance was explained by OER. It is apparent that OER are more important than ever in elevating overall student academic success.

Introduction

OER have become an increasingly attractive option for several compelling reasons. They can unquestionably reduce educational costs and increase course material availability (Watson, Domizi, & Clouser, 2017). The National Survey of Student Engagement (NSSE) examined whether students declined to purchase required academic materials (books, coursepacks, supplies) due to their cost. The percentages of students who responded "never" were 45% for freshmen, 36% for sophomores, and 31% for seniors, and approximately 63% of college students chose not to purchase required academic materials such as textbooks due to their cost (B. Gonyea, personal communication, July 16, 2019). Likewise, the U.S. Public Interest Research Group (PIRG, 2014) revealed that 65% of college students have forgone buying a textbook due to its high cost, and of those students, 94% acknowledged they suffered academically as a result.

Many students believe that textbooks are too expensive, especially if used infrequently in their course or if not in their chosen academic major, nor did they plan to keep those books as future resources. Although 34% of respondents agreed or strongly agreed that their school makes textbooks more affordable, 44% disagreed or strongly disagreed (Klepfer, Cornett, Fletcher, & Webster, 2019). Moreover, the Florida Virtual Campus (FLVC) survey (2018) identified five consequences of high textbook costs: not purchasing the required textbook (64%), taking fewer courses (43%), not registering for a specific course (41%), earning a poor grade (36%), and dropping a course (23%). These findings suggest that the cost of textbooks was negatively impacting student access, success, and degree completion.

The Babson Survey Research Group (2019) explored instructors' views on textbooks and found 61% of faculty members believed the cost of course materials was a serious concern for students, and 52% of faculty members responded cost was the primary factor why students did not have access to textbooks; however, 38% believed that students did not think they needed textbooks. Forty-six percent of faculty were aware of OER, up from 34 percent in 2015. Just 61% of all faculty believed that "over 90% of my students have access to all the required textbook(s)," and 57% among faculty teaching large enrollment introductory-level courses agreed. Nevertheless, only 16% of faculty had adopted open textbooks, while 23% of those taught introductory level courses.

Consistent with the FLVC (2018) findings, a large-scale national survey by the Association of American Colleges and Universities (AAC&U, 2018) found that issues surrounding retention and completion, the quality and assessment of student learning, and college affordability were the greatest challenges facing our higher education. Due to the increasing cost of higher education (U.S. Bureau of Labor Statistics, 2018), previous studies indicated that OER textbooks lowered students' educational expenses and increased learning opportunities (e.g., Clinton, 2018). Hardin et al. (2018) found no evidence that use of the OER textbooks impeded students' critical thinking compared to traditional textbooks, even after accounting for instructor characteristics. The lower textbook cost had a positive influence on a student's decision to enroll and remain in the course. Moreover, OER textbooks increased grades (Colvard, Watson, & Park, 2018; Winitzky-Stephens & Pickavance, 2017) and decreased DFW (D, F, and Withdrawal letter grades) rates for all students (Colvard et al., 2018).

The existing research on the efficacy of OER textbooks on student performance has typically shown yield equivalent or better outcomes (Cooney, 2017; Croteau, 2017; Hilton, 2016; Hilton, 2019; Jhangiani, Dastur, Le Grand, & Penner, 2018) in a wide range of disciplines, including psychology (Clinton, 2018; Grissett & Huffman, 2019), physics (Hendricks, Reinsberg, & Rieger, 2017), statistics (Illowsky, Hilton III, Whiting, & Ackerman, 2016), and business, geography, chemistry, and biology (Hilton III, Robinson, Wiley, & Ackerman, 2014).

Attendance and Attainment

Attendance is an important factor that has affected students' performance in higher education. A meta-analysis of the relationship between class attendance in college and grades revealed that attendance has strong relationships with both class grades and grade point average (GPA) (Credé, Roch, & Kieszczynka, 2010). Class attendance significantly improves student performance. Specifically, a 10-percentage point increase was observed in students' overall attendance rates, resulting in a 0.17 standard deviation increase in the final exam score for intermediate level economics classes (Dobkin, Gil, & Marion, 2010). Students with fewer class absences were less likely to repeat the first college-level accounting course (Xiang & Hinchliffe, 2019). Paradoxically, one of the rare studies examining OER and attendance reported that Chilean students who used OER in a college freshman mathematics course had significantly lower attendance than those in traditional textbook classes (Venegas-Muggli & Westermann, 2019). The authors theorized that in this case, student confidence resulting from the availability of OER actually lessened their perceived need to attend classes.

One of the benefits of OER is free or low-cost access to required materials. Materials can be posted on an LMS and projected in class, allowing the instructor to show students the lesson material while simultaneously teaching the concepts. The benefits of this can include increasing student attention and engagement and helping them assimilate the concepts being introduced. Other advantages of using OER are myriad. Students can access OER anywhere and anytime with their phones (i.e., no heavy textbooks to carry) with unlimited retrievals that can potentially expand their learning. Updated information may be disseminated promptly to increase the timeliness and/or relevance of the material being presented.

There are undeniably challenges associated with OER, such as quality concerns voiced by many given that any user can create an account and post material in OER repositories, introducing what is often irrelevant and/or inaccurate material. Other concerns include lower attendance thanks to the availability of materials outside the classroom, which might cause certain students to forgo in-class discussions and miss the instructor's feedback. The OER content may be less user friendly than a bound-and-printed textbook, and reading the textbook online may lead to vision fatigue.

Survey results from national and state levels show that approximately 65% of students did not purchase required textbooks due to high costs, indicating that about 35% did so for other than financial reasons. These results may signify that students' personal characteristics are a factor when making the decision to forgo purchasing textbooks, which could also affect their various learning approaches and engagement and as a consequence their final grades. For example, attendance and turning in assignments on time might be factors that also influence students' final grades. These factors were rarely considered in extant research when investigating the effect of OER on students' overall outcomes.

In addition, the review of the existing studies on OER has shown that most of them typically examined students' final grades without consideration of the dispersions of students' engagement and overall performance. In this study student engagement is operationally defined with components consisting of (1) the number of page views, (2) OTAS rates (excluding late and missing assignments), and (3) attendance. For example, as to the question of whether there is a path for a student to get a good grade in a course: students could comprehend more from the instructor's lectures by attending classes because they become better prepared as a result of the availability of textbooks in the OER classes. In contrast, there is the question of whether students in the traditional textbook classes would adopt adaptive approaches when they did not own a required textbook. An example would be if they opted to view the instructor's notes on the LMS instead of utilizing the course reserves at the library, which lead to higher number of page views on the LMS than those in the OER classes. Conversely, it is possible those owning the traditional textbook did not need to depend on the instructor's notes, resulting in both a lower number of page views on the LMS and an extreme dispersion of page views in the traditional textbook class. In addition, it has rarely been reported whether the availability of OER encourages students' previews/reviews of the course content and better preparedness, which in turn increases their classroom engagement. Hence, the present study explored whether:

1) students' final grades in the OER class can be on a par with those in the traditional textbook;
2) OER equalize students' learning and performance by narrowing the dispersions of:
    (a) attendance,
    (b) page views,
    (c) OTAS, and
    (d) final grades;
3) OER positively influence students' learning by:

   (a) lessening excessive dependence on LMS course materials;
   (b) increasing on-time assignment submittals;
   (c) encouraging students' attendance;
4) OER potentially facilitate assimilation of course content and comprehension of lectures as shown by:
   (a) attendance mediating the effect of OTAS on final grades;
   (b) OTAS mediating the effect of attendance on final grades;
5) the availability of textbooks appears to be a factor for students' course success as shown by:
   (a) attendance moderating the effect of OTAS on final grades;
   (b) OTAS moderating the effect of attendance on final grades.

Textbook Affordability Project

At the instructor's institution, the University Library offers a Textbook Affordability Project that provides faculty with a stipend to cease using a commercial textbook in order to help students have a more affordable higher education. The instructor's proposal to stop using a commercial textbook and to adopt OER was selected for the 2018-19 academic year. The participating instructors are required to complete a course evaluation sharing cost savings data, student performance, and general feedback to the University Library by the end of the semester in which the project is conducted. Portions of this report were submitted to the University Library as a partial fulfillment of the requirements. This report compared final grades, attendance, OTAS rates, and page views on LMS (e.g., Canvas) for two classes of the same course taught by the same instructor in consecutive academic years.

Method

Participants

One hundred and thirty-eight students from two general education (GenEd) quantitative literacy (QL) classes at a large urban publicly funded research I institution in the mid-Atlantic United States were included in this study (n[traditional textbook users fall 2017] = 66 and n[OER users fall 2018] = 72). Details about the students and demographics are displayed in Table 1. Students were comprised of various colleges in the University since it was a GenEd course and freshmen were a majority representation in these two classes. Both classes were comprised of 80-minute lectures by the instructor twice a week. Students were assigned to one of the three 50-minute recitation groups (approximately 24 students each group) with the teaching assistant each week for practice, discussions, and data analysis and graphing. Both courses counted for four credits.

Table 1
Number of Students and Demographics in Classes

		Fall 2017 (traditional textbook)	Fall 2018 (OER textbook)
Class size		66	72
Gender	Male	16 (24%)	21 (29%)
	Female	50 (76%)	51 (71%)
Race/ethnicity	White	34 (52%)	42 (58%)
	Black	18 (27%)	15 (21%)
	Hispanics	3 (5%)	7 (10%)
	Asian/PI	10 (15%)	7 (10%)
	Native	1 (1%)	1 (1%)
Class standing	Freshmen	48 (73%)	55 (76%)
	Sophomore	13 (20%)	12 (17%)
	Junior	3 (4%)	4 (6%)
	Senior	3 (4%)	1 (1%)
Major	Psychology	27 (41%)	26 (36%)
	Other	39 (59%)	46 (64%)

Note: Due to rounding, percentages may not always appear to add up to 100%. Gender: at the class level

Interactive learning has been a favored teaching style for the instructor. Interactive learning is defined as consisting of student-student, student-instructor, and student-computer interaction on in-class and out-of-class activities. For both classes, assignments included on-line examinations and quizzes (multiple-choice items), homework assignments (short-answer questions), in-class group activities and discussions, in-class "bite-sized" interactive learning checks on LMS, and one group project and presentation. For both classes, there were about 45 assignments for 690 possible points throughout the semester. All assignments were interactive and created by the instructor and students responded to all items on the LMS. Assignments were graded and real-time feedback were provided.

Students in both classes did group projects and wrote team papers. There were typically four students in each group for the projects consisting of 7-step assignments such as research questions, development of surveys, data collection and analysis, and the writing of a report. Each group created a survey and collected data online. Upon the completion of the data collection, the teaching assistant helped them with downloading the data, figuring descriptive statistics, and generating graphs and tables during the lab recitations. Afterwards, each group of students wrote a joint report and prepared a poster for presentations. Posters were mounted on the classroom walls when the groups were presenting their projects, and each group presentation was allotted approximately 12 minutes with about six posters per meeting.

For the fall 2017 class, the instructor had adopted a popular introductory quantitative analysis and understanding statistics textbook for psychology majors published by one of the industry leaders in textbook publishing. An OER considered by the instructor to contain up-to-date, clear, and well-organized content was adopted for the fall 2018 class. Instructors in the department have the discretion to make their independent decisions in adopting course materials. The OER class met in a lecture hall with a pitched floor (i.e., tiered seating) and in a regular classroom setting for the traditional textbook class.

For the traditional textbook class, a course reserve was placed at the library and available for review by students who did not purchase the textbook for a maximum of four hours a day per student. However, the University Library did not track for individual students who checked out the text on how long and how often they reviewed it in the library. The link of the adopted OER textbook was posted on the LMS where students could download and review it. Furthermore, attendance was recorded for every meeting throughout the semester for both classes. Data were downloaded from LMS and analyzed using Analysis of Moment Structures (AMOS, 2019) and SPSS (IBM Corporation, 2019) with PROCESS Macro (Hayes, 2019).

Results

Descriptive statistics of page views, OTAS, attendance, and final grades were displayed in Figure 1. Final grades show no differences between the traditional textbook and OER classes (p = .945) (Table 2), indicating that students' final grades in the OER class were on a par with those using the traditional textbook. The dispersions of students' page views, OTAS, attendance, and final grades in the OER class were much narrower with an evidently smaller standard deviations than those of the traditional textbook class (Figure 1*a, b, c,* and *d*). The dispersions were less extreme, resulting in smaller standard deviations in the OER class than those in the traditional textbook class, indicating OER equalized the students' engagement and performance. The dispersions were clustered closer to the means in the OER class despite having an equally high final grade average as the traditional textbook class. Research questions (1) and (2) have been supported.

Results of the independent t-test show that students in the traditional textbook class had marginally higher page views on LMS than those in the OER, [$t(88)$ = 1.95, p = .055]. There were no differences in the OTAS rates (p = .469) which both reached 90% or higher. Attendance trended higher in the OER class than that of the textbook class (p = .070), although 90% or higher attendance rates were observed for both classes. Research question (3) has been partially supported in that, 3(a) OER lessened students' dependence on LMS course materials; 3(b) The OTAS in OER class was not significantly higher than that in the traditional textbook class, and 3(c) OER increased students' attendance.

Table 3 presents the correlation matrix of page views, OTAS, attendance, and final grades. Attendance was the strongest predictor of students' final grades and OTAS; however, page views was weakly correlated with final grades and attendance for both classes. The OTAS rates were significantly correlated with attendance for both classes, indicating that students who attended classes regularly were more likely to submit their assignments on time. Since the significant correlations between attendance, OTAS, and final grades were observed, mediation and moderation analyses were conducted.

Mediation

Mediation analyses were employed to understand the observed significant relations between attendance, OTAS, and final grades by exploring the underlying mechanism or process by which one variable (e.g., attendance) influences another variable (e.g., final grades) through a mediator variable (e.g., OTAS). Mediation analysis facilitates a better understanding of the relations between the predictor and criterion variables when the variables appear not to have a definite connection.

Figure 1

Descriptive statistics of page views, on-time assignment submissions, attendance, and final grades in OER and Traditional classes
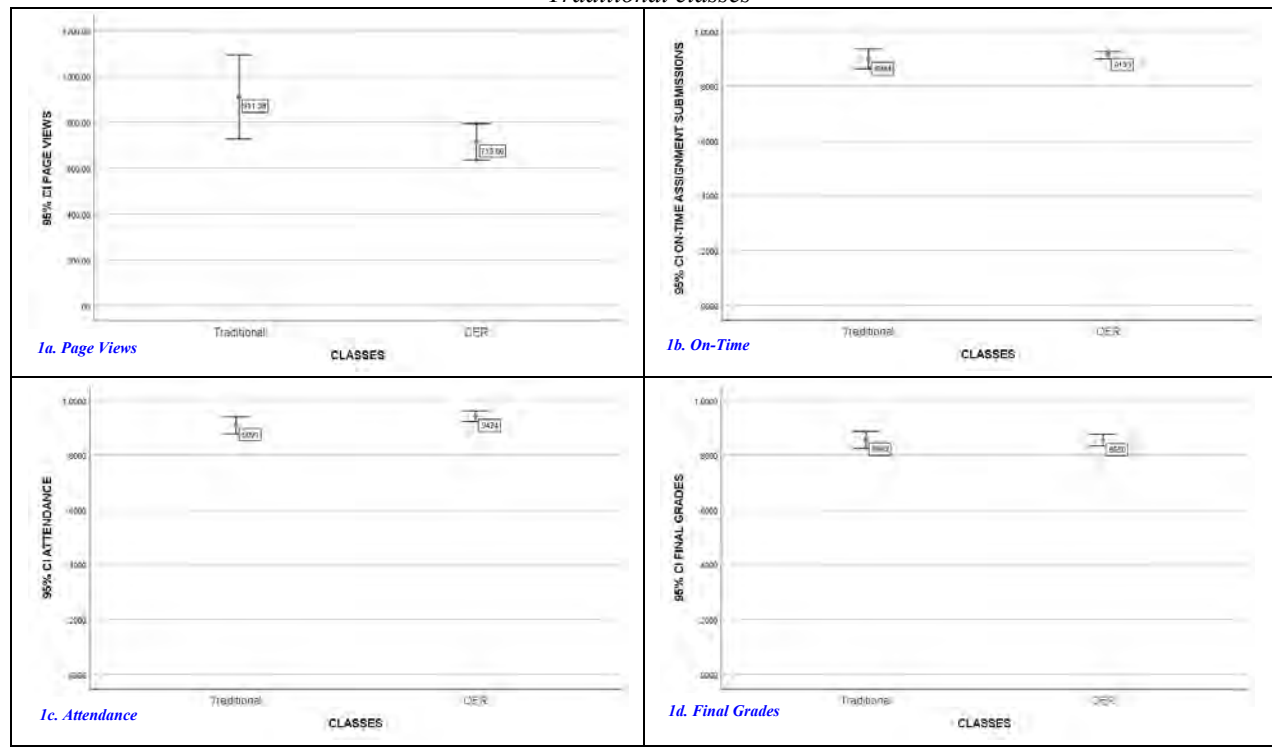

1a. Page Views

1b. On-Time

1c. Attendance

1d. Final Grades

Table 2

Descriptive Statistics and Independent t-test Results

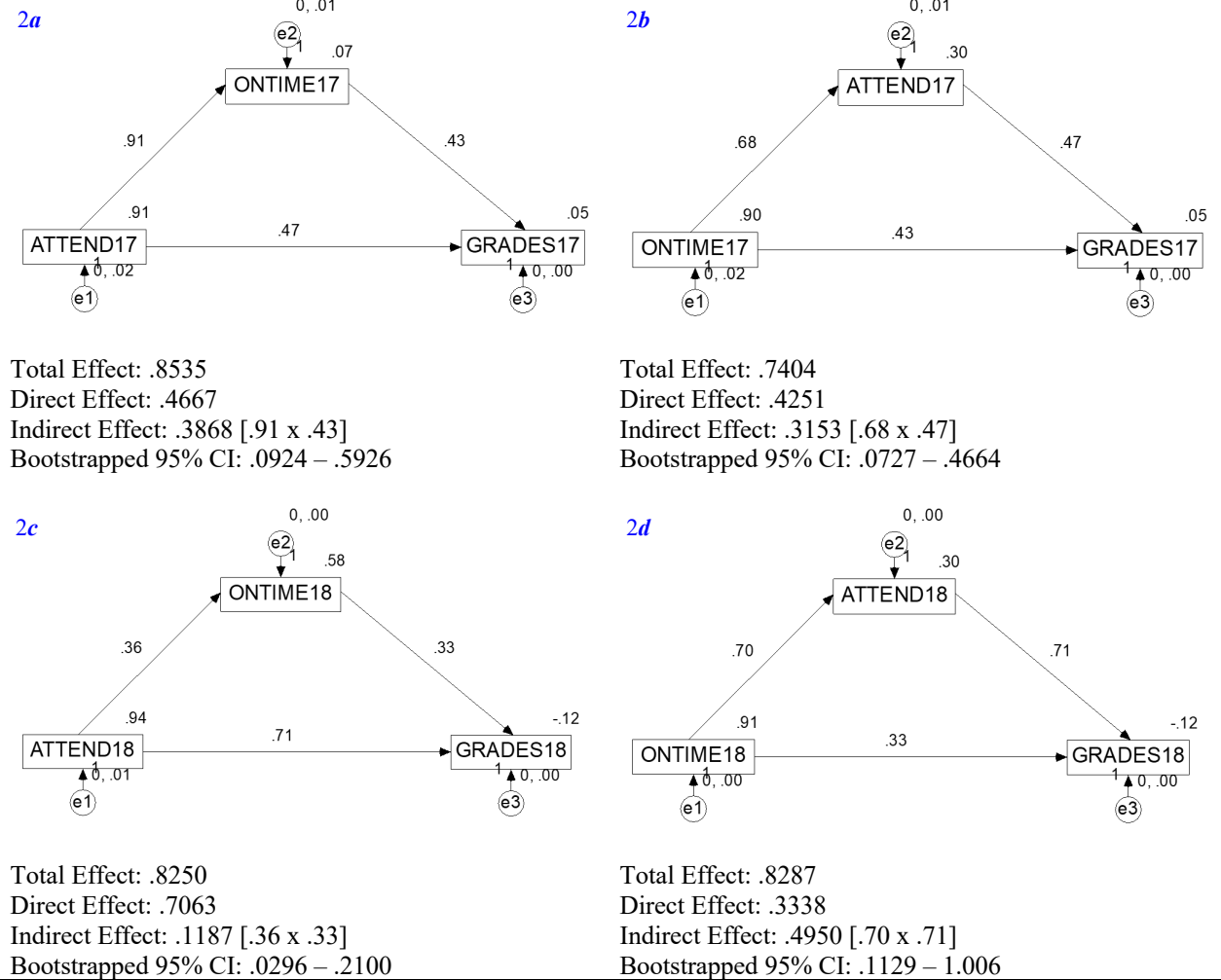|	Fall 2017 (*n* = 66) Traditional textbook	Fall 2018 (*n* = 72) OER textbook	*t*	*df*	*sig*
Grades	85.63 (12.44)	85.50 (9.14)	.067	136	.945
Page Views	911.38 (750.04)	715.86 (334.05)	1.95	88	.055
Attendance	.91 (.13)	.94 (.08)	1.83	110	.070
OTAS	.90(.15)	.91 (.06)	.73	84	.469

Note: OTAS: percentages of on-time assignment submittals; Page Views: each time a user views the page; (standard deviation in parentheses)

Table 3

Correlation Matrix of Grades and Page Views, Attendance, and On-Time Assignments

	Fall 2017 (*n* = 66) Traditional textbook				Fall 2018 (*n* = 72) OER textbook			
	1	2	3	4	1	2	3	4
1. Grades	---				---			
2. Page Views	.11				.21			
3. Attendance	.86***	.20			.74***	.06		
4. OTAS	.87***	.04	.78***	---	.53***	.18	.50***	---

Note: *** Correlation is significant at the .001 level (2-tailed).

Figure 2
Mediation effects of OTAS or attendance on final grades

Total Effect: .8535
Direct Effect: .4667
Indirect Effect: .3868 [.91 x .43]
Bootstrapped 95% CI: .0924 – .5926

Total Effect: .7404
Direct Effect: .4251
Indirect Effect: .3153 [.68 x .47]
Bootstrapped 95% CI: .0727 – .4664

Total Effect: .8250
Direct Effect: .7063
Indirect Effect: .1187 [.36 x .33]
Bootstrapped 95% CI: .0296 – .2100

Total Effect: .8287
Direct Effect: .3338
Indirect Effect: .4950 [.70 x .71]
Bootstrapped 95% CI: .1129 – 1.006

Traditional textbook class. A measure for the indirect effect of OTAS on final grades shows that the effect size was .3868, with a bootstrapped 95% confidence interval, which did not include zero indicating that the effect was significantly greater than zero at α = .05. Using OTAS as the mediator, the total effect of attendance on final grades was .8535, with a direct effect of .4667 from attendance and an indirect effect of .3868 (45% of the total effect) from OTAS (Figure 2*a*). The other measure for the indirect effect of attendance on final grades shows that the effect size was .3153, with a bootstrapped 95% confidence interval, which did not include zero indicating that the effect was significantly greater than zero at α = .05. However, when using attendance as the mediator, the total effect of OTAS on final grades dropped to .7404, with a direct effect of .4251 from OTAS and an indirect effect of .3153 (43% of the total effect) from attendance (Figure 2*b*).

OER class. A measure for the indirect effect of OTAS on final grades shows that the effect size was

.1187, with a bootstrapped 95% confidence interval, not including zero, indicating that the effect was significantly greater than zero at α = .05. The total effect of attendance on final grades was .8250, with a direct effect of .7063 (86% of the total effect) from attendance and an indirect effect of .1187 from OTAS (Figure 2*c*). The other measure for the indirect effect of attendance on final grades shows an effect size of .4950, with a bootstrapped 95% confidence interval, not including zero, indicating that the effect was significantly greater than zero at α = .05. The total effect of OTAS on final grades was .8287, with a direct effect of .3338 from OTAS and an indirect effect of .4950 from attendance (60% of the total effect) (Figure 2*d*). The two models revealed that attendance was a major factor in students' final grades in the OER class.

Full mediation was observed when the presence of the mediation variable (e.g., OTAS) dropped the relation between the predictor (e.g., attendance) and

Table 4
Moderation Effects (Fall 2017)

	Fall 2017 ($n = 66$)				
	Traditional textbook				
Model Summary	R	R^2		F	p
	.9248	.8889		165.32	.0000
		b	s.e.	t	p
ATTEND17		.32	.07	4.46	.0000
OTAS17		.24	.07	3.63	.0006
Interaction		-.80	.15	-5.49	.0000
(Unconditional)		R^2-chng		F	p
ATT17 x OTAS17		.0539		30.10	.0000
Conditional effects		b	s.e.	t	p
OTAS17	-.1455	.44	.07	6.49	.0000
(Figure 3*a*)	.0000	.32	.07	4.46	.0000
	.1245	.22	.08	2.77	.0074
ATT17	-.1254	.34	.06	5.72	.0000
(Figure 3*b*)	.0000	.24	.07	3.63	.0006
	.1136	.15	.08	1.99	.0511

criterion variable (e.g., final grades) and became a weaker, yet still significant path, with the inclusion of the mediation effect for all four models. The total effect was lower in Model 2*b* in the traditional textbook class than Model 2*d* in the OER class when attendance was a mediator. The results support question (4) indicating that undergraduate students need textbooks to better comprehend and assimilate course content and lectures thanks to the large amount of direct and indirect effect from attendance on the final grades in the OER class.
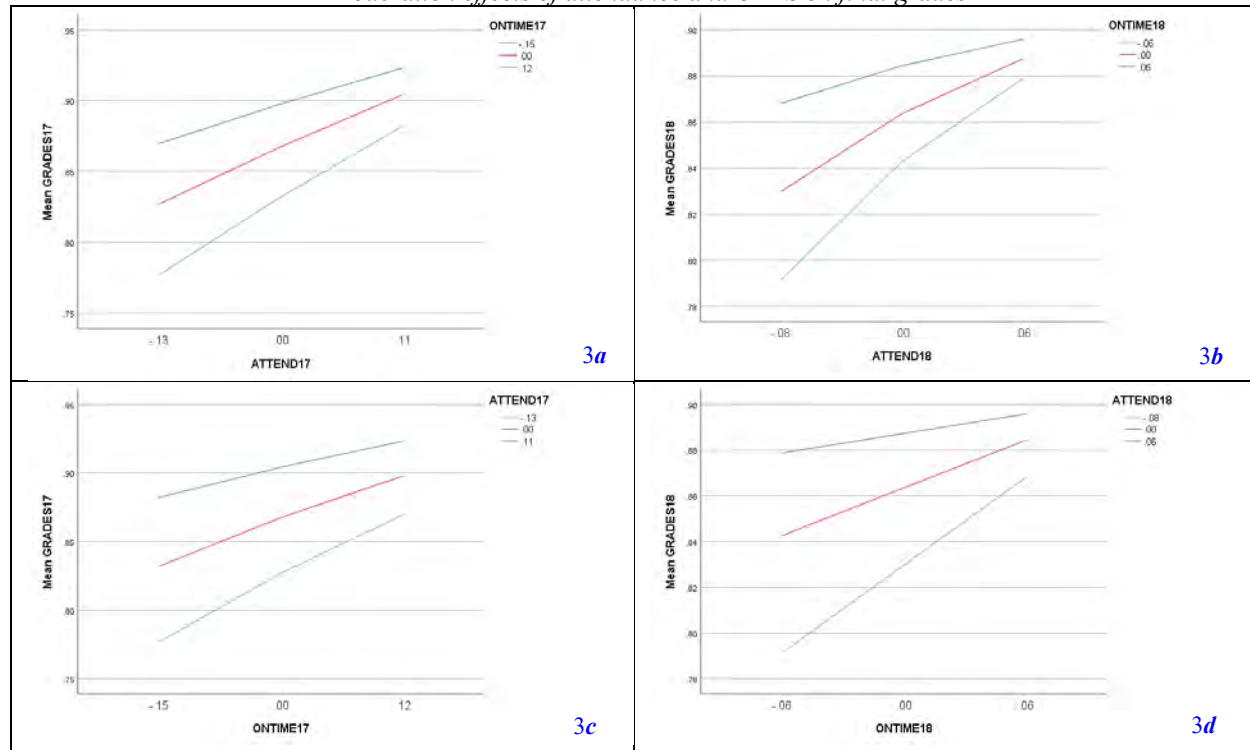
Moderation

Moderator analyses were conducted to determine whether the relationship between two variables (e.g., attendance and final grades) depended on (was moderated by) the value of a third variable (e.g., OTAS). Although mean centering is not a requirement when carrying out moderated multiple regression, it can facilitate interpretation of the regression parameters (Hayes, 2018). The (continuous) moderator variables (e.g., OTAS) were segmented into "-1SD, Mean, and +1SD" to represent "low," "medium," and "high" values for that variable (e.g., Aiken & West, 1991). Therefore, the relation between attendance and final grades was tested at those three levels.

Traditional textbook class. In the traditional textbook class, the interaction term was significant ($b = -.8027$, $p < .0001$), indicating that OTAS was a significant moderator of the effect of attendance on final grades. The R^2 change from adding in the

interaction term was .0539, indicating the interaction effect accounted for 5.39% added variability in final grades. The effect of attendance on final grades was positive and significant ($b = .3237$, $p < .0001$), conditional on OTAS = 0, indicating that the effect of attendance was .3237 for those individuals scoring at the grand mean on OTAS. In addition, the conditional effect of OTAS was positive and significant ($b = .2346$, $p = .0006$), conditional on attendance = 0, indicating the effect of attendance was .2346 for those individuals scoring at the grand mean on attendance.

Since the interaction term was statistically significant, additional analyses were performed to examine the relationship between attendance and final grades at three levels of the moderator (i.e., OTAS). At -1SD on the centered OTAS (representing low OTAS), the relationship between attendance and final grades was positive and significant ($b = .4405$, $p < .0001$). Next, at the mean (i.e., at .0000) on the centered moderator variable (representing medium OTAS), the relationship was positive and significant ($b = .3237$, $p < .0001$). Finally, at +1SD on the centered OTAS (representing high OTAS), the relationship was positive and significant ($b = .2238$, $p = .0074$) (Table 4, Figure 3*a*). However, when using attendance as the moderator, at +1SD on the centered attendance (representing high attendance), the relationship was positive but not significant ($b = .1524$, $p = .0511$) (Table 4, Figure 3*b*). The value that defined Johnson-Neyman significance region was .1129 ($p = .0500$), with 98.48% below and 1.52% above this value of .1129.

Figure 3
Moderation effects of attendance and OTAS on final grades

OER class. In the OER class, the interaction term was statistically significant (b = -3.6640, p = .0033), indicating that OTAS was a significant moderator of the effect of attendance on final grades. The R^2 change from adding in the interaction term was .0504, indicating the interaction effect accounted for 5.04% added variability in final grades. The effect of attendance on final grades was positive and significant (b = .4131, p = .0032), conditional on OTAS = 0, indicating that the effect of attendance was .4131 for those individuals scoring at the grand mean on OTAS. In addition, the conditional effect of OTAS was positive and significant (b = .3580, p = .0093), conditional on attendance = 0, indicating the effect of attendance was .3580 for those individuals scoring at the grand mean on attendance.

Since the interaction term was statistically significant, additional analyses were performed to examine the relationship between attendance and final grades at three levels of the moderator (i.e., OTAS). At -1SD (i.e., at -.0583) on the centered OTAS (representing low OTAS), the relationship between attendance and final grades was positive and significant (b = .6266, p < .0001). Next, at the mean (i.e., at .0000) on the centered moderator variable (representing medium OTAS), the relationship was positive and

significant (b = .4131, p = .0032). Finally, at +1SD (i.e., at .0583) on the centered OTAS (representing high OTAS), the relationship was insignificant (b = .1996, p = .3014) (Table 5 and Figure 3*c*). The moderator value that defined Johnson-Neyman significance region was .0261 (p = .0500), with 59.72% below and 40.28% above this value of .0261. Similarly, at +1SD (i.e., at .0576) on the centered attendance (representing high attendance), the relationship was insignificant (b = .1468, p = .3210) (Table 5 and Figure 3*d*). The moderator value that defined Johnson-Neyman significance region was .0242 (p = .0500), with 45.83% below and 54.17% above this value of .0242. Furthermore, the R^2 value which is the percent of variance explained by the model dropped to 63.03% in the OER class from 88.89% in the traditional textbook class (Table 5). Table 6 displays a summary of statistical analysis results.

Discussion

The mean of the final grades for both classes were indistinguishable, albeit with a widespread dispersion in the traditional textbook class, indicating when every student had access to a textbook the class performance distribution narrowed. The results also show that

Table 4
Moderation Effects (Fall 2017)

| | | | Fall 2017 (*n* = 66) | | |
| | | | Traditional textbook | | |
Model Summary	*R*	*R*²		*F*	*p*
	.9248	.8889		165.32	.0000
		b	*s.e.*	*t*	*p*
ATTEND17		.32	.07	4.46	.0000
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Interaction		-.80	.15	-5.49	.0000
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Conditional effects		*b*	*s.e.*	*t*	*p*
OTAS17	-.1455	.44	.07	6.49	.0000
(Figure 3*a*)	.0000	.32	.07	4.46	.0000
	.1245	.22	.08	2.77	.0074
ATT17	-.1254	.34	.06	5.72	.0000
(Figure 3*b*)	.0000	.24	.07	3.63	.0006
	.1136	.15	.08	1.99	.0511

Table 5
Moderation Effects (Fall 2018)

| | | | Fall 2018 (*n* = 72) | | |
| | | | OER textbook | | |
Model Summary	*R*	*R*²		*F*	*p*
	.7939	.6303		38.6450	.0000
		b	*s.e.*	*t*	*p*
ATTEND18		.4131	.1353	3.0534	.0032
OTAS18		.3580	.1336	2.6789	.0093
Interaction		-3.6640	1.2036	-3.0443	.0033
(Unconditional)		*R*²-chng		*F*	*p*
ATT18 x OTAS18		.0504		9.27	.0033
Conditional effects		*b*	*s.e.*	*t*	*p*
OTAS18	-.0583	.63	.10	6.36	.0000
(Figure 3*c*)	.0000	.41	.14	3.05	.0032
	.0583	.20	.19	1.04	.3014
ATT18	-.0818	.66	.17	3.85	.0003
(Figure 3*d*)	.0000	.36	.13	2.68	.0093
	.0576	.15	.15	1.00	.3210

students in the traditional textbook class viewed the instructor's notes marginally more than those in the OER class, suggesting that those who did not have the textbook depended more on the materials posted by the instructor. It appears that students who owned the traditional textbook were less likely to display excessive dependence on the LMS notes than those who did not buy the textbook, resulting in extreme distribution of page views in the traditional textbook class. In contrast, students in the OER class only needed to download the

textbook once and could review it anywhere and anytime they wished, whereas those in the traditional textbook class had to download them by the units organized by the instructors. The results show that the dispersions of page views, OTAS, attendance, and final grades were narrower in the OER class and persuasively support the question that OER equalize students' engagement and course success. One intriguing implication is that OER might have elevated the performance of students lacking the traditional textbook, thus resulting in a narrower dispersion of the final grades. To further elaborate, it appears from this study that OER spurs a convergence of students' final grades closer to the class average (i.e., equalizing), contrary to the larger standard deviation recorded in the traditional textbook class. In addition, OER narrowed the standard deviation of attendance, page views, and OTAS.

Inconsistent with the findings by Venegas-Muggli and Westermann (2019), students in the OER class had marginally higher attendance rates than those in the traditional textbooks. The fact that an almost equal number of in-class activities and assignments for both classes occurred suggests that if students had previewed and/or reviewed the materials they might have been better prepared and attended class more regularly. When attendance served as the mediator in the OER class (i.e., Model 3*d*), it was the only model where the indirect effect was stronger than the direct effect. In comparison, in the traditional textbook class attendance could not generate as much effect as that in the OER class, resulting in lower total effect of the model when attendance was a mediator. The results of all four models suggest that textbooks may potentially help undergraduate students better assimilate course content and comprehend materials covered in class as reflected in their final grades. Note that the indirect effect of attendance on final grades was stronger than the direct effect of OTAS in the OER class. The instructor projected the PowerPoint slides, OER text, and related videos and information during lectures throughout the semester and encouraged students to have the OER text on their laptops. Correspondingly, students could easily locate the materials discussed in the lectures, with resulting increases in attention and comprehension. In other words, when the instructor and students are on the "same page" students seem to better assimilate course content and comprehend lectures. In contrast, attendance could not generate as much of an indirect effect in the traditional textbook class, even though the instructor had similar classroom practices but without projecting the traditional text in class. There are few things more satisfying for instructors than seeing their students comprehend the lectures.

In addition, the proportion of variance explained by variables in the OER class declined to 63.03% from 88.89% in the traditional textbook class. Since one of the major differences between the two classes was the availability of textbooks, this suggests that textbook availability appears to be an influential factor impacting students' course success. However, how much of the variance can be explained by the availability of textbooks needs to be determined.

Results from the present study indicate major benefits for students' learning and performance when textbooks are available to them such as OER, including equalized students' engagement and performance and better comprehension of lectures. Regrettably, findings from the Babson Survey Research Group (2019) show that only 16% of faculty had adopted open textbooks, and 23% of those taught introductory level courses. Colleges and universities across the country should commit to promoting the benefits of OER and encourage faculty to adopt OER to foster overall students' success and not just with the goal of making college education more affordable.

It is paradoxical that there was merely a distinguishable mean difference in final grades between these two classes, yet there were many noteworthy disparities among other aspects observed. Future research should broaden to examine variables beyond students' final grades (i.e., product) and to measure difference between students' engagement and performance throughout the semester (i.e., process) for both OER and traditional textbook classes. Data for variables other than final grades and perceptions on OER commonly investigated in the extant studies should be recorded throughout the semester to closely monitor students' engagement. The current study using continuous data from LMS to investigate students' performance and to find patterns of college students' learning unreported in the previous studies can be considered the strength of the study.

Conclusion

Some of the major implications that can be drawn from the current study are as follows: (1) Final grades in the OER class were on a par with those in the traditional textbook class. (2) OER equalize students' engagement and performance by narrowing the dispersions of page views, OTAS rates, attendance, and final grades. OER appear to have elevated the performance of students lacking the traditional textbook. (3) OER narrowed the dispersion of page views and diminished excessive dependence on the instructor's notes. When students had access to textbooks, they displayed less dependence on the instructor's LMS notes, hence the reduced number of page views. Not surprisingly, when students did not have a required traditional textbook and did not utilize the course reserve, viewing the LMS notes became their default method of learning, resulting in extreme distributions of page views. (4) When students have free

access to textbooks (e.g., OER), they apparently were better prepared, would attend class more regularly, and had better assimilation of the course content and comprehension of the lecture material. (5) Finally, the availability of textbooks appears to be a factor impacting students' course success. Thus, OER equalize college students' learning and performance, foster engagement, and facilitate their comprehension of lectures while still maintaining the same level of quality in final grades as that in the traditional textbook class.

Limitations

There are limitations to this study. The findings of this report only measured students in two classes of one instructor at a large publicly funded urban doctoral-granting research university. This should be taken under consideration as readers evaluate the generalizability of these findings. No data exist for students who did not purchase the required textbook in the 2017 class and/or did not utilize the course reserve at the library. Therefore, whether students who did not purchase the required textbook utilized the course reserve is unknown. However, even if the instructor had conducted a survey during the semester as to the access (or lack thereof) of the traditional textbook, the truthfulness of the students' responses would be hard to determine. Additionally, the total activity time on the LMS would be another valuable variable for inclusion in this study; however, the records of the traditional textbook class were no longer available for download despite their availability for the OER class. Finally, this study only evaluated two Gen Ed classes, 75% of which consisted of students taking their first college courses, and 75% of the students were females. Upper-class students (juniors and seniors) were a small percentage of the population under consideration, and the institution is comprised of approximately 54% females and 46% males. Most importantly, this study was not based on an experiment due to the fact that the classes studied had already concluded at the time the idea for the study was formulated.

It would be beneficial if future research could include upper class students from both doctoral-granting and non-doctoral granting universities, courses in different fields taught by instructors with varying years of lecturing experience, and large and small class sizes in an experimental design to see if the results from this study could be replicated. This study evolved from the initial report to the Library's Textbook Affordability Project at the end of the fall 2018 semester. No data were collected during the semester for analysis in a research paper of this scale. In this study, engagement was operationally defined as (1) page views, (2) on-time assignment submissions, and (3) attendance merely because data were available from

the LMS. However, they were not comprehensive in scope. Future studies could try to define engagement by incorporating definitions from Alrashidi, Phan, and Ngu (2016), Kuh, Kinzie, Buckley, Bridges, and Hayek (2006), and McCormick, Kinzie, and Gonyea (2013) to create instruments to collect data. In addition, figuring the percentage of variance that can be explained by the availability of textbooks on students' final grades would be important.

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DR. ISABELLE CHANG has been a faculty member in the department of psychology for more than a decade. She is attracted to the simple logic of mathematics and is interested in statistics and psychometrics. As such, most of her teaching assignments are in quantitative topics such as statistics. She enjoys constructing statistical models using graphics to lay out her hypotheses and testing them on large-scale national and international data. After more than a decade in the classroom, she is increasingly interested in studying college student's learning behaviors and approaches. She is most interested in studying her own student's learning and the long-term benefits that they can realize from her classes. She strongly believes that by studying her own student's learning she can improve her own teaching performance and outcomes.