Development and Use of Open Educational Resources in Research Methods for Psychology

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Research methods course(s), a standard in psychology programs, often use multiple textbooks to address conceptual and data-analytic information. This study involved transitioning from traditional textbooks to open educational resources in a research methods course. Two psychology instructors, each offering course sections, identified open-access textbooks that aligned with course learning objectives and developed instructional materials to accompany those textbooks. All materials were organized publicly in an institutional subject guide. We compared students' grades, pretest-posttest scores, and survey reports of resource use and evaluation in a spring semester, when traditional/costly textbooks were used, to the following fall semester, when no-cost textbooks were used. Student grades and pretest-posttest growth, and reported use and ratings of course materials, were similar across semesters. Though the present findings are limited in scope, they suggest that no-cost resources can be used successfully for teaching research methods with minimal transition difficulties and without student learning deficits.

In the psychology major, it has become commonplace (if not standard) for programs to require at least one research course. The Psychology Major Guidelines, Version 2.0 (American Psychological Association, 2013), identify Goal 2 (of five total) of undergraduate education for psychology majors as "Scientific Inquiry & Critical Thinking". Research course(s)—named variably as *Psychological Science*, *Research Methods*, *Research Design & Methodology*, or else—address a range of topics from ethics, logic of design, conceptual understanding of variables and relations between them, popular data-analytic techniques, and public sharing of research. Specific research skills addressed by research courses include: "scientific reasoning", "information literacy", "problem solving", and "interpret, design, and conduct...research" (American Psychological Association). To target these varied skills, course instructors may use two to three different resources: (1) a textbook/resource to address conceptual content (e.g., White & McBurney, 2013); (2) a textbook/resource to address statistical techniques (e.g., Privitera, 2016); and (3) a textbook/resource to address APA-style writing (e.g., American Psychological Association, 2019). Sometimes a laboratory manual (e.g., SPSS Manual or book of laboratory exercises; Aspelmeier & Pierce, 2015) also is adopted by instructors. The textbooks used to teach research methods at our institution, where the cost of these materials for students was between $270-$400, are listed in Table 1. In this paper, we explore open educational resources as a means to save student financial stress that can be created by expensive textbooks in a research methods course for psychology.

OPEN EDUCATIONAL RESOURCES

Defined as "any educational resource that is openly licensed and freely distributed" (Grimaldi et al., 2019, p. 1), use of *open educational resources* (OER) have accelerated in the past decade. OER include, but are not limited to: instructor-written texts and problem sets; open-access articles and chapters; online workshops and exercises; free instructional websites and teaching resources; instructor-created video lectures; and free software (Smith, 2009). Ehiyazaryan-White (2012), for instance, aided instructors' selection and use of open-access laboratory exercises, datasets, etc. for improvement of research skills in the social sciences. Among the most popular OER are open-access, web-based textbooks. Online textbooks—viewable on the web or downloadable as Adobe files—often are funded by grant agencies and foundations (e.g., Hewlett Foundation, OpenStax by Rice University) to lower the cost of higher education in hopes of making it more inclusive.

Most commonly, research indicates that OER textbooks generate outcomes on par with commercial textbooks (see Hilton, 2016, for a review). In one such study, Jhangiani and colleagues (2018) reported that Canadian introductory psychology students who were assigned OER earned grades equivalent to their peers who were assigned costly textbooks. Winitzky-Stephens and Pickavance (2017) similarly found that returning community college students had similar grades, passing rates, and withdrawal rates whether courses used OER or traditional/commercial textbooks. (Although, among students new to college, their use of OER was related to higher grades.)

Other studies of larger scale show mixed effects of OER, with one study (Gurung, 2017) reporting lesser performance on learning and biopsychology quiz items when OER versus traditional textbooks were used, and two others reporting improved outcomes with OER use. In Biology, History, Psychology, and Sociology courses for over 10,000 students at a large State university, Colvard and colleagues (2018) showed that course grades increased and rates of nonproductive grades (i.e., earning a D or F grade, or a W for course withdrawal) decreased for students who typically are at risk in college (e.g., part-time students, students who received Pell grant) when OER was adopted. Similarly, Fischer and colleagues (2015) reported higher course completion rates and course grades among nearly 5000 students across 9 different community and 4-year colleges whose instructors used OER than in a comparison set of over 11,000 students at the same colleges whose instructors used traditional textbooks. Such findings suggest that publication and adoption of OER is worthwhile by making higher education more attainable for some students.

STATEMENT OF PURPOSE

We believed limited access to expensive materials for some students served as a potential barrier to their earning productive grades in research courses. The goal of the current project was to develop and adopt no-cost materials (housed and managed in one location) to increase accessibility of resources to students. Whereas Ehiyazaryan-White (2012) focused on outcomes for *instructors* of research methods, our aim was to determine if OER adoption helps *students* in research courses. Prior to OER adoption, student success (defined as A, B, or C course grades) in our targeted research course fluctuated between 65-80%. Similar to Jhangiani et al. (2018), we measured student performance and learning outcomes, as well as student perceptions and reported use of course materials. We first offered the research course using (previously adopted) traditional materials and measured student success and growth. Then we identified and created open-access materials during the summer for use in the immediately following term; again, measuring student success and growth. Finally, we collected students' reactions to course materials. Past research on OER was mixed with neutral, negative, and positive impacts on learning outcomes. We hypothesized in the present study that students' use of the no-cost resources would be higher than the costly resources, thereby increasing student success in the course when no-cost materials were used.

METHOD

Participants

Undergraduate students enrolled in a research methods course required for psychology majors at a regional State university were potential participants. The total number of enrolled students after the initial drop-add week was 65 (spring n = 31, fall n = 34). Enrolled students were mostly juniors and seniors, and an introductory statistics course offered by the Mathematics Department was a pre-requisite for the course. Per instructor observation and knowledge, 7 were men, 57 were women, and 1 was transgender. Analysis of course outcomes and survey data were approved by the Institutional Review Board and all aspects of this research were completed prior to 2019/COVID-19.

Student Outcomes

Final grades were analyzed for all students enrolled in the course. Pretest-Posttest scores were collected and compared for students in both sections of each semester who attended the first and last days of classes. In the spring semester, 23 students completed both tests, 7 students completed only one of the tests (either pretest or posttest), and 1 student completed neither test. In the fall semester, 27 students completed both pre- and posttests, 7 students completed only one of the tests, and 3 completed neither test. These pretests and posttests are part of regular assessment practices in our department and, therefore, informed consent was not used upon their administration. The data were used by the department of psychology for program assessment and retroactive approval from IRB was obtained to use the data for this publication.

Survey Respondents

Of the total number of enrolled students for both semesters, 22 (spring n = 8, fall n = 15) completed an informed consent form and survey asking about their use and opinions of the course resources. Average age of survey respondents was 23.68 years (ranging from age 22 to 33), M_{spring} = 25.25 (range = 21-33) and M_{fall} = 22.79 (range = 20-30). Of all respondents, there were 15 seniors (six in spring and nine in fall), 7 juniors (two in spring and five in fall), and 1 sophomore from the fall semester. Self-identification of race indicated one Hispanic or Latinx responded from each semester, two and seven Blacks or Africans responded from spring and fall respectively, and five and seven Whites or Caucasians responded from spring and fall respectively. From spring semester, 1 man and 7 women responded to the survey; from fall semester, 10 women, 4 men, and 1 transgender responded to the survey. English was the primary language of all respondents. These survey data were collected with informed consent for a state-level instructional grant report; retroactive approval from the IRB was obtained to use the data for this publication.

Design

Two instructors, each teaching one section per semester, offered *Research Design and Methods I* during the spring and fall semesters of the same calendar year. During the spring semester, each instructor continued to use traditional (pay-for) textbooks they had been using in previous semesters (see Table 1), along with corresponding PowerPoint slides, study guides, and class exercises created by the instructors separately. The textbooks were published by for-profit companies and were available to students through the campus bookstore, various bookstores in town, and online. All students who purchased these textbooks used paper-based versions rather than e-versions. These materials, hereafter, will be termed "costly" since they are more expensive and gener-

Table 1. Textbooks Used Each Semester in Each Instructor's Course

	Costly (Spring) Semester		No-Cost (Fall) Semester	
Instructor 1	Passer, M. (2013). *Research Methods: Concepts and Connections*.	$142.47	Battacherjee, A. (2012). *Social Science Research: Principles, Methods, and Practices*. University of South Florida Scholar Commons: USF Tampa Library Open Access Collections	$0.00
	Spatz, C. (2010). *Basic Statistics: Tales of Distributions* [paperback].	$96.84		
	APA (2009). *Publication Manual*.	$29.95	Lane, D. M., et al. (n.d.). *Introduction to Statistics*. Rice University	$0.00
Instructor 2	Cozby, P. C., & Bates, S. C. (2011). *Methods in Behavioral Research* (11th ed).	$129.95	Battacherjee, A. (2012). *Social Science Research: Principles, Methods, and Practices*. University of South Florida Scholar Commons: USF Tampa Library Open Access Collections	$0.00
	Howell, D. C. (2013). *Fundamental Stats for Behavioral Sciences*.	$241.50		
	APA (2009). *Publication Manual*.	$29.95	Lane, D. M., et al. (n.d.). *Introduction to Statistics*. Rice University	$0.00

Note. This table contains materials used in each section of *Research Design & Methods I* during the spring semester when costly materials were used and the fall semester when common, no-cost materials were used. All textbooks were required, except the *Publication Manual* (APA, 2009) which was optional. No-Cost materials were developed during summer. Instructor 1 now uses Jhangiani, Cuttler, and Leighton (2019), *Research Methods in Psychology*, and Foster, Lane, Scott, Hebl, Guerra, Osherson, and Zimmer (2018), *An Introduction to Psychological Statistics*.

ated for profit. During the fall semester, each instructor adopted shared/common no-cost resources. Course goals and learning objectives remained the same across both semesters. Student learning (measured via pretest-posttest), student course performance (i.e., grades) were compared across costly and no-cost semesters. Students from both the spring and fall semesters completed the survey to measure their use and evaluation of course textbooks at the end of the no-cost semester (i.e., in December of the calendar year).

INSTRUCTORS AND COURSE MATERIALS

As much as possible, all aspects of the courses remained the same from the spring semester (when costly materials were used) to the fall semester (when no-cost materials were used) except for the main course resources (i.e., textbooks). The instructors remained the same, and both were experienced in teaching the course with at least three iterations of teaching it in their past. Course learning objectives and content (determined at the department level) remained the same across semesters, which included basics of research design as well as use of statistical analyses common in psychological science. The learning objectives are provided in the Appendix A. There were a few instances when the order of material in the course calendar was modified to accommodate the newly adopted, no-cost textbooks (e.g., addressing single-subject designs after quasi-experiments) and to create similar calendars across instructors in the fall as they shared the resources, but all major content and assignments remained the same across semesters. Note that changes in course structure and pedagogy are often reported with adoption of OER (Otto, 2019). Maintaining precisely the same course features, such as study guides and lecture slides, across the costly and no-cost semesters was not feasible in the present design given subtle changes in the textbook content.

One final difference across the costly and no-cost semesters was the transition of course materials that were posted and available for separate course sections in the university Learning Management System (spring semester) to a publicly available subject guide shared by instructors and students across course sections in the fall semester. The creation of the shared subject guide, housed by the institutional library, was a required element of the funding agency that supported this project (i.e., transition to OER) in efforts to keep instructional materials available to the public. The subject guide was not created to increase student access to materials or improve student performance since all course materials would otherwise be accessible in the Learning Management System.

Costly Semester

Textbooks in the spring semester differed across sections/instructors of the course and are identified in Table 1. The total cost of resources used by Instructor 1 was $269.26 and the total cost of resources used by Instructor 2 was $401.40. All textbooks were required except the APA (2009) *Publication Manual* for Instructor 1. Data concerning the numbers of students who purchased books was not collected formally, but instructors' observations and questions of students indicated that several students—as many as half of those enrolled—did not purchase or rent the required textbooks.

No-Cost Semester

Two open-access textbooks were used. The main resource for conceptual (i.e., research design and methods) content was Battacherjee (2012) and the main resource for statistical content was Lane and colleagues (n.d.). Instructor-created materials included links to open-access web material, integrated research design with statistical analyses, and addressed rules of APA-style writing. Materials were posted in a subject guide via the institution's library using LibGuides software by Springshare. The public subject guide (White & da Silva, 2015) contained:

1. **Home** tab containing a welcome statement, course syllabi, instructor information, and textbook information with links.
2. **Unit** tabs containing content clustered into themes with a goal statement for the unit. There were 5 units total.
3. **Class Project** tab containing information and resources related to a common research project completed by students enrolled in the courses. This tab included instructions for writing sections of an APA-style empirical paper.
4. **Additional Resources** tab contained extra resources (e.g., "new statistics", Cumming, 2013) and links to important sites (e.g., library databases) of the institution.
5. **Statistical Analysis** tab containing laboratory exercises and resources.

ASSESSMENT MATERIALS

Course Grades

Course grades both semesters were comprised of varied assignments targeting the learning outcomes. Assignments included class and lab exercises requiring students practice with statistical testing; traditional tests containing various multiple-choice, true-false, and open-ended items; and completion of a class project with written APA-style empirical paper. Course grade was defined as percent of points earned in the course, calculated by dividing the number of points earned by the total points possible in the course. Grades were categorized into a letter grade (A, B, C, D, or F) across 10% decrements in grades, where 90% or above was an A, 80%-89% was a B, and so on. Any course grade of 59% or lower was assigned an F. These letter grades were further categorized into productive and nonproductive grades, where an A, B, or C grade was productive (in the sense that the course could count toward the student's psychology degree) and a D or F grade was nonproductive (in the sense that the course would need to be retaken to earn credits towards the psychology degree).

Pretest-Posttest

An 18-item general assessment of student knowledge on major course concepts was developed by the instructors. Its purpose was to gauge student understanding at the beginning and end of the semester and, ultimately, determine student growth through the semester. Each item provided four lettered choices to student respondents. Items addressed the course learning objectives, such as understanding of research design, statistical testing and conclusions, and graphical interpretations. Student test scores were calculated as a percent correct, where the number of items answered correctly was divided by the total number (18) of items; example scores include 94.4% (generated by answering 17 of the

18 items correctly), 66.67% (generated by answering 12 of 18 items correctly), etc.

SURVEY OF OER USE AND EVALUATION

Instructors created and administered five items to ask students about their use and evaluation of the costly and no-cost materials. (See Appendix B for complete survey.) Quantitative information was collected by asking students to indicate how frequently they used the textbooks and rate the usefulness, accessibility, and cohesiveness of the materials. Frequency of textbook use was assessed using a single item for each textbook (e.g., "In your PSYC 3211 course, how often did you use the Lane et al. STATISTICS textbook?"), with responses indicated on a scale ranging from 1 (*3 or more times a week*) to 5 (*rarely or never*). General positive perceptions of the textbooks (usefulness, accessibility, and cohesiveness) were measured using five ratings for *each* textbook (e.g., "I found the textbook easy to read and understand"). Ratings were scaled from 1 (*disagree*) to 5 (*agree*), and were averaged for each participant, resulting in a score that could range from 1 to 5 for each textbook. Higher scores indicated greater perceptions that the textbook was useful, accessible, and cohesive (with other course materials).

Qualitative feedback was secured via an open-ended question that asked students to provide feedback on their experiences with the materials ("Please provide additional feedback on your experience with the PSYC 3211 textbook materials"). Responses were examined for thematic patterns.

Survey data were collected and compared between students who used the no-cost resources and those who purchased textbooks in a previous semester. This survey was also used to gather basic demographic information (e.g., age, ethnicity, classification) about the student samples.

PROCEDURE

OER Procurement and Development

OER procurement and development was completed by the two course instructors during the months of May through August that spanned the time between spring (costly) and fall (no-cost) semesters. Both instructors attended a state-wide OER training session earlier in the year where OER adoption was discussed, with examples of open-access textbooks, educational repositories (MERLOT), and previous success stories. Building on that experience, the instructors aimed to find existing textbooks that best matched their needs with plans to supplement the textbooks with additional materials (if needed). There were a limited number of open-access textbooks that addressed our general needs: research design/methods content and statistical analysis content. Two options most centrally addressed content needs while having high face validity. Content relevance and face validity was determined by the table of contents, organization of the text, writing style, and inclusion of graphics and figures that were clear and helpful. The two textbooks (see Table 1) chosen were Battacherjee (2012) for research design/methods content and Lane and colleagues (n.d.) for statistical analysis content. Battacherjee's textbook was strong in conceptual foundations of research and social research designs, but contained limited content on experimental design compared to the previously used costly research methods textbooks. Thus, the no-cost research methods text was supplemented by an additional open-access chapter on single-subject designs by Sage publications and an additional chapter on experimental control from Morling (2015). Lane et al.'s statistics textbook addressed all units needed, except factorial design for which instructors created explanations and exercises.

A table containing a list of the major units of the research methods course was created in a word processing document to track procurement of content. Rows of the table represented 15 weekly units to be covered in the course and columns represented relevant materials for each unit: reading materials, instructional slides, class exercises, lab exercises, and study guides. Textbook chapters and other resources obtained from websites or archives of previously used course materials were aligned with weekly units in the table. Each resource (e.g., textbook chapter, website material, or previously used class exercise) was analyzed for its content and listed beside the course unit in the table. Revised study guides, test items, and instructional slides were edited or created based on the no-cost textbooks and chapters. Procurement, creation, and alignment of resources continued until all course units were assigned corresponding materials.

OER Adoption

When most resources had been obtained and organized, instructors collaborated with library faculty to learn how to create a subject guide. The instructors designed the subject guide (White & da Silva, 2015) according to five major units described previously and populated it with open-access materials. After syllabi and other course resources were loaded into the subject guide, it was published for availability to students and the public. Students were introduced to the subject guide in the first class meeting and the link to the subject guide was shared on the course page of the institution's Learning Management System and via e-mail to students. The subject guide was used in class meetings as needed to display or use relevant content, such as instructional slides, recommendations for APA format, and textbook material.

Student Outcomes

Grades were compared quantitatively in two ways: (1) final course grades, as a percent score, and (2) percent non-productive grades (D's & F's) in the courses were compared between the costly and no-cost semesters.

Pretest-Posttest

On the first and last days of class meetings in each the spring and fall semester, students were provided paper copies of the test/instrument with a scantron form and offered a pencil to use if they did not have a writing utensil. While distributing test materials, the instructors informed students of the testing purpose and that their performance on the assessment would not impact their course grades. The purpose provided was to assess their growth in the course to evaluate the instructor, course, and psychology program. Students were informed that their identities are needed on the scantron form to connect their pretest scores to their posttest scores, but that their identifications would be removed once pretest-posttest scores are generated and stored in a dataset. Students were instructed to select and bubble a scantron form that corresponded to the best of four possible answers provided on the test form. Students were allowed to mark on the test forms, but the test forms were not analyzed or stored; they were shredded. The scantron forms were scored by machine to generate percent scores from first administration (pretest score) and second administration (posttest score). Most students completed

this assessment at the beginning and end of the semester for both the spring (costly) and fall (no-cost) semesters. Score improvements from pre- to post-test on this assessment were compared across semesters.

Survey Administration

The survey was administered anonymously via an online survey platform. A survey link was distributed to all former students in the course (both costly and no-cost semesters) approximately one week after the end of the no-cost semester, which was mid-December of the calendar year. The first item of the survey was an informed consent form asking student permission to assess their use and evaluation of course materials for purposes of a public state grant received for use of OER. If they consented to the survey, respondents progressed to the second and remaining items. There was no incentive provided for completion of the survey. Survey responses were stored in the survey program until responses were downloaded en masse by the instructors for analysis. Survey data were analyzed using SPSS and stored in a password-protected Internet cloud drive.

RESULTS

Student Outcomes

Three outcome measures were analyzed to determine if adoption of OER impacted student grades and learning. These are shown in Figure 1 as a function of costly and no-cost resources.

Student Grades

In the costly (spring) semester, the *M* (*SD*) percent grade in the section taught by Instructor 1 (*n* = 13) was 71. 67% (15.90) and the *M* (*SD*) percent grade in the section taught by Instructor 2 (*n* = 18) was 77.50% (19.36). In the no-cost (fall) semester, the *M* (*SD*) percent grade in the section taught by Instructor 1 (*n* = 17) was 73.85% (13.86) and the *M* (*SD*) percent grade in the section taught by Instructor 2 (*n* = 17) was 77.24% (11.96). Given the similar mean grades—75.06% and 75.55%— earned in each semester, it is no surprise that an independent-samples *t* test indicated no significant difference in course grades between the costly and no-cost semesters, $t(63) = 0.13$, $p = .901$.

Nonproductive Grades

In the costly semester, there were eight nonproductive grades (4 D's and 4 F's) earned by students. In the no-cost semester, there were ten nonproductive grades (8 D's and 2 F's) earned by students. Assignment of nonproductive grades across semesters was similar for each instructor; Instructor 1 assigned five and six nonproductive grades to students in the costly and no-cost semesters, respectively, and Instructor 2 assigned three and four nonproductive grades in the costly and no-cost semesters, respectively. Each instructor increased the raw number of nonproductive grades assigned by 1 from the costly semester to the no-cost semester. However, a Chi-Square analysis indicated that nonproductive grades were independent of the semester (or, whether costly or no-cost materials were used), X^2 (2) = .11, $p = .746$.

Pretest-Posttest/Growth Scores

To measure student learning directly, an 18-item test was administered to all students (who were present) in the first class meeting (hereafter, pretest) and last class meeting (hereafter, posttest). Test material was cumulative, addressing content from across the semester, and none of the items were used on assessments at other times during the semesters. Test scores were computed as percent of items correct. In the costly semester, mean test scores improved from 34.92% to 51.39%, a mean improvement of 16.47% for Instructor 1, and from 41.85% to 59.63%, a mean improvement of 17.78%, for Instructor 2. Overall, in the costly semester, students' *M* (*SD*) test scores changed from 39.64% (12.11%) to 56.76% (12.97%) pre- to posttest. In the no-cost semester, mean test scores improved from 35.42% to 53.82%, a mean improvement of 18.40% for Instructor 1, and from 35.86% to 59.60%, a mean improvement of 23.73% for Instructor 2. Overall, in the no-cost semester, students' *M* (*SD*) test scores changed from 35.60% (13.37%) to 56.17% (15.43%) pre- to posttest.

Growth scores were computed for each student by subtracting pretest scores from posttest scores. One student in the costly semester and two students in the no-cost semester had higher pretest scores than posttest scores (i.e., negative growth scores), and one student in the no-cost semester had the same pretest and posttest score (i.e., zero growth score); for all other students, growth scores were positive. See Table 2 for the *M* (*SD*) student growth in each semester. There was similar student growth, or learning, during the costly and no-cost semesters, as indicated by an independent-samples *t* test, $t(48) = 0.792$, $p = .433$.

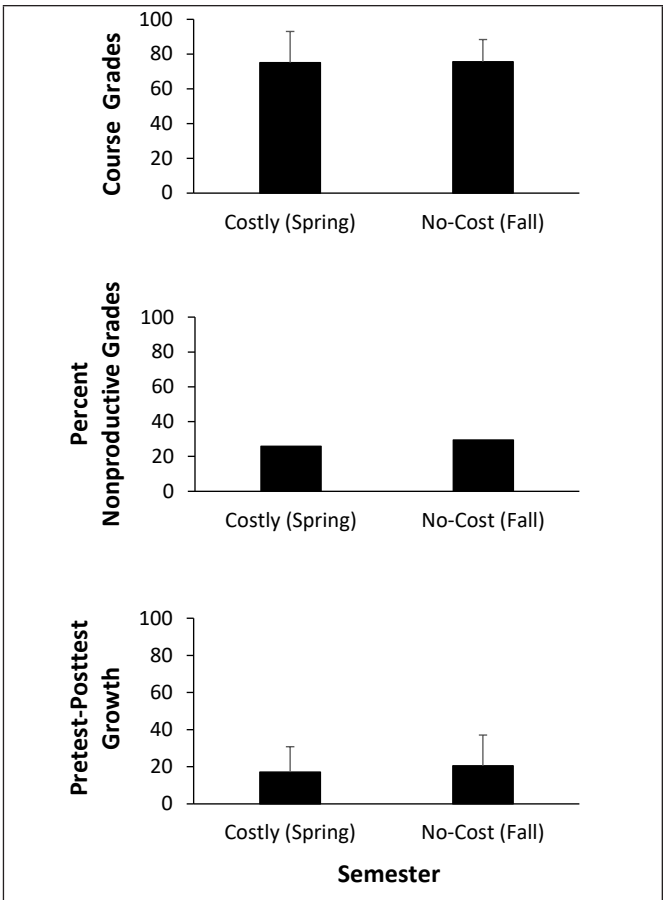

Figure 1. Student Course Grades, Percent Nonproductive Grades, and Pretest-Posttest Growth in Costly (Spring) and No-Cost (Fall) Semesters

Note. This figure contains Mean values, with Standard Deviations shown in error bars, of outcome measures for students (*N* = 65) who were assigned costly materials (*n* = 31) and assigned no-cost materials (*n* = 34).

Survey Responses

A survey administered at the end of the fall semester provided information about students' reported use and evaluation of each textbook. Of all students enrolled during both semesters, eight students from the costly semester and 15 students from the no-cost semester completed the optional, anonymous survey. Responses are summarized in Table 2 and described in the sections that follow.

Table 2. Survey Results Among Respondents from Costly (n = 8) and No-Cost (n = 15) Semesters

	Semester	
Measure	Costly (Spring)	No-Cost (Fall)
Reported Use of Statistics Book		
	Mdn = 2.0	*Mdn* = 1.0
	25th percentile = 1.00	25th percentile = 1.00
	75th percentile = 2.00	75th percentile = 2.00
Reported Use of Methods Book		
	Mdn = 1.0	*Mdn* = 1.0
	Mode = 1	Mode = 2
	25th percentile = 1.00	25th percentile = 1.00
	75th percentile = 1.75	75th percentile = 1.00
Evaluation of Statistics Book		
	M = 3.53	*M* = 3.69
	SD = 1.39	*SD* = 1.04
	Mdn = 4.10	*Mdn* = 3.80
Evaluation of Methods Book		
	M = 4.36	*M* = 3.87
	SD = 0.86	*SD* = 1.02
	Mdn = 4.75	*Mdn* = 4.20

Note. Summaries of responses to items about use and evaluation of textbooks are shown in this table. Use of textbooks was measured using the following rating scale: 1 = 3 or more times per week, 2 = 1-2 times per week, 3 = every other week, 4 = about once a month, 5 = rarely or never. Evaluation of textbooks was measured using the following rating scale: 1 = disagree, 2 = somewhat disagree, 3 = neither agree or disagree, 4 = somewhat agree, 5 = agree.

Use of Textbooks

Students were asked to identify how often the course resources were used on an ordinal scale of 1 = 3 or more times per week, 2 = 1-2 times per week, 3 = every other week, 4 = about once a month, or 5 = rarely or never. Median reported use of the statistics book was 1.5, with a range of 4 and interquartile range of 1 (25th percentile = 1, 75th percentile = 2) when averaged for both semesters. In the costly semester (n = 8): *Mdn* = 2.0, *Min* = 1 and *Max* = 4. All students reported using the costly statistics book; three students (37.5%) reported using it 3 or more times per week, four students (50.0%) reported using it 1-2 times per week, and one student (12.5%) reported using it once every two weeks. In the no-cost semester (n = 14): *Mdn* = 1.0, *Min* = 1 and *Max* = 5. Two students (14.3%) reported rarely or never using the no-cost statistics book; eight students (57.1%) reported using it 3 or more times per week, four students (28.6%) reported using it 1-2 times per week. (One student in the no-cost semester left this item unanswered.) Reported ratings of statistics textbook use was not different across semesters per a Mann-Whitney test, $U(20) = 48.0$, $p = .616$.

Median reported use of the research methods book was 1.0, with a range of 4 and interquartile range of 0 (25th percentile = 1, 75th percentile = 1) when averaged for both semesters. In the costly semester (n = 8): *Mdn* = 1.0, *Min* = 1 and *Max* = 2. All students reported using the costly research methods book; six students (75.0%) reported using it 3 or more times per week and two students (25.0%) reported using it 1-2 times per week. In the no-cost semester (n = 15): *Mdn* = 1.0, *Min* = 1 and *Max* = 5. Two students (13.3%) reported rarely or never using the no-cost research methods book; twelve students (80.0%) reported using it 3 or more times per week and one student (6.7%) reported using it 1-2 times per week. Reported ratings of research methods textbook use was not different across semesters per a Mann-Whitney test, $U(21) = 59.0$, $p = .975$.

Evaluation of Textbooks

Students were asked to evaluate each course textbook anonymously through five survey items. The items addressed how easy the book was to read and understand, how well the textbook "fit" with the other textbook used in the course, and how much it increased their grasp of course material. Answers to the five survey items were averaged to compute mean evaluation of the course textbook for each respondent.

In evaluating the costly statistics books, five respondents (62.5%) rated it positively (3.5 or higher on a 1-5 scale); zero respondents (0.0%) rated it neutrally (2.5 -3.4 on a 1-5 scale); and three respondents (37.5%) rated it negatively (less than 2.4 on a 1-5 scale). In evaluating the no-cost statistics book (Lane et al., n.d.), ten respondents (66.6%) rated it positively, four respondents (26.6%) rated it neutrally, and one respondent (6.6%) rated it negatively. As shown in Table 2, mean ratings of the statistics books were similar across semesters, $t(21) = 0.33$, $p = .746$.

In evaluating the costly research methods books, seven respondents (87.5%) rated it positively (3.5 or higher on a 1-5 scale); one respondent (12.5%) rated it neutrally (2.5 -3.4 on a 1-5 scale); and zero respondents (0.0%) rated it negatively (less than 2.4 on a 1-5 scale). In evaluating the no-cost research methods book (Battacherjee, 2012), 11 respondents (73.3%) rated it positively (3.5 or higher on a 1-5 scale); two respondents (13.3%) rated it neutrally (2.5 -3.4 on a 1-5 scale); and two respondents (13.3%) rated it negatively (less than 2.4 on a 1-5 scale). The research methods book was rated roughly 0.5 lower in the no-cost semester (see Table 2), but this decrease was not significant, $t(21) = 1.17$, $p = .256$.

Survey Comments

A final gauge of student opinion were their comments in an open-ended feedback item. In the costly semester, three students (60% of those who answered the item) made positive comments (e.g., "good materials" or "it was helpful and well organized") about the course resources and one student (20%) stated that the "Statistics book did very little to help". In the no-cost semester, five students (71.4% of those who answered the item) made positive comments, such as: (a) "Working together, they really helped me understand the material. I definitely appreciate this and I found having a variety of textbooks was helpful- different authors and perspectives made it easier to get stuff read.", (b) "The textbook made the class easier and more convenient due to having to purchase books for other courses. The online textbook was a great idea, and should be used in the future.", and (c) "The textbook materials were great. It was easy to follow and understand and the in class [sic] practice tied everything together." Two students (28.6%) in the no-cost semester commented negatively about the course materials: (a) "I need a physical book that I can access with me at anytime [sic], so it was not helpful. [sic] and staring at a computer screen for hours at a time weakens your eyes anyway.", and (b) "I'm sure that the books would have been able to help but it was too hard to look up certain terms or items when you were studying due to the books being in different links and portions. I ended up printing

out most pages anyway because I needed something to actually mark up and study off of" [sic].

There were a few common themes across semesters. Specifically, students in both the costly and no-cost semesters indicated that they found the textbooks helpful, easy to follow or well-organized, and thought that they worked well together. Other course materials (e.g., lecture slides, assignments) were also identified as useful and helpful in about 40% of responses in both semesters, suggesting that students did not lean more heavily on these resources in the no-cost semester. There was one unique theme that emerged from the no-cost semester responses, which concerned the online format of the no-cost textbooks. While one student specifically noted they found the online format convenient and helpful, two students indicated they preferred a physical textbook. There was no mention of textbook format in the costly semester responses. This suggests that faculty may expect more variable responses from students regarding textbook format if they adopt online OER books. We should note, however, that negative comments regarding these textbooks concerned only their format, and not their content or organization, which are arguably more important. Overall, the qualitative comments from students reinforced the quantitative results – students' perceptions of the costly and no-cost textbooks were similarly positive.

DISCUSSION

This study was a small-scale assessment of OER impact, demonstrating the development and use of no-cost resources in a required research course in psychology without known detriment to students. Two instructors successfully obtained free digital textbooks, developed instructor materials for those textbooks, and organized the resources in a public online platform for use in teaching a research methods course. Similar grades, student performance, student learning, and ratings of course materials occurred across semesters when costly and no-cost materials were used. That is, regardless of whether materials were free or purchased, students benefited similarly from the course. The neutral impact of OER adoption did not support our expected outcome that students would be more likely to access course resources and, therefore, be more likely to earn passing grades in the course. Other aspects of the course (e.g., new instructional materials to accompany the textbook, transition to digital rather than print textbook, and use of an online subject guide to organize course materials) were changed with adoption of the OER and these other variables could offset impacts of OER and prevented detection of OER impact (in either direction). Based on the present study alone, we cannot determine whether the "open" nature of resources alone would produce the same outcome, or if the present findings that OER adoption was neither detrimental nor helpful occurred because of its co-occurrence with transition to digital materials, subject guide organization, and/or new and commonly used instructional materials (Griggs & Jackson, 2017). On the whole, however, savings to students was around $270-$400, and students reported appreciation for no-cost resources (similar to findings of Ikahihifo et al., 2017). In the words of Clinton's (2018) title, there was "savings without sacrifice" in the present use of OER for roughly 65 students.

The neutral outcome is consistent with most prior work on OER (e.g., Clinton, 2018; Hilton, 2016; Wang & Wang, 2017) and inconsistent with prior work reporting positive (Weller et al., 2015) and negative (Gurung, 2017) impacts of OER. Clinton (2018), in another study of undergraduates at a regional State university, reported similar outcomes for students when OER and commercial textbooks were used; further, students in that study - like ours and in French et al. (2015) - indicated their likelihood of using the course resources and perceived quality of resources were similar regardless of whether the resources were costly or free. Our nil OER effects are different from prior research of Colvard and colleagues (2018) and Fischer and colleagues (2015), who found a positive impact of OER on course completion. Discrepancies between our study and theirs make sense if viewed in light of arguments by Grimaldi and colleagues (2019), who argue that increased student outcomes with more access to resources (known as the "access hypothesis") may not be detected via typical research methods. That is, use of aggregated scores for all students across sections or semesters can mask the impact of OER on at-risk students, those that OER is hypothesized to affect most. Through simulated experiments, Grimaldi and colleagues found little power in detecting the impact of OER, even in hypothetical cases where hundreds of students are studied and initial access rates to costly materials are as low as 40%. These simulations are consistent with our lack of effects (given our low power from small n and aggregated data across students) and the empirical literature we reviewed. Assessment of OER by Colvard and colleagues (1) included over 11,000 students who used costly textbooks and 10,000 students who used OER, and (2) focused on at-risk students, eliminating most of the general student population from many of their analyses. Fischer and colleagues, too, assessed OER impacts on thousands of students and obtained mixed-to-positive impact of OER (4 of 15 courses yielded higher grades for students with OER whereas 10 courses yielded similar grades for students with OER); their relatively muddier positive impacts could be attributed to their analysis of all students (regardless of prior accessibility and risk level). Grimaldi and colleagues recommend instructors measure student access to costly resources prior to adopting OER and assess impact for students with limited access and/or higher risk level. Winitzky-Stephens and Pickavance (2017), for instance, reported no change in course grades or likelihood of passing for returning college students, but increased grades for new college students, when instructors adopted OER. We did not measure students' access to costly resources prior to adoption of no-cost resources.

LIMITATIONS AND CONSIDERATIONS

The present study was small in scale with limited power (by assessing OER for one course at one institution), and the neutral findings regarding OER adoption should be considered in light of other limitations. Participation rates were low and probably inconsistent across quality of student and no information is available regarding student readiness, skill sets, or learning disabilities across the two semesters. Further, no demographic information was collected systematically for all students enrolled in the course during the spring and fall semesters; as such, participant information was obtained only for those students who completed the survey. Pretest-Posttest scores were collected from 74.2% of students in the costly semester and 79.4% of students in the no-cost semester, which omits students with worse attendance records because they were not present for one or more administrations of the test. Given that students with traditionally poorer performance records are most impacted by OER use (Colvard et al., 2018; Grimaldi, 2019), the present failure to detect increases in

student growth after adopting OER could, in part, be attributed to omission of these students from the sample of student outcomes. Motivation to complete the pretest and posttest—even for students who were present on both test occasions—may have been low because pretest and posttest scores did not contribute to course grades. Two students performed worse on the posttest than the pretest, and we believe that is largely due to a lack of effort on the assessment. Only 25.8% of students in the costly semester completed the survey asking students to rate resources and report their use. The survey was administered at the end of the calendar year, which was more proximal to the no-cost (fall) semester, so that response rates were higher (44.1%), though still low, among those students who used OER. The low response rates provide data that may not represent the full range of student use and opinions regarding course materials. In particular, reported textbook use may be artificially inflated from the costly semester given instructors' informal observations that many students in that semester did not appear to have access to the textbooks. Further, survey completion relied on students' recollections rather than asking about their uses and opinions of materials throughout the semester. As noted by Schwartz (1999), biases in estimates are expected when asking people about their past actions, and it could be that survey respondents from the costly semester recalled using their textbooks more often than they truly did to appear more dedicated and internally justify their purchase.

Our failure to detect impact of OER on student outcomes could be due to a lack of student interaction with the OER. There were no reported increases in *use* of course materials when they were costly or free. Ideally, our study could have manipulated or controlled more directly students' access to and use of costly and no-cost materials; after all, a central argument of OER adoption is that students benefit from increased access to materials (Buczynski, 2007). If the probability of students *using* the course resources is not increased by greater accessibility, learning and course outcomes are unlikely to change with adoption of OER. Like the demographic and educational backgrounds discussed by Winitzky-Stephens and Pickavance (2017), motivational factors could play a larger role in students' success and use of resources than accessibility, and we suggest this as a topic to be explored in subsequent research involving OER. French et al. (2015) reported that students can be classified as those who use the book often, rarely, or never; according to their findings, the worst course performance was among students who rarely used the book, whereas students who never and frequently use the book perform similarly and are more likely to pass the course. Perhaps *access* to course resources is not the crux of learning barriers for many students, leaving important work still to be done to identify the critical aspects/components of OER in helping students. We should note, however, that we did not collect any data on whether students had reliable access to internet and/or suitable devices for accessing the no-cost materials. While the cost of traditional textbooks may present one financial barrier, the technological requirements of online no-cost materials may also present a financial barrier that limits access.

One strategy to motivate use of resources is to make the OER more interactive, or discursive (as suggested by Ehiyazaryan-White, 2012), by using real-world datasets and contemporary problems, class discussion about resources, higher number of videos, and by explicitly requiring interaction with resources. It may also help to adopt up-to-date/current resources with seemingly more relevant content for students. A second approach to increase students' use of OER is to have students themselves find, create, and/or share the OER, such as student blogs integrated by Dos and Demir (2013), which requires their interactions with the materials. Finally, a third mechanism could involve changing the way a no-cost resource is branded and accessed. If investment theory and *marketing placebo effects* (Plassman et al., 2008) are applied to textbook consumption, students may be less likely to use and appreciate textbooks that are free (much like the finding that energy drinks were less enjoyed when purchased at a discount price; Shiv et al., 2005). Any improvements in efficiency and access that no-cost resources provide might be offset by the larger investment students make in costly resources (making it more likely they follow through and use them) and inflated perceptions of quality (as when higher-priced wines are rated as tastier). Perhaps engaging students in a registration process to access resources, or investing in the format to make them appear expensive could help with student perceptions, evaluation, and use of no-cost textbooks. A final possible reason OER were not used more than costly resources is that instructors may provide enough information for students to succeed without explicit use of course resources (costly or otherwise), a finding reported by Kinskey and colleagues (2018). Several students in the present study mentioned instructor-generated resources – which were similar across semesters of the present study – as highly beneficial for the course, with one student even claiming they were more helpful than the (costly) textbooks.

IMPLICATIONS AND RECOMMENDATIONS

The present project has limited scope given its use of a small number of students for a specific psychology course and possible confounds (e.g., no-cost items were digitally organized in a subject guide whereas costly materials were not; Griggs & Jackson, 2017); still, other authors also reported neutral or positive effects of OER in community colleges (Bliss et al., 2013) and in distance education (e.g., Hockings et al., 2012) using similar measures (see COUP, costs, outcomes, use, and perceptions; Clinton, 2018) on a larger scale. For instructors, OER textbooks can be used with similar effort expended to adopt any textbook (Bliss et al., 2013) and they are more malleable, allowing removal or addition of content when needed specifically for a course (e.g., see use of "flexbooks" by Lindshield and Adhikari, 2013). Over 80 % of instructors report spending similar time preparing for classes when OER were used compared to traditional textbooks; even among the 18% who reported allocating more time to course preparation with OER, an overwhelming majority view the extra time as justified given the benefits to students (Jung et al., 2017). Further, any extended preparation time reported by instructors when adopting OER often is allocated to increased reflection about their teaching goals and practice (Weller et al., 2015) rather than additional time required to handle or use OER.

If one's aim is collaborative or to share resources with other instructors, use of web repositories are a good option (e.g., CloudWorks in Ehiyazaryan-White, 2012; MERLOT in Malloy & Hanley, 2001; see Clements et al., 2015, for a review). We published the presently used subject guide through our institution's library, but the use of a larger-scale repository would make the OER we created more easily accessible to external research

methods instructors. Student perceptions of the resources may differ based on the format of the OER, where printed versions of OER may be viewed as higher quality (Jhangiani et al., 2018). Recall that only two negative comments about OER materials in the present study involved student's desire for print materials. While "professionalization" is critical for students to perceive them as credible (Bliss et al., 2013, Gurung, 2017), OER also should be mobile friendly (Ally & Samaka, 2013). Finally, web-based supplements (e.g., StatHand, Allen et al., 2019) can enrich streamlined open-access textbooks.

Finally, while the instructors of this project remained the same across costly and no-cost semesters, Instructor 1 used a flipped-classroom model whereas Instructor 2 used a more traditional lecture model infused with class exercises. The varied pedagogical approaches increase the external validity of the findings since both instructors were able to incorporate the materials using active learning strategies, lectures, hands-on lab sessions, etc. Results did not vary across these approaches, increasing confidence that OER adoption can be successfully incorporated into a variety of pedagogical approaches. The present instructors who adopted OER in research methods gained confidence in OER development and use for other courses, showing the cumulative effect of OER identified by Hughes and McKenna (2012) who call the initial OER experience "transformational" for teaching. Similarly, among students, use of OER begets appreciation and use of OER (Anderson & Cuttler, 2020).

SUMMARY

The impact of textbooks on student learning has interested educators since the early 1900s, a time when textbooks were less common and varied widely in content (Zirbes, 1921). Now, a century later, the "digital age" shepherded in novel ideas and approaches to textbooks, providing new appearances and levels of availability for course resources. We believed the flexibility and accessibility of open-access textbooks could improve student gains in a challenging research methods course in which costly textbooks were used previously. After identifying existing topical digital textbooks that were free for use, instructional materials (e.g., slides, study guides, class exercises) were created to accompany the texts and all materials were posted openly to others through a subject guide at the institution's library. Development and adoption of OER did not increase student learning or course grades in this case, but the present study suggests it is possible to teach a challenging undergraduate course using OER and achieve similar student outcomes, with reportedly similar use and satisfaction with resources, when compared to a semester when costly materials were used. These findings replicate those reported previously (see Hilton, 2016) regarding adoption of open-access textbooks. One important conclusion is that adoption of OER does not necessitate use of OER by students (French et al., 2015; Kinskey et al., 2018), so instructors may need to introduce other mechanisms to motivate student interaction with materials if such interaction is believed to improve student outcomes. Still, the present study's results provide tentative support for the argument that use of OER can provide students with significant financial savings, all while maintaining student learning outcomes.

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APPENDIX A

Course learning objectives in Research Design and Methods I at Columbus State University as worded in the course syllabus.

"At the end of the course, students should be able to:

- Discuss ethical issues in psychological research and their impact in research and beyond.
- Ask research questions and gather relevant information using library and other resources.
- Describe and select appropriate methods, including controls, to address research questions.
- Demonstrate the appropriate selection, use, and interpretation of descriptive and inferential statistics.
- Communicate the research process and outcomes to an audience (using APA style).
- Critically evaluate research (e.g., identifying confounds, limitations), and recognize limits of findings."

APPENDIX B

Survey items distributed electronically to gauge student use and evaluation of textbooks.

1.) In your PSYC 3211 course, how often did you use the required STATISTICS textbook?

2.) In your PSYC 3211 course, how often did you use the required RESEARCH METHODS textbook?

[Both scaled with the following:]
1 = 3 or more times a week
2 = 1-2 times a week
3 = every other week
4 = maybe once a month
5 = rarely or never

3.) The following statements refer to the required STATISTICS textbook in PSYC 3211. Indicate your agreement with each statement using the provided scale.

- I found the textbook easy to read and understand.
- The textbook's content often seemed to contradict material from the Research Methods book.
- The textbook's content helped me to better understand the course concepts.
- It was easy to understand how the content from the textbook fit together with content from the Research Methods book.
- The textbook effectively increased my grasp of the course material.

4.) The following statements refer to the required RESEARCH METHODS textbook in PSYC 3211. Indicate your agreement with each statement using the provided scale.

- I found the textbook easy to read and understand.
- The textbook's content often seemed to contradict material from the Research Methods book.
- The textbook's content helped me to better understand the course concepts.
- It was easy to understand how the content from the textbook fit together with content from the Statistics book.
- The textbook effectively increased my grasp of the course material.

[Both scaled with the following:]
1 = disagree
2 = somewhat disagree
3 = neither agree or disagree
4 = somewhat agree
5 = agree

5.) Please provide additional feedback on your experience with the PSYC 3211 textbook materials.