The Dissertation Committee for Heidi Anna Neu-Stephens certifies that this is the approved version of the following dissertation:

Open Education Resources and Enrollment Intensity in One Southern California Community College

Committee:

Noreen Thomas Ed.D.

Noreen Thomas

Keith D. McLaughlin, Ph.D.

Keith McLaughlin

Open Education Resources and Enrollment Intensity in One Southern California Community College

by

Heidi Anna Neu-Stephens
B.A., California State University, Long Beach, 1990
M.A., California State University, Long Beach, 1991

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Dedication

This dissertation is dedicated first to God, who makes all things possible. Secondly, I dedicate this to my children, James, Christian, and Katie, who cheered me on throughout this journey and inspired me to keep going. You can do whatever you set your mind to. Lastly, I dedicate this study to my mother, Ellen, who has always seen the best in me.

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Abstract

The California Community College system is investing in the development of free educational resources, or OER, as an alternative to traditional textbooks to relieve some of the financial burden students experience and remove barriers to student completion and access. However, little research on the impacts of OER in the community college sector exists, especially as related to its impacts on credit hour intensity (units and enrollment). This study's focus was to determine whether at one large, urban southern California community college students who enrolled in any classes utilizing OER in the Fall 2018 and Spring 2019 terms enrolled in a higher number of credit hours than those who did not. The second purpose was to determine whether students enrolled in a greater number of credit hours when they enrolled in multiple courses utilizing OER. An ex post facto quasi-experimental study utilizing t-tests and propensity score matching revealed that students who enroll in classes utilizing OER enroll in statistically significant higher numbers of credit hours than those who do not. Additionally, the number of additional credit hours increases in a statistically significant manner when students enrolled in multiple classes utilizing OER. These findings provide evidence for further investment and support of OER in the community colleges as increased credit intensity is positively related not only to student completions but also apportionment funding.

Keywords: OER, open educational resources, credit intensity, units, enrollment, completion, community college, cost of education, textbooks

Table of Contents

List of Tables

List of Figures

CHAPTER ONE

INTRODUCTION

Though technology has had significant impacts on the daily lives of the 2.1 million students served in California's 114 community colleges, these institutions are only now realizing technology's potential to partially address some of the state community college system's most troubling challenges (California Community Colleges Chancellor's Office, 2019). One of these challenges is the cost of education relative to the average income of the families from which a large portion of community college (CC) students come. Another is that the financial aid available to these students is not enough to cover the true cost of college attendance, which includes not only tuition and books, but also housing, food, transportation, and for many, childcare. While higher education officials have recognized this funding shortfall as a significant barrier to higher education and improved economic opportunity for the communities they serve, they have been frustrated by what seem to be insurmountable facts: states and federal governments have limited funding, which they must share across all public sector service types and a growing population of low-income learners. Given these frustrations, it is no wonder it has taken some time for CC leadership to recognize the possibilities technology and the openness and accessibility of the Internet provides. One such possibility is the free sharing of knowledge and information. This idea, however, did not escape the attention of world leaders, who recognized the need for greater access to learning and the impact of inequitable information access on economic development as a global concern. At the 2002 United Nations Educational, Scientific, and Cultural Organization forum on open courseware, the concept and term of open educational resources were widely introduced and captured the attention of leaders in the education sector.

> Open educational resources (OER) are considered
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> Teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge. (Atkins, Brown, & Hammond, 2007, p. 4)

Because these educational resources are free, the community college sector has finally recognized OER's potential to help alleviate the cost of education to students. By encouraging faculty to adopt OER in lieu of traditional textbooks and offering colleges and faculty funds to do so, the state and CC systems are investing in this potential.

Since OERs are free, the cost savings to students is obvious and has been well-documented (Hilton, Robinson, Wiley, & Ackerman, 2014; Wakefield Research, 2018; Wiley, Hilton, Ellington, & Hall, 2012). What CC students do with this savings has also been documented in a more limited way (Ikahihifo, Spring, Rosecrans, & Watson, 2017); many students report reinvesting these savings in their education, both directly and indirectly, in the way of books for other classes, paying living expenses, and making ends meet. At least one study found evidence that students enrolled in classes offering OER reinvest by enrolling in additional credit hours (Robinson, 2015). Credit hours in much of the literature are also referred to interchangeably as *units* or *credits*, a number assigned to each course indicating the number of learning hours required for the course, including homework, study time, and in-class hours. The higher the number of credit hours or units, the higher a student's intensity of enrollment.

Robinson's (2015) found that students in OER classes are more likely to enroll in greater numbers of credit hours, is important in that other studies have shown that students who take

higher numbers of units (credit hours) are more likely to complete their educational goals. Students who take 15 credit hours per semester are more likely to complete associate and bachelor's degrees, and to complete bachelor's degrees after transferring from a community college, than students taking fewer credit hours (Attewell & Monaghan, 2016). In addition, students enrolled in a higher number of credit hours provide colleges with additional state funding. This additional funding may offset local investments in OER or other student success initiatives. While the results of this study are promising, it was a broad study of seven higher educational institutions, five of which are in California. In order to better understand the potential impact of OER, this study will focus on a single institution in the nascent stages of OER adoption. The overarching question to be asked is whether students in courses utilizing OER enroll in a greater number of credit hours than students not enrolled in OER courses. If results indicate greater credit hour enrollment intensity for students enrolled in OER classes, it may provide encouragement to administrators and faculty who are skeptical about OER or reluctant to invest limited time and resources in the effort.

In this chapter, the author will outline the problem addressed via this study, the purpose of the study or what the author hopes to accomplish via the study, a description of the significance of the study, how the study is designed, and a presentation of the research questions being asked.

Statement of the Problem

Technology has had an obvious and significant impact on society. In the last few decades, educational institutions have been adapting to these changes, which have influenced all aspects of operations, as well as teaching and learning. One such impact has been the influence of the Internet and its infinite wealth of freely accessible information. Computers, in

combination with the Internet, can collect, store, and even generate ever-increasing amounts of data, which is done at an exponential pace. Information is freely accessible to an unprecedented number of people no matter their location, and society has readily harnessed the power of the Internet not only to share information locally and globally but to build community. Technology has shaped changes in societies globally, with the Arab spring, the opening of China, and various national movements such as #metoo and #blacklivesmatter. Technology is used for more mundane purposes as well. For example, to assist with daily activities such as ordering laundry detergent, booking flights, learning how to repair automobiles, or understanding how to write legal documents. It is this last aspect, the power to learn nearly anything cost-free via a few clicks of a mouse impacts post-secondary education greatly. Students, who are accustomed to instantaneous access to information that is now public property, find little relevance in more traditional modes of information dissemination, expensive commercial textbooks are among them. Though the high cost of textbooks and students that so seldom use them have long exasperated educators, higher education has been slow to adapt to this change (Harley, Lawrence, Acord, & Dixon, 2010).

Thus far, one of the main ways in which colleges have attempted to align with these technological changes is to move many of their once paper-bound processes online. Long lines at the registration office have been replaced with online applications. In California CCs, a single online application is used to enroll in any one of the 114 institutions. Class schedules are found online, and students register this way as well. Email is the main form of communication used with students and CC employees. In terms of classroom practice, faculty utilize online presentation software and post-course outlines and assignments in the online Canvas Learning Management System (adopted system-wide in California). Some faculty have even adopted some

form of electronic teaching materials. Publishers large and small have developed course textbooks and paired them with proprietary online supplementary materials for which students pay an access fee. In some disciplines, such as mathematics, the "flipped classroom" model has become a popular pedagogical approach; here students purchase access to self-paced online instructional software and much of the "instruction" takes place outside of class with the idea that valuable class time is reserved for working out problems, diving deeper into concepts and collaborative learning. While these more innovative approaches do take advantage of some of the benefits of technological advancements and represent needed cost savings to institutions, students are experiencing little if any financial relief.

At the same time, the cost of education has risen, especially as a proportion of income (American Association of Community Colleges, 2017). It is estimated that the cost per year of attendance at California public community colleges including living expenses is approximately $5,000 to $12,000 (Cochrane & Ahlman, 2017). Community college students cite paying for college as the top reason for not succeeding (Porter & Umbach, 2019). Given these facts, the demographics of the typical urban community college student and the mission of community colleges as "...centers of educational opportunity . . . inclusive institutions that welcome all who desire to learn, regardless of wealth, heritage, or previous academic experience" (American Association of Community Colleges, 2004), many are seeking to lower this cost. Among the costs incurred are print and online textbooks, which rose more than double the rate of inflation from 1986-2004 (Bliss, Hilton, Wiley, & Thanos, 2013; Usdan & Gottheimer, 2012). Both faculty and students are frustrated with this phenomenon (Harley et al., 2010). The cost of textbooks, though not always the primary criterion in the textbook selection, is a major concern

for faculty when adopting texts. Because of the cost, students report forgoing purchasing texts even though they feel they would perform better in class with them (Senack, 2014).

The rising cost of textbooks has come to the attention of state and federal governments as well, due to its negative impact on their budgets as providers of student financial aid. Several types of federal policies and programs have been implemented to address this issue. The College Affordability and Opportunity Act, which became effective in 2010, requires publishers to provide more transparent and flexible textbook pricing. 2009's Learning Opportunity with Creation of Open Source Textbooks (Low Cost) Act required the development of freely-available open-source educational materials in science, technology, and other fields, and funding for their creation. The Open College Textbook Act of 2009 was intended to create a grant program for the creation of freely available, online open college textbooks to significantly lower college textbook costs (Nicholls, 2010).

At the state level, similar action has occurred led by the California community colleges (CCC) system office, which is promoting the adoption of OERs as a solution to the cost of education. Legislation supporting this effort was enacted in 2013 to "support faculty in choosing lower cost, more flexible, and dynamic alternatives such as open-source textbooks and related teaching tools," (S.1053, 2012). Additional legislation intended to help students understand how to access courses with free resources was developed in 2016 (California Community Colleges Chancellor's Office, n.d.). Students can now see via online schedules of classes which sections offer OER. The goal of this legislation is to save college students money by empowering students to access and professors and local campuses to adopt high quality, free and open educational resources for course materials. State legislators recognized that free and open

educational resources can reduce the total cost of education for students and their families in California's higher education institutions.

Reducing the cost of textbooks to students was the focus of this legislation and subsequent grants provided to the California community colleges; the cost/benefit of free textbooks, though obvious, has also been documented in the research (Hilton et al., 2014; Wakefield Research, 2018; Wiley et al., 2012). Also documented are the impacts of OER adoption on student outcomes such as drop rates, withdrawal rates, success/C or better, and cumulative effect on throughput rate (Bowen, Lack, Chingos, & Nygren, 2012; Hilton & Laman, 2012; Hilton, Gaudet, et al., 2013; Lovett, Meyer, & Thille, 2008; Winitzky-Stephens & Pickavance, 2017). One high-level study across multiple higher education institutions was conducted on OER's impacts on the number of credits students enroll in per semester (Robinson, 2015). This study has implications for another issue critical to California's community colleges – the completion rate.

Rates of completion among the CCCs are dismally low. The average completion rate across the California community college system's nearly 1,127,000 students is 48.2% (California Community Colleges Chancellor's Office, 2019). Of course, to complete educational goals, students must enroll in a certain number of credit hours, typically 60 for those who intend to transfer. With a higher number of credits taken per semester, students can complete their educational goals faster, thus leading to higher rates of completion. Should OER impact positively the number of credits students enroll in, the benefits of OER may not only include making college more affordable to both governments and students, but also perhaps achievable.

While Robinson's (2015) study found OER had a positive impact on student credit-taking behavior, the study was conducted across multiple institutions. In his conclusions, Robinson

called for additional studies including studies in which cumulative effects of OER on credit hour enrollment are evaluated. Therefore, a closer look at a single institution is in order. Doing so may enable institutions and others to look more deeply into how OER might serve to help community colleges fulfill their missions to serve their communities, especially those with profiles and completion rates similar to that of the proposed study institution: a large (21,000 students), urban community college, with a diverse student population, 75% of which qualify for financial aid, and an overall completion rate of 39.5% (California Community Colleges Chancellor's Office, 2018; Long Beach City College, 2019b). It may also provide greater insights into the course-taking patterns of students in specific disciplines and provide a rationale for further support for OER-related initiatives. In addition, in California, individual colleges are evaluated and will be, in part, funded by the rate at which they graduate students. A new funding structure being phased in by the California Community College Chancellor's Office will allocate 20% of individual college's apportionments contingent upon the number of student completions (California Community Colleges Chancellor's Office, College Finance and Facilities Planning Division, n.d.). Studies on individual institutions may inform the impacts of new policies such as this and help colleges maximize funding. Also, in order to encourage local adoption of OER at individual institutions, local constituents must be engaged. An understanding of local impacts can help foster shared values so critical to initiative success (Yukl, 2013). A study such as this may also provide a template for other institutional studies.

Purpose of the Study

No single-institution study of OER's relation to credit hours appears to have been conducted. Therefore, the purpose of this study is to determine whether at one large, urban southern California community college students who enrolled in any classes utilizing OER in the

Fall 2018 and Spring 2019 terms enrolled in a higher number of credit hours than those who did not. The second purpose is to determine whether students enroll in a greater number of credit hours when they enroll in multiple courses utilizing OER.

Significance of the Study

Globally, nationally, and at the state level, the OER movement is being promoted as a method for reducing barriers to student success and as a way of improving equitable economic prosperity. Much funding is backing this movement. However, relatively little research on OER's effects on measures of student success, especially at the state and local levels, has been completed. Seminal studies on the benefits of OER and its impacts on student outcomes have been conducted by Hilton, Gaudet et al. (2013), Hilton et al. (2014), Wiley et al. (2012), Hilton (2016), and Robinson (2015). These studies called for continued study in multiple contexts to gain a more detailed view of what happens when OERs are substituted for traditional learning materials (Hilton, Gaudet et al., 2013), including replicative studies of enrollment intensity (Hilton, 2016), studies specific to various campuses, use of OER in various subjects (Hilton & Laman, 2012), and studies that expand the number of teacher and student participants (Wiley et al., 2012). This study addresses some of these needs by focusing on a larger number of faculty OER users at a single institution in the community college context, and by analyzing credit hour intensity of students using OER in various subject areas.

This study and OER's impacts on the number of credits students enroll in per term has implications for another critical CCC issue, the completion rate. Across California's 114 community colleges are their nearly 1,127,000 students, the rate is a dismal 48.2% (California Community Colleges Chancellor's Office, 2018). This is not a two-year rate of completion - the time most associated by the public with community colleges - but rather this rate indicates that

even after six years, fewer than half of CC students complete their educational goals. At specific institutions, such as the one in this study, the rates are even lower. Studies have shown that higher credits taken per semester lead to higher completion rates (Attewell & Monaghan, 2016; Scrivener et al., 2015). Should OER impact positively the number of credits in which students enroll, the benefits of OER may not only include making college more affordable, but also achievable and timely.

A lack of literature concerning OER's relationship to credit hours currently exists. Via a review of literature, no single-institution study of OER's relation to credits appears to have been conducted. Action research of this nature may improve practitioners' understanding of OER's role in fulfilling CCs' mission to serve their very diverse and often low-income communities. It may also provide greater insights into the course-taking patterns of students and provide a rationale for further support for OER-related initiatives. Any findings may also support efforts at the study institution; with information specific to this college, those involved with the implementation of OER locally will have data to inform decision-making. Any findings on the relationship between OER and credit hours will aid administrators in better determining how to direct limited resources toward various student success efforts. Any positive findings can also be shared with potential faculty OER adopters. Since providing local evidence is a significant factor in motivating faculty to change teaching practice (Bergquist, 1992; Henderson & Dancy, 2011; Kezar & Eckel, 2002), this may be especially beneficial. When faculty are presented with existing data on the significant cost savings for students, data on OER and credit intensity, along with data on how greater credit intensity leads to higher completion rates, this may accelerate efforts. In turn, this will improve the efficient use of resources and a timely benefit for students.

In light of changing funding models in the state which are newly-based on completions, this may also improve local fiscal stability.

Design of the Study

No single-institution study of OER's relationship to educational credits appears to have been conducted. Therefore, the purpose of this study was to determine whether there is a significant difference in the number of credit hours students enroll in between those enrolled in classes that offer free open-educational resources and those not enrolled in classes that offer this type of learning material at one large urban Southern California community college. The researcher also sought to evaluate whether students enrolled in multiple classes offering OER enrolled in a higher number of credit hours than those enrolled in only one.

To do this, an applied evaluative research method is used. The goal of applied research is to determine how knowledge from basic research can be used to address a pressing problem. In contrast, evaluative research involves making judgments about the value or merit of a program or initiative (Miller & Salkind, 2002). As this study sought to both apply existing research to a local college context in order to help solve problems of student success and to inform practitioners as to the impacts of the OER initiative, it is both applied and evaluative in nature. To this end, institutional research office student data on the number of credits in which students enrolled was correlated to data from the class scheduling records indicating which classes offered OER in a quantitative quasi-experimental study. The study explored the relationship between the dependent variable (the number of credit hours in which students enrolled) and the independent variable (enrollment in classes offering OER).

Further, a study was conducted in order to determine whether OER has compounded effects on the number of credit hours in which students enroll. That is, do students enrolled in

multiple OER classes enroll in more credit hours than those who enroll in only one? In this case, both variables are quantitative, the number of OER classes in which students enrolled and the total number of credit hours in which the students enrolled.

The population involved in the study was students enrolled in one southern California community college from the Fall 2018 and Spring 2019 terms. The students were representative of the overall college demographics: 64% are 24 years old and younger, a slight majority are enrolled part-time (6-11.5 units), 55% are female, 45% are male, the majority (59%) are Hispanic, average grade point is 2.34, and 55% have a bachelor's degree as their educational goal (Long Beach City College, 2019b).

Research Questions

Via this study, the researcher aimed to answer these questions:

1) Is there a statistically significant difference in the number of credit hours in which students enroll between students who enroll in any courses utilizing OER and students who do not enroll in any courses utilizing OER?

This question was intended to help determine whether the utilization of OER in college classes may result in enrollment in a higher number of credit hours. A positive relationship between these variables may influence the adoption of OER and have implications for student completion and college apportionments.

2) Is there a statistically significant difference in the number of credit hours in which students enroll between students who enroll in one course utilizing OER and students who enroll in two courses utilizing OER?

This question is intended to help understand whether the impacts of OER increase with greater utilization of this type of educational material. A positive relationship between these variables

may influence the adoption of OER and have wider implications for student completion and college apportionments.

Limitations

Limitations are occurrences of the research design that are not within the scope of control of the researcher (Creswell, 2014). This study is limited by its quasi-experimental methodology, and therefore, less conclusive than true experimental designs. However, when considering the setting, an experimental study was not possible. The study is also limited due to the number of class sections and types of courses (disciplines) represented in the data set are relatively low compared to the overall number of class sections and disciplines offered at the institution. OER adoption at the study institution is still in its infancy, and the total number of OER classes offered is small relative to the non-OER courses. There may be some human error in the reporting of class sections with OER. The data set of class sections included in the OER class section data may not be complete or may be inaccurate since not all faculty may fully understand what constitutes OER. Lastly, although students can self-select courses with the OER designation from the schedule of classes, some students may not be aware that the course(s) they select will provide savings that can be reinvested in enrolling in additional courses (credit hours); therefore, OER may have a limited direct influence on enrollment patterns or credit hour intensity for these students.

Assumptions

Several assumptions are made in this study, namely:

1. Data collected in the samples used are accurate and representative of the community college population of students at the focus college.

2. All classes indicated in the data as "ZTC" or "zero textbook cost," the study institution's designation for classes having adopted OER, utilized OER as the primary course material. Additionally, the sources used it within the definition of OER as:

> Teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge. (Atkins et al., 2007, p. 4)

Definition of Terms

Open Educational Resources (OER). "Teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others (Atkins et al., 2007, p. 4).

Credits/credit hours. Per the California Code of Regulations, Title 5, Section 55002.5, one credit hour of community college work (one unit of credit) shall require a minimum of 48 semester hours of total student work, which may include inside- and/or outside-of-class hours. A course requiring 96 hours or more of total student work at colleges operating on the semester system shall provide at least two units of credit, and so on. The system office for the college in this study requires that one unit of credit be defined as a minimum of 48 total hours of student

work, inclusive of all instructor contact hours, plus outside-of-class or homework hours. This is based on the hours of student work per week over a 16-week term, for one unit of credit. The college in this study uses 54 total hours of student work (18 weeks x 3 hours) for this calculation, rather than the minimum 48.

Units. The term units is used interchangeably in this and other studies to indicate credit hours. The number of course units is equivalent to the number of credit hours as defined previously.

Term/Primary term. The term is a 16-week period over which courses are offered over the course of the year. The study institution offers four terms: a spring 16-week term, a summer 8-week term, a fall 16-week term, and a winter 5-week term. The fall and spring terms are considered the primary terms or terms with the highest student enrollment, the greatest number of class offerings, and the longest term lengths.

Equity. As used in relation to students in the California community colleges including the one in this study, equity refers to equal educational opportunities and success for all students, regardless of race, gender, disability, or economic circumstances. The term is also utilized in this study to refer to ensuring that all learners globally, regardless of race, gender, disability, or economic circumstances, have equal access to information and education. For both groups, the goals of equity are also equal opportunities for positive educational and economic mobility and increased democratic participation in society.

Summary

Chapter 2 of this proposal contains a review of the literature on OER, including OER's impact on curriculum, OER's impact on student success metrics, student and faculty perceptions about OER, and rationale for its use and the present study. Chapter 3 describes the methods and

research strategies employed in this study, the population and sample, data collection procedures, and how the data will be analyzed.

CHAPTER TWO

LITERATURE REVIEW

Society and educational institutions have evolved as a result of the advent of technology. With unlimited and easy access to free learning and information provided by the Internet, textbooks are becoming less relevant to newer generations of learners. Even traditional methods of information sharing are becoming obsolete. Static methods of knowledge acquisition accessible only via the cloistered halls of academia are becoming less applicable to the world outside, including expensive publishing house-produced printed textbooks. Business and society globally have been adapting to this new technological reality. While this change is happening rapidly outside the walls of academia, within the change is happening quite slowly.

At the same time, Americans are required to spend a much greater proportion of their income on higher education, with attendance at public community colleges costing as much as $12,000, including living expenses (American Association of Community Colleges, 2017; Cochrane & Ahlman, 2017). This increased expense is due, in part, to the cost of textbooks increasing more than double the rate of inflation from 1986-2004 (Bliss et al., 2013; Usdan & Gottheimer, 2012). The California community college system office views the adoption of OER as a way to ameliorate this problem and is promoting OER via system policy and state legislation (California Community Colleges Chancellor's Office, n.d.).

Though a relatively new field, research connecting OER and student outcomes is documented (Hilton, Gaudet et al., 2013; Hilton et al., 2014; Hilton, Fischer, Wiley, & Willam, 2016; Robinson, 2015; Wiley et al., 2012). The use of OER impacts the number of credits students enroll in per semester, which, in turn, impacts completion rates, another critical issue for community colleges. California community college leaders, policymakers, and the public are

disheartened by the dismal 48.2% completion rate of its 1,127,000 students (California Community Colleges Chancellor's Office, 2018). Scrivener et al. (2015) showed that when students enroll in greater numbers of credits taken per term, they complete at higher rates. If OER positively impacts the number of credits students enroll in, OER may not only make college more affordable, but also more achievable.

No single-institution study of OER's relation to credits has been identified in the literature. Conducting such a study will improve practitioners' understanding of OER's role in fulfilling community colleges' mission to serve its diverse and lower-income communities. Greater insights into the course-taking patterns of students and the rationale for further support for OER-related initiatives may also be provided.

Therefore, the purpose of this study is to evaluate whether students enrolled in courses offering free open educational resources enroll in more credit hours than those who do not. To describe the context in which this study takes place, this chapter will provide a discussion of technology's impact on society and education, provide a definition, the origins and social purpose for OER, and OER's growth and implementation in higher education, community colleges, and California community colleges in particular. Following this, the chief rationale for OER adoption is outlined, which includes OER's enhancements to curriculum and pedagogy and positive impact on the cost of education and equitable student success. Lastly, a review of studies on student and faculty perceptions of OER and its effects on student outcomes is presented.

Technology's Impact

Impact on Society

Friedman (2006) famously posited that the world is flat – that the global economic playing field between developed and emerging market countries is leveling, and that individuals, as well as companies, are becoming part of a large, complex, global supply chain. He contends that this phenomenon grew out of the collapse of communism, the dot-com bubble and overinvestment in fiber-optic telecommunications, and the subsequent outsourcing of engineers enlisted to fix the perceived Y2K problem. This led to great changes, as lightning-swift advances in technology and communications put people all over the world in touch as never before, resulting in an explosion of wealth in India, China, and elsewhere. Friedman (2006) warned his United States readers that they would need to learn and develop faster if they hoped to keep pace with the rest of the world.

However, at the time of publication, 2006, readers were only beginning to feel and understand the full implications of these events, which were prior to more recent developments, such as Facebook, cloud-based data/information storage and sharing, Twitter, and Skype (Friedman & Mandelbaum, 2011), and these types of advancements continue at an exponential pace. In the evolving Information Age, new ways to utilize the massive amounts of data that are being collected on everything from our personal interests on social media, to our shopping preferences on Amazon, to our medical histories via electronic systems, to our genomes via Ancestry.com are being discovered and developed. This is commonly referred to as *big data*, which is defined as "characterized by such a high volume, velocity and variety to require specific technology and analytical methods for its transformation into value" (De Mauro, Greco & Grimaldi, 2016, p. 122).

The management and use of this big data will require the collaboration of multidisciplinary teams of skilled professionals from industry, academia, and the government to develop novel methods, disciplines, and a workforce that can blend data networking, management, and computational and statistical sciences (Fang et al., 2015). Along with teaching students to live and thrive in an environment with instant access to large amounts of data and knowledge that heretofore would have been difficult or impossible to find, students will need to learn skills to collaborate and communicate with those outside of their own disciplines and industries. Educators have both the obligation and opportunity to not only provide students with the skills and abilities to function in the current environment, but also to contribute to shaping the world as it is evolving.

Impact on Education

While the world has changed, methods of education have by and large remained stagnant. As Berry (2013) contended, "We are still educating our students and teachers about an economy and a world that has passed, neither of which is coming back" (p. 58). In general, educators are also teaching in a way that does not prepare students for current and future jobs that are inexorably tied to a world economy. Our traditional mission as educators to foster students' creative, aesthetic, cultural, communication, and critical thinking skills remains, but educators must now do so in a way that reflects the context in which students will use those skills.

The technological changes described previously have had a historically significant impact on higher education; the advent of the Internet sent shock waves through a rather slow-moving and extremely hierarchical system of knowledge dissemination. With the Internet, access to information no longer emanated solely from the bastions of higher education and was no longer provided and obtained only by a privileged few. The system by which information,

communication, and knowledge were accessed flattened and became reachable and shareable across boundaries, groups, and institutions.

As information technology developed and knowledge became instantly and ubiquitously available, educators discovered the vast resources available to them via the Internet and use them to supplement their courses. In the past decade, the development and sharing of resources among practitioners have grown. Until recently, however, nearly all of what was being used as course materials online was still proprietary in nature and required students to pay subscription or access fees.

The Internet also made possible online learning and distance education. The spread of online learning in community colleges was seen as a way to further the mission of the California Community Colleges (CCC) by making education more accessible to more segments of the community, such as learners who are unable to physically get to campus. Offering courses online also enables colleges with limited physical space to expand offerings of the most impactful courses – usually those that students need to meet general education requirements for transfer and completion. Shea and Bidjerano (2014) showed that students who take some courses online or at a distance have a significantly better chance of attaining a community college credential. The popularity of online education has increased over time, with colleges offering more and more classes in electronic format. In fact, the number of students enrolled in online classes in California community colleges has tripled since 2005. In the 2016-2017 year, 28% of students (unduplicated) in all course sections were enrolled in online courses (Woodyard & Larson, 2017). During the 2017-2018 academic year, 932,343 California community college students took at least one online course (California Community Colleges Chancellor's Office, n.d.). The popularity of these offerings may be attributable to the multiple obligations students

in CCCs have today. At least two-thirds attend part-time; 81% work, with 60% working more than 20 hours per week; 33% have children in the home; and nearly all commute to class ("Report: Community Colleges," 2004). For these students, the tasks of managing and balancing all of these demands make access to and success in post-secondary education extremely challenging, if not impossible. The need to purchase expensive commercial textbooks adds to these obstacles. However, an outgrowth of the same technological advancements that enabled online education is access to free information, which both world leaders and now community college leaders recognize and are promoting as a means to level the educational access and economic playing field.

OER: Definition, Origins and Purpose

Definition and Origins

The aforementioned developments have led to the movement toward open educational resources. The term was first used at a United Nations Educational, Scientific and Cultural Organization (UNESCO) forum on open courseware in 2002, where it was described as:

> Teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge. (Atkins et al., 2007, p. 4)

The forum was supported by the philanthropic William and Flora Hewlett Foundation, which provides a similar definition.

The roots of OER go deeper still, however, and the movement was made possible only by a wide range of earlier innovations, from the conceptual to the material. These include the idea that software should be open to all, the Freedom of Information Act, the invention of the World Wide Web, and the introduction of the consumer microcomputer to the mass market. Wiley (2006) claimed much can be attributed to Hodgkins' use of the term *learning objects*, which popularized the idea that electronic educational materials could be created, used, and reused for a variety of pedagogical purposes. Wiley (2006) also described how, in 1998, he coined the term *open content*, which, despite it was originally aimed at the education community, caught on with Internet users as it related to the open-source software movement. Lawrence Lessig, Professor of Law and Leadership at Harvard Law School, and others developed Creative Commons in 2002 and a set of easy-to-use licenses that allowed OER creators to describe the level of sharing they wished to provide for their materials. In 2001, the Massachusetts Institute of Technology launched its OpenCourseWare initiative, which Friesen (2009) stated effectively pioneered the concept of providing free access to course materials, popularized the term *open courseware*, and was one of the inspirations for the OER movement. By 2007, the Institute had published nearly every university course with free public access for noncommercial use, thus providing an exemplary institutional-level commitment to OER as well as the prestige of the Institute. Since that time, policymakers on the local, state, and national levels have increasingly developed policies that encourage the creation and adoption of OER. Approaches to this encouragement vary from directly funding the creation of OER to making federal or state grant or research

dollars conditional, such that any educational resources produced as a result of the funding be made openly accessible.

Social Purpose of OER

The goal of providing OER is to increase equitable access to knowledge and education worldwide. Expanding free access to knowledge aligns with the idea of a social, egalitarian, inclusive, and equitable education. Duart and Mengual (2014) cited numerous studies clarifying the potentialities of OER in developing countries, including the expansion of economies and scientific productivity. Thus, OER makes access to knowledge and education more balanced among regions of the world in which there have long been much deeper divides between the knowledge "haves" and "have nots." Indeed, this was the goal of the William and Flora Hewlett Foundation in investing in OER:

> to catalyze universal access to and use of high-quality academic content on a global scale. ...to expand people's substantive freedoms through the removal of 'unfreedoms': poverty, limited economic opportunity, inadequate education and access to knowledge, deficient health care, and oppression. (Atkins et al., 2007, p. 1)

In short, the purpose of OER is to equalize access to knowledge and educational opportunities across the world.

OER's fundamental purpose or underlying principle, therefore, is social inclusion (Andrade et al., 2011; Dos Santos, 2008; Geser, 2007). Social inclusion is about equity, as Willems and Bossu (2012) pointed out. Social inclusion is defined as the opportunity for individuals or groups to "access available education, professional, economic and/or political opportunities" (Mancinelli, 2008, p. 243) with the end goal of diminishing social inequality (Hylén, 2007). OER is seen as a way to positively impact social inclusion in higher education

(Kozinska et al., 2010). OER is also seen as a potential solution to many of the challenges facing higher education, including globalization, an aging populace, competition among higher education institutions, and the rapid pace of technological development (Organization for Economic Cooperation and Development, 2007).

OER's Growth and Implementation

Growth in Higher Education

Since OER's origins at UNESCO, the OER movement has been gradually embraced by those in higher education. Given the foundational purpose of OER, it is not surprising that Caro and Lesko (2014) found that many higher education institutions internationally are adopting OER, stating that OER initiatives align with their existing institutional missions or policies to provide, increase, or widen access to education. In addition, many see OER as part of their marketing efforts, showcasing their quality educational materials to the rest of the world for the purpose of attracting new students (Carson, Kanchanaraksa, Gooding, Mulder, & Schuwer, 2012).

Recent surveys highlight the OER movement as a common theme among higher education institutions and that higher education leaders' belief in OER as an important educational tool is growing. Results of surveys by the Association of Chief Academic Officers attest to this. Their 2017 digital learning survey indicated that nearly three-fourths (72%) of the provosts and chief academic officers who participated reported that they expected "OER to be a major source of curricular content in five years" (Greene, 2017, p. 9). In addition, four-fifths (81%) of chief instructional officers who participated in their 2018 Campus Computing Survey believed that "OER course materials and textbooks will be an important source for instructional resources in five years" (Greene, 2018, p. 6). Two-thirds (64%) of chief instructional officers

reported that their campus "encourages faculty to use OER content in their courses" (Greene, 2018, p. 6). This is 30 percentage points higher than in 2014. Though Greene (2018) indicated awareness and enthusiasm for OER among faculty is lower than their administrators, the positive attitudes of instructional officers is spurring OER's growth among the faculty ranks, including those in community colleges.

Growth in Community Colleges

The OER movement has spread to community colleges. The American Association of Community Colleges (2017) reported that since the implementation of Tidewater Community College's no-cost degree in business or *Z-degree* in 2013, community colleges across the country have been supporting faculty adoption and creation of OER. This is being accomplished in various ways. Examples include support from organizations such as Achieving the Dream, whose Open Education Resources Degree Initiative has been aiding OER efforts at Peirce College in Washington, the first state to have implemented a statewide OER initiative. The Open Oregon initiative, funded primarily by the Oregon state legislature, has a $200,000 grant program under way, which is funding the adaption, revision, and creation of OER courses. Philanthropic foundations such as the William and Flora Hewlett and the Gates Foundations support efforts at the statewide and institutional levels as well.

Community colleges across the nation differ greatly in the extent of their use of OER. Though some states, such as Oregon, are tracking the development of OER statewide, there is no national data tracking concerning the use of OER. Therefore, it is difficult to know how widespread use has become. However, the Community College Consortium for Open Educational Resources' website currently states that the "Open Education Consortium is composed of over 250 community and technical colleges representing individual, regional, and

statewide consortia members in 17 North American states and provinces" (Open Education Consortium, n.d., para.1). Less is known about the state of OER implementation than other educational variables speaks to its nascence as well as the need for additional study. It may also be helpful to have a better understanding of how OER is implemented at community colleges.

Implementation at Community Colleges

What does adoption of OER mean for community college practitioners? Generally, OER is used much the same as a traditional course textbook or supplemental course material. They are listed in an instructor's course syllabus and, when adopted in discipline departments, may be listed in the course outline of record. Rather than accessing OER via the campus bookstore, most often OER course materials are provided by the instructor to students via a link to an online document or website.

Another important distinction between traditional textbook-based course materials and OER is that OER is licensed, such that it provides users with free and perpetual permission to engage with the material much differently than copyrighted work. When faculty decide to create or adopt OER course materials in place of traditional cost-bearing publisher-produced textbooks, they use this open permission to take advantage of any or all of several key features, known as the *5R Activities of OER*, coined by David Wiley (n.d.). These are:

- Retain: Faculty may make, own, and control their copy of the content, for example downloading, duplicating, storing, and managing the material.
- Reuse: Faculty may adopt OER created by others and use the content as-is, for example, in a class, in a study group, on a website, or in a video.
- Revise: Faculty may adapt, adjust, modify, improve, or alter the content of existing OER, for example, translating it to another language.

- Remix: Faculty may combine the original or revised content with other OER to create something new, perhaps to fit a unique set of course objectives or a particular group of learners.
- Redistribute: Faculty may share copies of the original content, revisions, or remixes with others, perhaps sharing the material with other faculty.

Faculty take advantage of these positive features in various ways, and there is little uniformity as to how faculty integrate OER into their courses. Chae and Jenkins (2015) describe this variation. While many faculty adopt OER as a replacement for commercial textbooks, others may use OER only as a supplement to their course and commercial textbook. Some unintentionally do so by, for example, exploring the Internet to find YouTube videos to help explain or demonstrate a particular concept or skill, unaware of the material's copyright status. Others intentionally use OER as a way to transition away from what they see as the limiting nature of a textbook format altogether. These faculty wish to use OER to respond to student needs in real time, making constant and immediate changes to maintain topical content. This diversity is a defining characteristic of OER that many faculty find exciting and others find intimidating. The California community college system is hoping to cultivate this excitement among its faculty.

Growth and Implementation at California Community Colleges

As mentioned previously, OER is being used by faculty in a variety of ways to enhance the teaching and learning experience and to lower costs for students. The state of California's public higher education system hopes to harness this energy and expand it statewide. Driven by the high cost of education for students and their families and a desire to make access to education

more equitable, state community college systems have forwarded initiatives and promoted related legislation to expand the use of OER in the classroom.

In 2007, the Foothill-DeAnza Community College district founded the Community College Consortium for Open Educational Resources (CCCOER), whose mission is "to promote the adoption of open education to enhance teaching and learning at community and technical colleges" (Community College Consortium for Open Educational Resources, n.d., para.4). With support from the William and Flora Hewlett Foundation, the CCCOER has expanded to 87 member colleges nationally and joined the global Open Education Consortium. The CCCOER also partners with the national nonprofit championing institutional improvement, Achieving the Dream, as well as the California Community College's Zero-Textbook-Cost Degree Technical Assistance Program.

According to the Academic Senate for the California Community Colleges, California expanded its investment in OER in 2012 with two pieces of legislation, which, for all intents and purposes, was an effort to reduce textbook costs (Aschenbach, Crump, & Davidson, 2015). The two bills called for the establishment of an open education resources council and a digital open-source library, toward which the legislation apportioned $5,000,000. Matching funds were awarded from the William and Flora Hewlett Foundation and the Bill and Melinda Gates Foundation.

Legislation supporting this effort, Assembly Bill 798, otherwise known as the College Textbook Affordability Act, was enacted in 2016 to empower "professors and local campuses to adopt high quality, free and open educational resources for courses materials," (California Open Online Library for Education, n.d.). Further, the Chancellor's Office described this bill as being intended to support faculty in choosing more flexible and dynamic alternatives. Additionally,

Senate Bill 1359 was intended to help students understand how to access courses with free resources or OER (California Community Colleges Chancellor's Office, n.d.). OER is defined in the California legislation as:

> high-quality teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license, such as a Creative Commons license, which permits their free use and repurposing by others, and may include other resources that are legally available and free of cost to students. 'Open educational resources' include, but are not limited to, full courses, course materials, modules, textbooks, faculty-created content, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge. (S.1359)

This definition is very similar to that put forth at UNESCO in 2002, which sparked global action toward freely accessible education (Atkins et al., 2007), as well as that stated by the William and Flora Hewlett Foundation.

More specifically, the provisions of Senate Bill 1359 required that all California community colleges and California State universities have student-focused information on how to access courses utilizing OER in place by January 1, 2018. Since that time, California community colleges, including that in this study, have been publicizing to students via the online schedule of classes which course sections offer OER.

Announcing to students which courses offer OER is accomplished via an icon that appears next to each class section on the list of all class sections in the online schedule of classes. Thus, students can see prior to registration which courses require them to purchase a textbook. This allows them to make enrollment decisions that are not only informed by logistical convenience (class time and day) or preference for particular instructors but financial impact as

well. Students can thereby determine the priority level of cost savings in their journey to attain a college education, which is an important factor in evaluating the justifications for OER.

Rationales for OER Adoption

The rationales for OER adoption are numerous. As cited by the Center for Educational Research and Innovation, OER has the potential to harness digital technology to address common educational challenges, serve as a catalyst for innovation, and change the ways teachers and students interact with knowledge, as well as improve access to high-quality educational materials (Orr, Rimini, & van Damme, 2015). The educational challenges that have most often been cited in the literature, especially as they relate to this study and California community colleges, are the high cost of education, barriers to learning for diverse populations, and inequitable student educational outcomes. How OER serves to address these challenges via its impact on curriculum and pedagogy, the cost of education, and equitable student success is the topic of the remainder of this section.

OER Enhancements to Curriculum

In addition to the cost benefits to students associated with the adoption of OER, there are several enhancements to course materials. As discussed below, studies demonstrate that students value OER's widened accessibility, which is especially helpful to low-income students. Faculty comment on the benefits of OER being a collaborative and customizable source of information sharing, representing for them a pedagogical shift, and for students, educational opportunity. Whether faculty are aware of it or not, these benefits also represent a greater alignment with societal and workplace skill trends.

Accessibility

The impetus for expanded use of OER, as stated in the Paris OER Declaration of 2012 (UNESCO), was,

> ...to widen access to education at all levels, both formal and non-formal, in a perspective of lifelong learning, thus contributing to social inclusion, gender equity and special needs education. Improve both cost-efficiency and quality of teaching and learning outcomes through greater use of OER. (p. 2)

Cost is a significant factor in access; absent the barrier of cost, accessibility increases. Lane and VanDorp (2001) discussed OER's potential to serve as a bridge from informal to formal education, allowing those without the capacity to enroll in higher education access to materials they otherwise would not; this may also build the confidence of potential college students in their ability to participate in higher education. This greater confidence is due in part to the expansion of time students can study; OER can be studied at any time or place as long as they are accessible by the user. Students cite accessibility as one of the key positive OER features (Grissett & Huffman, 2019; Petrides, Jimes, Middleton-Detzner, Walling, & Weiss, 2011; Ross, Hendricks, & Mowat, 2018).

OER resources can be accessed ubiquitously by an infinite number of people and are infinitely replicable. OER is abundant and does not experience wear and tear eliminates issues of physical scarcity. Hylén (2007) stated that it is in this way – free and abundant accessibility – OER has the potential to promote the dissemination of knowledge more widely, thereby speeding personal development, societal development, the quality of education, and the reduction of societal inequity. Faculty who adopted OER in the Washington state community college system

expressed that they were motivated to do so for reasons of equity, because of a philosophical belief in educational opportunity for all (Chae & Jenkins, 2015).

OER is not only more widely accessible to students, but to faculty as well. This can engender greater efficiencies in the development and revision of OER; communities of practice among discipline faculty can lead to faculty sharing resources and ideas that allow for extended use, configuration, and updating of materials. Revision and sharing can potentially be done in real-time with the use of shared document platforms. Not only is local sharing possible, but, because OER is characterized by open licensing, educators can access materials developed by other educators anywhere in the world. This expands communities of practice on a global scale, giving educators a networked wealth of content from which to draw upon to make the learning experience of their students the best it can be. Indeed, Harley et al.'s (2010) study of faculty perceptions of OER highlight that community college faculty in particular (as opposed to public four-year higher education faculty) viewed the development of OER as a collective rather than an individual effort. This bent toward collective information development and dissemination aligns with the societal challenges the Information Age presents (Mancinelli, 2008). In addition, in the OER development process, faculty use, remix, and create educational materials. Thus, their ability to actively engage with accelerated, globalized, and complex information is also enhanced (Tosato & Bodi, 2011). When this concept of shared knowledge development is expanded outward to students, their skills in this area are fostered as well.

Customization

Because OER is "teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited

restrictions," faculty who adopt OER have unlimited options for customizing learning materials for the courses they teach (United Nations Educational, Scientific and Cultural Organization, 2012, p. 1). OER appeals to faculty who appreciate its fluid and flexible nature, which they believe provides a greater degree of pedagogical freedom (Chae & Jenkins, 2015) and they take advantage of this feature (Atkins et al., 2007; Bliss et al., 2013; Petrides et al., 2011). Faculty do this in various ways. Examples include: rearranging sections of the content to suit their particular teaching preferences or that of their students, removing irrelevant sections or adding content they or even students provide, or posting links to portions of the OER they would like to upload to course websites.

In the Information Age, innovation is not a discrete activity relegated to solitary inventors once learned about, such as Thomas Edison or Benjamin Franklin tinkering alone in a lab. Today, innovation arises from our natural, universal need to adapt and to process the vast amounts of information available to us. The world has now become:

> increasingly knowable and the opportunities for innovation have kept pace with the need to innovate. Once it became possible to encode information in digital form and thence transmit it, the gathering, arrangement, and processing of information has become much easier as has the potential to collaborate in these activities. (Holczer, 2008, p. 94)

Given the view that community college faculty see the development of these resources as a collaborative effort, and that collaborative knowledge sharing and development align with the globalized economy and world of work, there is much to be gained from OER (Harley et al., 2010).

Updated Pedagogy

Teachers' pedagogical practice is influenced by this concept of collaborative knowledge generation. These conceptions are reflected in student learning; however, students also bring with them prior knowledge, experience, and alternative approaches to knowledge and learning. "Pedagogical strategies that recognize this and that harness students' experience and existing knowledge tend to enhance the academic engagement of students in mixed groups" (Hockings, Brett, & Terentjevs, 2012, p. 239).

Acknowledging this enhancement to student engagement, some faculty also extend the customization and curation of course materials and knowledge sharing to their students and/or cite this as a natural outgrowth of the use of OER (Petrides et al., 2011). Through this, faculty provide students a role and foster their skills as authors and designers of knowledge in the discipline. Community college faculty who have adopted OER in Washington state perceive greater active engagement with the course curriculum (Chae & Jenkins, 2015). Livingston and Condie's (2006) study of Scottish students' use of OER demonstrated greater engagement in self-initiated and self-directed learning, in which students transitioned from passive knowledge recipients into independent knowledge creators. This provides students with real-world skills they will use outside of academia and the opportunity to be competitive in the global marketplace. It also helps them to interpret the big data-based information they are presented daily. In the global marketplace new skills are in demand: cooperation of an interdisciplinary group of qualified people developing novel ways of joining together and applying existing information and knowledge as well as producing new information and knowledge (Fang et al., 2015; Holczer, 2008). The use of OER helps develop these skills.

Faculty attest to OER's inherent nature, the use of OER has positively impacted their teaching practice (Bliss et al., 2013) and has many potential pedagogical advantages. Robinson, Fischer, Wiley, and Hilton (2014) discussed OER's potential to change faculty engagement patterns with course curriculum via the development of this form of customized learning material. Recker et al. (2007) showed that the use of online resources, such as OER, increased teachers' capacity for designing learning activities and had "positive impacts on teachers' knowledge, attitudes, and subsequent behaviours using online learning resources" (p. 1). OER's impact on teaching is also supported by findings from a research project conducted at six United States community colleges by Farrow and Daly (2014). Faculty adopting OER indicated their teaching was impacted positively, chiefly in regard to comparing their teaching with that of others, having more up-to-date knowledge of their subject area, using a broader range of teaching and learning methods, collaborating more with colleagues, and making more use of culturally diverse resources. For example, instructors who use digital content can add hyperlinks within their course material or use learning management systems that can guide students to very specific areas of content, such as a particular page or passage. Oftentimes, it is shown that in an OER environment this content is provided by the students themselves (Chae & Jenkins, 2015). OER is also extremely simple to modify in real-time, thus enabling instructors to customize their content to reflect real-world or current events, make updates and mix, modify or change the content in whatever way desired to meet specific learning needs. This is also facilitated by that faculty may easily draw upon other digital resources.

Though a 2016 National Higher Education Report indicated that only 25% of faculty reported being "aware" or "very aware" of OER and that only 5.3% of courses were using OER; this is up 20% over the previous year's study (Allen & Seaman, 2016; Allen & Seaman, 2015),

and much higher than 7% of Florida faculty and administrators who were familiar with OER in 2012 (Morris-Babb & Henderson, 2012). Though not all faculty have the skills, knowledge, and/or confidence to implement more student-directed learning and knowledge generation, exposure to this pedagogical approach will lead to greater awareness, acceptance, and expansion thereof. This expanded awareness may be occurring at an optimal time, as community college students and the California community college system face additional significant challenges.

Addressing the Cost of Community College Education

The cost of a community college education has risen, especially as a proportion of income (American Association of Community Colleges, 2017). It is estimated that the cost per year of attendance at public community colleges including living expenses is approximately $5,000 to $12,000 (Cochrane & Ahlman, 2017). In fact, community college students cite paying for college as the top reason for not succeeding (Porter & Umbach, 2019). Given this, the demographics of the typical urban community college student, and the mission of community colleges as "...centers of educational opportunity . . . inclusive institutions that welcome all who desire to learn, regardless of wealth, heritage, or previous academic experience," higher education leaders, philanthropists, faculty, and others are seeking to lower this cost (American Association of Community Colleges, 2004, p. 1). Among the costs incurred is that of textbooks, which has risen more than double the rate of inflation from 1986-2004 (Bliss et al., 2013; Usdan & Gottheimer, 2012), outpacing the price increases of all goods and services by almost four times (Perry, 2016). Community college students spent an average of $900 per year on textbooks in 2005 (United States Government Accountability Organization, 2005). Since then, the cost has grown tremendously; the United States Public Interest Research Group (n.d.) cited $1,200 per year, which the College Board stated rose to $1,440 in 2018-2019, nearly a 60%

increase. Both faculty and students are frustrated with this costly phenomenon (Harley et al., 2010).

The cost of textbooks is particularly significant for community college students. Provasnik and Planty (2008) found that graduating high school seniors with a lower socioeconomic status who enrolled in college were more likely to attend a community college than their wealthier peers. This is corroborated by Bailey, Jenkins, and Leinbach (2005), who found that 55% of community college students are from the two lowest income quartiles compared with 38% of public 4-year students. A more recent Pew Research Center study indicated that the share of community college students impacted by poverty is growing, and increases in the number of poor undergraduates has been most pronounced at community colleges (versus other sectors of higher education), where from 1996 to 2016 the percent of dependent undergraduates has increased from 13 to 27% (Fry & Cilluffo, 2019). Though it may seem obvious, not all are aware that low-income students who choose to attend community colleges make this selection based on its affordability (National Center for Public Policy and Higher Education, 2011).

For the typical southern California community college student, the proportion of income required for community college attendance is high, and the number of students affected by this is higher than in any other state. California is first in the nation in terms of the number of working low-income families; more than a third of California's working families are considered low-income, earning less than $45,397 a year for a family of four in 2011 (Tran, Siqueiros, & Dow, 2013). For families with incomes of $30,000 or less, the cost of a two-year public college accounts for 45% of total annual income (Cochrane & Ahlman, 2017). This does not take into

consideration the costs incurred by the large numbers of students living at home, thereby greatly understating many students' net price and affordability challenges.

The price of textbooks represents a significant cost to these families. In California during 2007-2008, textbooks accounted for 59% of the total cost of attending community college (Goodwin, 2011). When forced to make choices due to financial constraints, students may choose not to purchase expensive textbooks (Buczynski, 2007). Without access to course materials, success is severely hampered for these students.

Addressing Student Equity and Success

Student success is a major focus for California's community colleges, and equitable success is at the heart of current key initiatives aimed at addressing the serious achievement gaps that persist across the state, especially in high-need regions. This is not only an altruistic goal but one that has impacts on the state economy as well. In order to fill state workforce skill gaps, the state will need to graduate more students from historically underrepresented groups (Rodriguez, Mejia, & Johnson, 2017). The system office for California Community Colleges' Vision for Success has a goal of reducing achievement gaps by 40% within five years and closing the gaps within ten (California Community Colleges Chancellor's Office, 2017). The system office stated that "College student equity plans focus on increasing access, course completion, ESL and basic skills completion, degrees, certificates and transfer for all students" (p. 1). It also stated that various metrics are used to "identify and measure areas for which disadvantaged populations may be impacted by issues of equal opportunity" (p. 1). Legislation specifies that colleges must review and address the following populations when looking at disproportionate impact: American Indians or Alaskan natives, Asians or Pacific Islanders, Blacks, Hispanics, Whites, men, women, persons with disabilities, foster youth, veterans, and

low-income students. Each college must develop plans, policies, activities, and procedures to improve equity and success at the college (Chancellor's Office California Community Colleges, 2019).

OER is one solution being proposed to address the issue of equity and success in higher education. Because it is low or no-cost and more accessible, it helps to "expand access to learning for everyone, but most of all for non-traditional groups of students, and thus widen participation in higher education" (Organization for Economic Cooperation and Development, 2007, p. 9). Expanding free access to knowledge aligns with the concept of inclusive and equitable education. Numerous studies illustrate the potential of OER in developing countries to equitize access to knowledge and education, thus expanding economies and scientific productivity (Duart & Mengual, 2014). OER decreases the gap between the knowledge "haves" and "have nots." Indeed, the William and Flora Hewlett Foundation's goal for investing in OER was to

> Catalyze universal access to and use of high-quality academic content on a global scale. ...to expand people's substantive freedoms through the removal of 'unfreedoms': poverty, limited economic opportunity, inadequate education and access to knowledge, deficient health care, and oppression. (Atkins et al., 2007, p. 1)

In short, the organization wished to equalize access to knowledge and educational opportunities around the world.

OER's fundamental purpose or underlying principle, therefore, is social inclusion (Dos Santos, 2008; Geser, 2007). Social inclusion is about equity (Willems & Bossu, 2012), and it is defined as the opportunity for individuals or groups to "access available education, professional, economic and/or political opportunities" (Mancinelli, 2008, p. 243), and, as pointed out by

Kozinska et al. (2010), many people are hopeful OER will positively impact social inclusion in higher education. It is also seen as a potential solution to many of the challenges facing higher education, including globalization, an aging populace, competition among higher education institutions, and the rapid pace of technological development (Organization for Economic Cooperation and Development, 2007).

OER Efficacy and Faculty and Student Perceptions

In order to determine whether OER is an effective way of creating more equitable student success, it is important to study its effects and review what studies have been conducted related to student and faculty perceptions of OER and student outcomes for those who use OER. A review of the effects, outcomes, and perceptions of OER is salient not only for those interested in studying OER's impacts both studies students but also for helping potential faculty OER adopters to understand its efficacy.

Hilton et al. (2016) produced much work in the area of assessing the impact of OER on learning outcomes as well as reviewing that of many others. What they found in their review of 16 studies was that faculty and students were generally positive in their perceptions of OER and that students in classes utilizing OER are able to reach the same learning outcomes as those who use traditional textbooks while at the same time saving significant amounts of money (Hilton et al., 2016). However, because of the challenge of creating truly randomized studies, controlling for other factors that confound any measure of student success and potential biases of faculty using OER, all studies must be seen as limited.

Perceptions

As mentioned earlier, OER has positive impacts on faculty teaching practice (Bliss et al., 2013; Farrow & Daly, 2014; Recker et al., 2007; Robinson et al., 2014). There are also a large

number of studies on student and/or faculty perceptions of OER both qualitative and quantitative, the vast majority of which found that students believe OER resources are comparable to traditional textbooks if not superior. In general, the studies' authors also found that faculty perceive OER to have no negative impact on learning.

Both Feldstein et al. (2012) and Hilton and Laman (2012) conducted surveys of nearly 2,800 students. In both studies, students agreed that open education resources were easy to use and provided access to more up-to-date material than was available in their print textbooks. Students also reported that open education resources were more useful than and preferable to traditional textbooks in the Feldstein et al. (2013) study. In the study by Hilton and Laman (2012), students also said they would recommend the OER to their classmates and that, overall, OER materials adequately supported the work they did outside of class.

Petrides et al. (2011) surveyed and conducted focus groups with a much smaller set of students and faculty at community colleges throughout the United States to determine that students preferred OER over traditional texts because it is easier to use and that faculty's decision to utilize OER was based primarily on cost savings to students. Via questionnaires, interviews, and focus groups of community college and university students and faculty, Pitt, Ebrahimi, McAndrew, and Coughlin (2013) found that 79% of students generally reported satisfaction with the quality of the OER and that they would recommend it to other students. Faculty involved in the study reported that 95% of their students mastered the subject of the course, and 90% had mastered *deeper learning*. Of interest to community college practitioners is that a slightly higher percentage (96%) of students from low-income backgrounds mastered the content. However, a very low response rate decreased the impact of this study.

Bliss et al. (2013) conducted studies at seven colleges, including five California community colleges, participating in a large scale OER initiative. Using online questionnaires, they found positive results from both teachers and students who reported various pedagogical and learning impacts due to the implementation of OER. Most students and teachers perceived the OER used to be at least equal in quality to traditional textbooks, and faculty reported that their students were more engaged and interested in the course material. This gave these teachers more opportunity to expand on assignments, assessments, and content. Importantly, students reported experiencing significant cost savings as a key reason for their satisfaction with OER.

Lindshield and Adhikari's (2013) follow-up study to their 2011 study of Kansas State University's use of OER in a human nutrition course resulted in the collection of 2 years' worth of student survey data (from 198 students) showing high levels of satisfaction with their OER, including its quality, ease of use, and related cost savings. They also reported students' preference for OER over a traditional textbook.

Allen and Seaman (2014) surveyed a large, nationally representative group of 2,144 higher education faculty, some of whom had used and some who had not utilized OER. Their findings indicated overall positive results: 61.5% of respondents felt OER had a similar quality to traditional resources, with 12.1% stating that OER were higher quality. The efficacy of OER and traditional materials were approximately the same for 68.2 %, while 16.5% said that OER was more efficacious.

More recent studies, including Lawrence and Lester's (2018) survey of students who used an OER for an American government class at Middle Georgia State University, showed mixed results. Contrary to most of the other studies listed, null to slightly negative satisfaction was reported. However, the authors warned that this may be related to the OER used was a

single text in a field where few resources from which faculty could select existed. Though the researchers sought through course success data to further inform their efforts, findings were very much confounded by other factors.

Results of Ross et al.'s (2018) study of students in a Canadian university's introductory sociology course counter Lawrence and Lester's (2018) findings and support most previous work cited. In this study, students perceived the quality of their OER positively, with 73% rating it as "above average" or "excellent," compared to textbooks they had used previously. Once again, the most important feature of OER was cost savings, followed by immediate access, then convenience and portability.

Ross et al. (2018) summarized the findings of research in this area generally: students were satisfied with OER texts and greatly appreciated the ease of access, portability, and most importantly, cost savings. With the cost of education rising and potentially impeding students from taking the courses they need to complete their educational goals, looking at the impact of these savings may have on students' course-taking patterns is warranted.

Outcomes One of the first published studies comparing learning outcomes for students randomly selected to use either traditional or OER course materials was by Lovett et al. (2008). It is significant that the authors used randomization in an effort to conduct an experimental study design. While there were several limitations and confounds, Lovett et al. (2008) found no significant difference in in-class exam scores for both sets of students taking an introductory statistics course. Bowen et al.'s (2012) study expanded upon that conducted by Lovett et al. (2008) by including a larger sample; Bowen conducted a randomized study with statistics students across six public universities. Though they attempted to collect data from three community colleges as well, they were unable, and therefore cautioned their findings may not be

applicable for this milieu. However, similar to community college student populations, the student participants were very diverse, half coming from families with incomes of $50,000 or less, half being first-generation college students, with less than half of the participants being White. Bowen et al. (2012) found that there were no statistically significant differences in the learning of both groups of students as measured by course completion, course grades, and performance on a national test of statistical literacy.

One community college's adoption of a free online psychology textbook in 23 sections of introductory psychology was studied by Hilton and Laman (2012). Compared to students using a traditional text, the 690 students who used the free online textbook scored higher on departmental final exams, had higher grade point averages in the class, and higher retention rates. Though no attempt to assess statistical significance was done and there were significant limitations, this study is notable as it is focused on a diverse community college.

Another community college-focused study was conducted by Hilton, Bliss, Robinson, and Wiley (2013) in Arizona where faculty in five different mathematics courses adopted OER. Compared to the 2 years prior to the adoption of the OER, there was no statistical difference found in the number of students who withdrew from the courses and those who completed the courses with a C grade or better.

A larger study of seven colleges, including five California community colleges, found mixed effects on student outcomes (Robinson, 2015). This was the first to show a negative effect on course grades, though the significance was relatively small. This study's results highlighted that perhaps not all OER are created equally and certainly not a panacea for the issues of student success. However, a second finding of the study was that during the semester, students in OER courses enrolled in a significantly higher number of credit hours than students

in courses using traditional textbooks. Though the difference between the two groups was relatively small at .27 credits, the results appeared to show that for some students, being relieved of the burden of textbook cost has a positive effect on their ability to pursue an additional number of courses.

How students use the cost savings resulting from OER adoption was the focus of Ikahihifo et al.'s (2017) survey of students using OER at a Virginia community college. Their study revealed that students reinvested the savings from OER in their education. Robinson's (2015) study reinforced this evidence. The increase in enrollments is important for two reasons: it is associated with accelerated academic progress and increased the likelihood of persistence and completion (Calcagno, Crosta, Bailey, & Jenkins, 2007), and, as Robinson (2015) reminded us, increased enrollments can increase revenue for community colleges. Wiley, Williams, DeMarte, and Hilton (2016) found that drop rates were significantly lower for Tidewater Community College students in courses utilizing OER than those in courses that did not, which translated to a dollar figure representing the potential institutional cost savings for one program's adoption of OER.

Winitzky-Stephens and Pickavance (2017) examined OER's impact on course grade, the likelihood of passing, and the likelihood of withdrawing at a Utah community college. Controlling for the student, instructor, and course effects, no difference was found between courses using OER and traditional textbooks for continuing students. For new students, they found evidence that OER increased average grade. At the same time, they cautioned that "demographic background and educational experience had a far greater impact on course grade and the likelihood of passing or withdrawing than an instructor's use of an OER text" (p. 35).

The authors called for future research focusing on the longer-term impacts of OER on retention, completion, and transfer.

Although the effects on student course success rates may be seen as neutralized by the many factors impacting a student's success in any given OER course studied, other significant impacts of OER, namely, cost savings, cannot be questioned. The few studies linking cost savings and student course-taking patterns represent a need in this area. Therefore, the aim of the present study was to investigate the link between enrollment in cost-saving OER courses and the number of credit hours in which students enroll.

CHAPTER THREE

METHOD

The adoption of open educational resources (OER) is being promoted by the California Community College (CCC) system office and state legislative action; through OER adoption policymakers are seeking to make higher education more accessible and equitable for California's lower-income and diverse student populations, to meet economic demand through the education of these groups and improve community college completion rates. The primary and most immediate impact of OER is critical cost savings to students; this is well-documented. However, secondary impacts such as how students use those cost savings are not. Some evidence indicates that students apply savings from OER in such a way that it allows them to take additional credit hours. Other studies have shown a positive correlation between increased credit hours and completion. If enrollment in classes utilizing OER leads to increased credit hours, OER may also impact the rate at which students complete their educational goals.

The aim of the present was to investigate the link between enrollment in OER courses and the number of credit hours in which students enroll. A quantitative analysis of student data from one southern California community college was used to investigate possible differences between student enrollment in classes utilizing OER and the number of credits in which they enrolled compared to students who were not enrolled in OER classes. Two data sets were utilized: a) de-identified student class enrollment and demographic information from the Fall 2018 and Spring 2019 semesters, and b) data on classes utilizing OER from Fall 2018 and Spring 2019.

The researcher sought to answer these questions:

1) Is there a statistically significant difference in the number of credit hours in which students enroll between students who enroll in any courses utilizing OER and students who do not enroll in any courses utilizing OER?

The hypothesis for research question 1 was that students who enroll in any courses utilizing OER will enroll in greater numbers of credit hours than those who do not.

The researcher also sought evidence for any type of compounded effect – that is, whether students who enroll in multiple OER classes are more likely to enroll in more credit hours than students in only one OER class. Therefore, the second research question:

2) Is there a statistically significant difference in the number of credit hours in which students enroll between students who enroll in one course utilizing OER and students who enroll in two courses utilizing OER?

The hypothesis for research question 2 was that students who enroll in two courses utilizing OER will enroll in greater numbers of credit hours than those who enroll in only one course utilizing OER.

The results of these questions provide practitioners information to inform and/or justify OER adoption, as well as add to the limited research in the field.

The remainder of this chapter is organized as follows: a rationale for the methodology used, a description of the research design, population and samples, procedures used to determine the samples, instrumentation used, how the data were collected, an analysis of the data, validation of the findings, and a discussion of limitations.

Rationale

Via a quantitative approach, the present study applies an ex-post-facto quasi-experimental design to investigate the possible link between enrollment in classes utilizing OER and the number of credit hours in which students enroll in a single southern California community college. This approach is appropriate for the type of data being evaluated in order to answer the research questions. Previous studies of this link, such as that conducted by Robinson (2015), found that students enrolled in OER courses enrolled in a small but significantly higher number of credit hours than those in courses utilizing traditional course materials. Robinson (2015) also applied an ex-post-facto quasi-experimental research design to study this phenomenon across seven colleges in multiple states. His findings suggest there is evidence that OER adoption can provide a significant benefit to students. However, due to the nascence of the OER movement in community colleges, more research on this phenomenon and the variety of effects it may have on students' education experience is needed. Therefore, as is called for in Robinson's (2015) suggestions for further research, this study also explores whether observed effects on enrollment intensity are additive – that is, does enrollment intensity increase as students enroll in multiple OER courses in the same semester?

To address this, student data from the institutional research office of one southern California community college was utilized. Each term, the college in question regularly collects a large set of individual student data on all students. During the period of this study, there were approximately 25,000 students per term. This data set includes the courses in which students enroll, the number of credit hours in which they enroll, their grades, and demographic data such as ethnicity, sex, first-generation status, Pell Grant status, and Board of Governors' Grant status. Since January 2018, the college has also collected records of which individual class sections

offer OER as the primary course materials each term via the schedule of classes. This data were ideal for this study since it includes all students enrolled at the college as well as all class sections offered each term, making the data representative of all students and class sections during the period under investigation. The OER status of the class section offered a purely categorical data element, allowing clear identification of this independent variable. The student data set also allowed one to clearly specify the number of credit hours for each student in the OER and non-OER class sections and determine any differences between the independent variable of the presence of OER and credit hours. Because the overall goal of this study was to make predictions regarding OER by demonstrating relationships among each of these variables, a quantitative research approach was taken.

Research Design

Following Robinson (2015) and much of social research, an ex-post-facto design was used (Shadish, Cook, & Campbell, 2002). Salkind (2010) explained that this type of after-the-fact investigation is used as a substitute for true experimental design in cases such as this wherein study data is taken from phenomenon that has already occurred without interference from the researcher and in a situation in which it was not possible or practically or ethically acceptable to manipulate the characteristics of human participants. As the data for this study was taken from past class schedules and previously collected student data, this design is appropriate.

The study is descriptive in that its intent is to provide a picture of the current state of the phenomenon as it exists in the institution studied, as well as explanatory in that it attempts to help practitioners understand the effects of OER on credit intensity (Johnson & Christensen, 2012). Ex-post-facto or causal-comparative analysis is that in which the researcher seeks to find relationships between independent and dependent variables after an action has already occurred

and to determine whether the independent variable affected the outcome (Salkind, 2010). In this study, a causal-comparative analysis was conducted in which the categorical independent variable was the presence of OER (student enrollment in any course utilizing OER), and the dependent variable the number of credit hours in which students enrolled. The presence of a relationship between OER and credit hours, multiple OER course enrollment, and increased credit hours was sought.

Population and Sample

The population is defined by Johnson and Christensen (2012) as the set of all elements or the large group to which a researcher wants to generalize his or her sample results. The population in this study consists of all students enrolled in the Fall 2018 and Spring 2019 terms at the focus institution, a large, urban community college located in southern California as indicated in their student data set. Per the institution's published online *College Facts,* approximately 25,000 students constitute the overall population, of which 67% indicate they are Hispanic, 18% Asian, 17% African American, 16% White, 1% Pacific Islander, and .8% American Indian/Alaskan Native, with the remainder unknown/decline to state (Long Beach City College, 2019b). Seventy-four percent of the population receive some form of financial aid (Long Beach City College, 2019b), indicating that cost savings of OER are critical to this population.

Johnson and Christensen (2012) went on to define sampling as the process of drawing a sample from the population to be studied. Samples in the study were drawn from all students who enrolled in courses in the Fall 2018 and Spring 2019 terms. To address the first research question, the samples included the treatment group, all students in those terms that enrolled in any credit-bearing classes that utilized OER, which was compared to the control group, all

students who enrolled in any classes that did not utilize OER (utilized traditional textbooks/course material). To address the second research question, two additional samples were drawn from the treatment group (students who enrolled in any classes utilizing OER), which included all students who enrolled in one class utilizing OER and all students who enrolled in more than one course utilizing OER.

Procedures

This study employed a non-probability purposive sampling technique. Per Lavrakas (2008a):

> Sampling involves the selection of a portion of the finite population being studied; nonprobability sampling does not attempt to select a random sample from the population of interest. Rather, subjective methods are used to decide which elements are included in the sample. (p. 523)

In the present study, the samples described previously (students who enrolled in classes utilizing OER, students in classes not utilizing OER) were purposively selected in order to evaluate the current research questions, with that of students who enrolled in classes utilizing OER purposively selected from the data available from the institution.

To strengthen the research design and decrease the chance that the effects of OER on credit intensity were not due to demographic covariates, propensity score matching via logistic regression was applied. This helps overcome the probability of selection bias in the samples and provide stronger evidence of the effects of OER. Propensity score matching minimizes pre-existing differences between treatment and control groups, which can help balance the probabilities of being in either group, thus approximating randomized control trials (Austin, 2011; Luellen, Shadish, & Clark, 2005). Propensity score matching also balances sample sizes

when treatment and control groups differ and will "model the chance of an outcome based on individual characteristics" (Sperandei, 2014, p. 14). In this case, the characteristics, or covariates, used for propensity score matching were age, sex, and ethnicity.

Instrumentation

Instrumentation is defined by Creswell (2014) as detailed information about the survey instrument to be used in the proposed study. No survey instrument was used in this study as it is ex-post-facto; rather, data sets from the institution under study were run through t-tests to compare the control and treatment groups in terms of credit hours.

Data Collection

After obtaining institutional review board approval from both the degree-granting and study institutions, the researcher requested secondary ex-post-facto data from the institution's research office. Written proposals were submitted to the Office of Research and Institutional Effectiveness. Upon approval, the researcher secured electronic student data for the sample selected. The de-identified confidential data were collected and secured by the researcher and used for research purposes only. Again, the data utilized for this study was acquired from existing institutional student data regularly gathered by the college under study as well as institutional class schedule data. The student demographic data are gathered online via the college application process, and the data on OER class enrollments are gathered from the class registration process conducted each term and are drawn from electronic files of past activity. Data includes student and class schedules from the Fall 2018 and Spring 2019 semesters.

Data Analysis

In general, data were analyzed with the support of IBM SPSS Statistics software, and included a two-step analysis process to address each of the research questions: first, identifying

treatment and control groups for each term and both terms combined, conducting t-tests on each of these groups, and second, using propensity score matching for each of the identified treatment and control groups and conducting t-tests on these matched groups. First, students enrolled in credit-bearing classes in the Fall 2018 and Spring 2019 semesters were identified in the student data set. Then, students enrolled in any OER classes were identified, students in one OER class were identified, and those in two OER classes were identified. Descriptive statistics by sex, ethnicity, and age were run in order to get an overview of the data and to ensure that the following analytical procedures were appropriate. This step included frequency tables, sample sizes, and percentages in each category. An example of this was determining the percentage of students who enrolled in at least one OER class. A means or an average number of credit hours in which students in both the treatment and control groups enrolled were calculated. The overview also included determining standard deviations and minimum and maximum values for each of the groups and credit values.

After this, the first research question, is there a statistically significant difference in the number of credit hours in which students enroll between students who enroll in any courses utilizing OER and students who do not enroll in any courses utilizing OER, was addressed via a t-test to compare standard deviations and means of the two groups, both for the two terms together as well as Fall 2018 and Spring 2019 individually. Following this, propensity score matching was used to create a more balanced treatment and control groups and reduce the level of bias that might be caused by covariates including sex, ethnicity, and age. T-tests were then run on these matched groups for the two terms together and individually.

For the second research question, is there a statistically significant difference in the number of credit hours in which students enroll between students who enroll in one course

utilizing OER and students who enroll in two courses utilizing OER, a t-test was conducted to compare standard deviations and means of the two groups for the Spring 2019 term only as no students had enrolled in more than one OER class during the Fall 2018 term. Following this, propensity score matching was used to create a more balanced treatment and control groups and reduce the level of bias that might be caused by other characteristics including sex, ethnicity, and age. A T-test was once again performed using these groups.

Rationale for Statistical Tests

Propensity Score Matching

True experiments are rarely feasible in school settings, however strong research designs can provide a great deal of control and thus closely approximate scientific studies. The What Works Clearinghouse of the United States Department of Education has established standards that describe the methods of evidence-based research designs that allow for strong causal inference. These include quasi-experimental designs that ensure baseline equivalence, which ensures a level of causal inference comparable to randomized trials. One way of doing this is via propensity score matching (Powell, Hull, & Beaujean, 2020).

In ex-post-facto studies such as this, the researcher has no control over how students are assigned the treatment, and therefore there may be large differences in covariates, such as sex or age, which can lead to biased estimates of the effects of the treatment (enrollment in OER). Per D'Agostino (1998):

> Even traditional covariance analysis adjustments may be inadequate to eliminate this bias. The propensity score, defined as the conditional probability of being treated given the covariates, can be used to balance the covariates in the two groups, and therefore reduce this bias. (p. 2265)

This is done by modeling the distribution of the treatment variable given the observed covariates. After this, "the propensity score can be used to reduce bias through matching, stratification (subclassification), regression adjustment, or some combination of all three" (D'Agostino, 1998, p. 2265). Therefore, in this study, propensity score matching was used to control for effects related to demographic covariates of age, sex, and ethnicity, as well as balance sample sizes. To estimate the propensity score, logistic regression was used to predict the probability a student will take at least one OER class based only on their age, sex and ethnicity.

T-Tests

T-tests are commonly used to determine whether the mean of a population differs significantly from the mean of another population. As explained by Siegle (n.d.):

> With a *t*-test, the researcher wants to state with some degree of confidence that the obtained difference between the means of the sample groups is too great to be a chance event and that some difference also exists in the population from which the sample was drawn. (para.4)

In other words, the t-test is run to ensure that the difference that the researcher might find between credit hours of students who took classes utilizing OER, and students who did not, has not occurred by chance. If the "*t*-test produces a *t*-value that results in a probability of .01, we can say that the likelihood of getting the difference we found by chance would be 1 in 100 times" (Siegle, n.d., para. 4).

For this study, the researcher used a significance level of .05, which indicates a 5% probability of rejecting the null hypothesis when it is true. In other words, with a significance level of .05, there is a 5% risk of concluding that a difference exists when there is no actual difference, so one will be 95% sure the results the researchers observed are correct. One "could

say that it is unlikely that the results occurred by chance and the difference one found in the sample probably exists in the populations from which it was drawn" (Siegle, n.d., para.4).

Therefore, a t-test was run to compare the treatment and control groups (students in OER classes and students not enrolled in OER classes) in terms of credit hours. The same was done to determine whether students who took two classes utilizing OER enrolled in a greater number of credit hours than those who enrolled in only one.

Validity Internal validity is defined by Sheppard (2004) as the "confidence we have that the results of a study accurately depict whether one variable is, or is not, the cause of another" (p. 123). It can also be described as how certain individuals are that a study has established a cause-and-effect relationship between two variables. Due to the number of possible confounding variables, the heterogeneous nature of the population and samples, and the non-experimental study design, establishing a causality was not possible. However, this is true of most educational research. Some concerns of internal validity were addressed via the statistical analysis described previously – e.g. t-tests and propensity score matching. Though all internal validity concerns cannot be addressed, in combination with results from other work, this study informs and adds to other evidence in the field and a nascent and growing body of OER research.

Whether the results of this study can be generalized or applied to students and settings outside of the study is a matter of external validity (Lavrakas, 2008b). While this study is intentionally focused on students at one southern California community college, the results are informative to educational practitioners at institutions across the state that are also working toward implementing this system-wide initiative, especially those with similar demographic profiles. It is also an addition to the small but growing body of national and international research on OER.

Assumptions

Assumptions are the tenets, principles, and concepts the author takes for granted in conducting a study. Philosophically, this study is transformative in nature, generally adhering to the worldview of researchers and theorists that draw upon the work of Marx, Adorno, Marcuse, Habermas, and Freire (Neuman, 2009). The author assumes that this study is worthy of research in order to contribute to reduced disenfranchisement and imbalanced power relationships due to educational and socioeconomic status. The author assumes that by conducting a study in order to determine the extent to which those oppressed by poverty and lack of education may become less marginalized by the implementation of OER via California community college policy and state legislation, she will contribute to transformative ends, and will align with the principal tenets of the transformative worldview as described by Mertens (2010).

Additionally, the author assumes the following:

1. Data collected in the samples used are accurate and representative of the community college population of students at the focus college.
2. The information contained in the class schedule is complete and that any courses marked as "ZTC" utilized OER as the primary course materials.

Limitations

Mauch and Park (2003) describe a limitation as "a factor that may or will affect the study but is not under the control of the researcher" (p. 114). For the present study, these include:

1. Non-experimental design – students were not randomly assigned to courses with or without OER, and therefore some selection bias may exist in that particular type of students may tend to select courses marked as OER classes in the schedule of classes.

There are limitations due to OER is in its nascent stages of implementation in the state and at the college being studied, namely:

2. The number of OER class sections and types of courses (disciplines) represented in the data set is relatively low compared to the overall number of class sections and disciplines offered at the institution, providing a limited data set.

3. There may be some human error in the reporting of class sections with OER. Some class sections included in the OER class section data may not be complete or may be inaccurate since not all faculty fully understand what constitutes OER.

Additionally,

4. Students self-report much of the demographic data, which therefore may contain inaccuracies. This would limit somewhat the generalizability of any results.

Summary

In order to address the research questions in this study related to relationships between OER and credit hour intensity, previously collected data from student records and class schedule characteristics were used. Though the gold standard in cause-effect relationships is true experimental research, in this case, it was not possible. Therefore, standard quantitative research methods that aim to approximate true experimental research methods were employed. In this way, the researcher can assess the impact of OER on credit hour intensity, thus adding to previous research in the field.

CHAPTER FOUR

FINDINGS

The purpose of this study was to investigate the relationship between student enrollment in courses offering free Open Educational Resources (OER) and the number of credit hours in which they enroll, or credit intensity. Additional aims of the study were to continue the advancement of research, policy, and practice concerning the use and implementation of OER in community colleges. To explore this phenomenon, an ex post facto quasi-experimental design was utilized.

The researcher acquired data from one large urban southern California community college's institutional research office's archived student information system on student demographics, including age, ethnicity, gender, course enrollments, and the OER status of each of the class sections offered in the Fall 2018 and Spring 2019 terms. Via the use of IBM SPSS Statistics, descriptive statistics were run on this data by group: students enrolled in any OER classes, students enrolled in no OER courses, students enrolled in one OER class and those enrolled in two OER classes. T-tests were then run to test the differences in the standard deviations and means between the two groups in terms of the number of credit hours they attempted in order to determine the significance of the differences. In order to control for any effect that might be due to demographic covariates, propensity score-matched groups were then created from the two groups and t-tests were again performed.

Descriptive Statistics

The total population of the college during the Fall 2018 and Spring 2019 terms were considered. For this study, students who did not enroll in any credit-bearing classes were omitted

from the data. Therefore, from the total population, the Fall 2018 sample was 25,315 and 23,639 in Spring 2019.

In Fall 2018 only 170 students took one OER class, and none took two OER classes; in Spring 2019 this number grew to 1,272 taking one OER class and 72 taking two OER classes. Since this initiative was first implemented and tracked institutionally with the Winter 2018 term, this increase from one term to the next was to be expected as the adoption of OER at the college grew. The mean number of credit hours in which students enrolled (units attempted) can be seen in Table 1, which shows that there is a difference in credit hours attempted among each of these groups, those with two OER classes being the largest and those with no OER classes being the smallest.

Table 1.

Students Enrolled in OER & Students Not Enrolled in OER classes and Mean Units (credit hours) Attempted Total Sample

	Fall 2018		**Spring 2019**	
	n	M	n	M
No OER class	25,145	9.12	22,295	8.81
1 OER class	170	11.77	1272	11.03
2 OER classes	0	0	72	12.74

Demographics

The demographic makeup of the students in the study mirrored that of the institution; the majority self-identified as Hispanic and were 18-22 years of age. There were more female than male students. These demographics were fairly consistent across the groups of students included in the study; however, students who took at least one OER class were more likely to be female,

Hispanic, and younger than those who did not. After propensity score matching, these groups were balanced. This is illustrated in Tables 2 and 3.

Table 2

Fall 2018 and Spring 2019 Students Who Enrolled in at Least One Class Utilizing OER & Students Who Enrolled in No Classes Utilizing OER – Gender, Age, Ethnicity

	Enrolled in at Least 1 OER		**Enrolled in No OER Classes**	
Sex	**%**	**N**	**%**	**N**
Female	57.76%	860	55.45%	15,655
Male	41.3%	615	43.91%	12,398
Unknown	0.64%	180	0.63%	186
Age	**%**	**N**	**%**	**N**
Under 18	0.4%	6	1.2%	339
18-22	63.8%	950	46.32%	13,077
23-29	24.85%	370	30.25%	8,541
30-49	10.07%	150	17.88%	5,047
50 & older	0.87%	13	4.36%	1,230
Ethnicity	**%**	**N**	**%**	**N**
Asian/Pacific Isl.	10.68%	159	12.34%	3,483
Black/African-Am.	12.69%	189	14.39%	4,063
Filipino	0.07%	1	0.27%	76
Hispanic	60.31%	898	54.07%	15,266
Other/Unknown	1.14%	17	2%	564
White	15.11%	225	16.94%	4,782

Table 3.

Propensity Score Matched Fall 2018 and Spring 2019 Students Who Enrolled in at Least One Class Utilizing OER & Students Who Enrolled in No Classes Utilizing OER – Sex, Age, Ethnicity

	Enrolled in at least 1 OER		**Enrolled in No OER**	
Sex	**%**	**n**	**%**	**n**
female	57.76	860	57.56	853
male	41.3	615	42.04	623
unknown	0.94	14	0.4	6
Age	**%**	**n**	**%**	**n**
Under 18	0.4	6	0.4	6
18-22	63.94	952	63.63	943
23-29	24.71	368	24.83	368
30-49	10.07	150	10.19	151
50 and older	0.87	13	0.94	14
Ethnicity	**%**	**n**	**%**	**n**
Asian/Pac.Island	10.68	159	10.66	158
Black/Af.-Amer.	12.69	189	12.89	191
Filipino	0.07	1	0.07	1
Hispanic	60.31	898	60.12	891
Other/unknown	1.14	17	1.08	16
White	15.11	225	15.18	225

Results

This section presents the results of the data testing for the study. The study was designed around two research questions. Sample data from the study institution were analyzed and compared using t-tests to determine if there was a statistically significant difference between the

samples, both for the total sample groups and propensity score-matched samples. The study's two research questions and the results of the analyses follow.

RQ 1: Is there a statistically significant difference in the number of credit hours in which students enroll between students who enroll in any courses utilizing OER and students who do not enroll in any courses utilizing OER?

Hypothesis 1: Students who enroll in any courses utilizing OER will enroll in a greater number of credit hours than those who do not.

The analysis supported hypothesis 1. Students who enrolled in any courses utilizing OER in the Fall 2018 and Spring 2019 terms (m=12.34 SD=3.45) enrolled in statistically significant greater numbers of credit hours than those who did not (m=10.84 SD = 3.90) t (129609) = -27.69, p =<.0001. As a check on the above, further analysis showed that students who enrolled in any courses utilizing OER in the Fall 2018 term (m=12.68 SD= 2.99) enrolled in statistically significant greater numbers of credit hours than those who did not (m=10.94 SD =3.83) t (67887) = -11.2, p =<.0001. Students who enrolled in any courses utilizing OER in the Spring 2019 term (m=12.3 SD= 3.5) enrolled in statistically significant greater numbers of credit hours than those who did not as well (m=12.3 SD = 3.5) t (61720) = -26.31, p =<.0001.

As noted earlier, propensity score matching via logistic regression was used to control for effects related to demographic covariates of age, sex, and ethnicity and to provide more balanced samples. The distribution of covariates among students who take at least one OER class was different from the distribution among students who do not take OER classes in that OER students were more likely to be younger, female, and Hispanic or African-American. Propensity score matching also balanced sample sizes (*n*s), which were quite different among students who did and did not enroll in classes utilizing OER (see Tables 1 and 2). Once propensity scores were

calculated for the total population, control students who had not enrolled in any OER classes were selected and matched with the treated students who had taken at least one OER class, based on the nearest propensity score. Controls were matched to treatments without replacement; each control was matched to only one treated case. Treatment effects were then estimated on the outcome variable via t-tests.

Hypothesis 1 was also supported when the propensity score-matched sample groups were created and analyzed. Students who enrolled in any courses utilizing OER in the Fall 2018 and Spring 2019 terms (m=12.34 SD=3.45) enrolled in statistically significant greater numbers of credit hours than those who did not (m=11.18 SD = 3.73) t (9742) = -15.9, p =<.0001. As a check on the above, further analysis showed that students who enrolled in any courses utilizing OER in the Fall 2018 term (m=12.68 SD= 2.99) enrolled in statistically significant greater numbers of credit hours than those who did not (m=11.39 SD =2.99) t (1141) = -6.87, p =<.0001. Students who enrolled in any courses utilizing OER in the Spring 2019 term (m=12.3 SD= 3.5) enrolled in statistically significant greater numbers of credit hours than those who did not as well (m=11.16 SD = 3.78) t (8599) = -14.53, p =<.0001. Table 4 illustrates the differences between both the propensity score-matched groups and non-propensity score-matched groups in terms of credit hour enrollment.

Table 4

Differences in Credit Hour Enrollment at Least 1 versus No OER Classes

		Total Sample: Fall 2018 & Spring 2019		Fall 2018		Spring 2019	
		M	SD	M	SD	M	SD
At least 1 OER class	No PSM	12.34	3.45	12.68	2.99	12.3	3.49
	PSM	12.34	3.45	12.68	2.99	12.3	3.49
No OER class	No PSM	10.84	3.9	10.94	3.83	10.73	3.98
	PSM	11.18	3.73	11.38	3.34	11.15	3.78

Note: All results statistically significant, $p < .001$

The researcher also sought evidence for any type of compounded effect – that is, whether students who enroll in multiple OER classes are more likely to enroll in more credit hours than students in only one OER class. Therefore, the second research question:

RQ2: Is there a statistically significant difference in the number of credit hours in which students enroll between students who enroll in one course utilizing OER and students who enroll in two courses utilizing OER?

Hypothesis 2: Students who enroll in two courses utilizing OER will enroll in greater numbers of credit hours than those who enroll in only one course utilizing OER.

The analysis supported hypothesis 2. As no students enrolled in more than one OER class in the Fall 2018 term, only data for the Spring 2019 term was analyzed for this question. Students who enrolled in two courses utilizing OER in the Spring 2019 term (m=13.56 SD= 3.43) enrolled in statistically significant greater numbers of credit hours than those who enrolled in one course utilizing OER (m=12.2 SD = 3.48) t (4761) = -7.12, p =<.0001.

Hypothesis 2 was also supported when the propensity score-matched sample groups were created and analyzed via logistic regression for the covariates of age, sex, and ethnicity. Students who enrolled in two courses utilizing OER in the Spring 2019 term (m=13.56 SD= 3.43) enrolled in statistically significant greater numbers of credit hours than those who enrolled in one course utilizing OER (m=12.52 SD = 3.29) t (617) = -3.77, p =<.0001. Table 5 illustrates the differences between both the propensity score-matched groups and non-propensity score-matched groups in terms of credit hour enrollment.

Table 5

Differences in Credit Hour Enrollment 1 versus 2 OER Classes – Spring 2019

		M	SD
2 OER classes	No PSM	13.56	3.43
	PSM	13.56	3.43
1 OER class	No PSM	12.2	3.48
	PSM	12.59	3.29

Note: All results statistically significant, p <.001

Analysis of Findings

Chapter 4 presented the study data and significant findings. The analysis revealed that students who enroll in classes utilizing OER enroll in statistically significant higher numbers of credit hours than those who do not. For the total propensity score-matched samples of Fall 2018 and Spring 2019, the difference was 1.16 credit hours. This is graphically illustrated in Figure 1. It also revealed that the number of additional credit hours increases in a statistically significant manner when students are enrolled in multiple classes utilizing OER and is further illustrated in

Figure 2. For the total propensity score-matched samples for Spring 2019, the difference was .96 credit hours/units. The implications for these findings are discussed in Chapter 5.

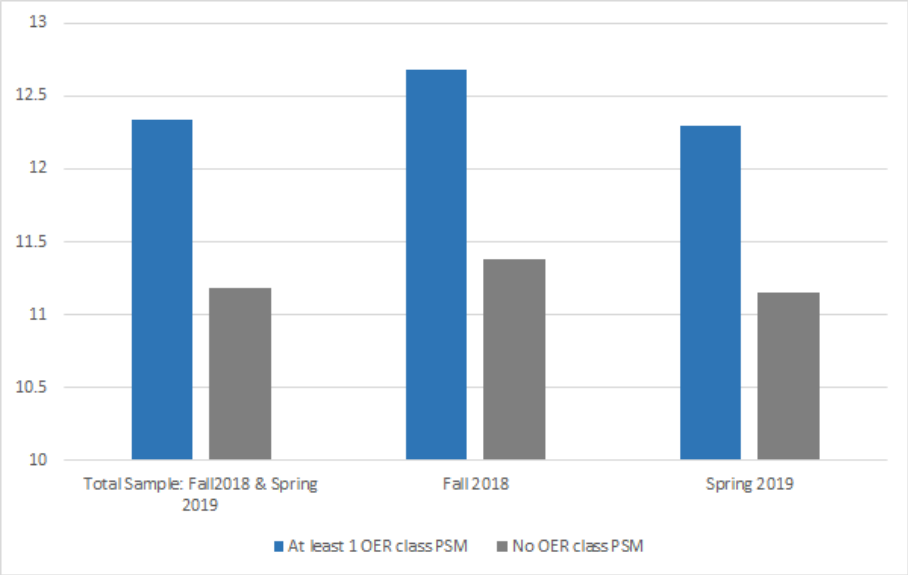

Figure 1. Differences in credit hour enrollment at least 1 versus no OER classes using propensity score matched samples.

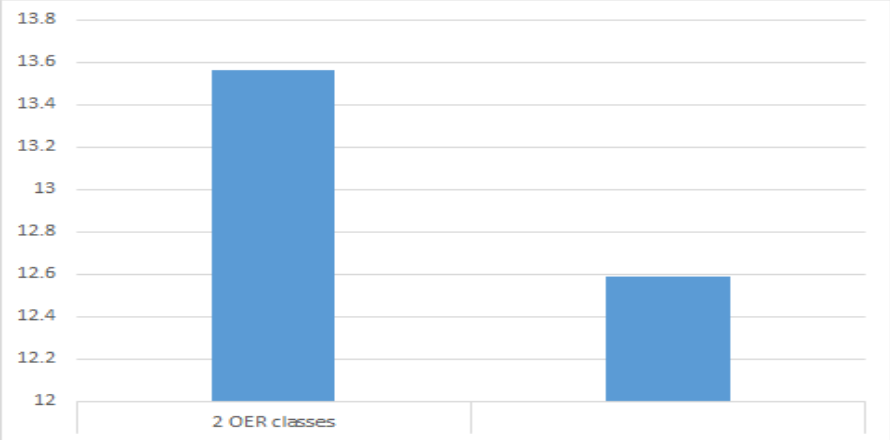

Figure 2. Differences in credit hour enrollment 2 versus 1 OER Class using propensity score matched samples.

CHAPTER FIVE

DISCUSSION

The California Community College system is investing in the development of free educational resources, or OER, as an alternative to traditional textbooks to relieve some of the financial burden experienced by students and remove barriers to student completion and access. Because of the link between credit hour intensity and student completion, the researcher designed the study to investigate the relationship of enrollment in classes utilizing OER as the primary course material and total credit hours in which students enroll. To determine if there is a statistically significant difference in the number of credit hours in which students enroll when they enroll in classes utilizing OER, the researcher performed independent samples t-tests on mean credit hours attempted for students who took any classes utilizing OER and for students who did not enroll in classes utilizing OER. The researcher also performed t-tests on the mean credit hours of students who enrolled in one class utilizing OER and students who enrolled in two classes utilizing OER. These tests were conducted on student data from the Fall 2018 and Spring 2019 terms at one large, urban, southern California community college. To reduce selection bias, t-tests were also conducted on the treatment and control groups when they were balanced via propensity score matching.

This chapter presents a summary of the statistical findings reached through this study. The chapter begins with a discussion of the study's focus and includes a review of the methodology used. It also contains a summary and discussion of the findings and their relation to the literature, discussion of additional findings not a focus of the study, and the implications of the study. The chapter closes with recommendations for future research and concluding thoughts.

Focus of the Study

Higher education has been challenged to keep pace with the rest of society in taking advantage of the benefits of technology for learning and student outcomes. While students can learn just about anything via online YouTube videos or a quick Google search, the vast majority of educators have continued to rely on traditional, commercially-produced learning materials. Despite some technology-driven instructional innovations, such as the proliferation of online courses, the use of commercial online supplemental materials and the use of web-based learning management systems, such as Canvas or Blackboard, students have as yet experienced little relief from the high relative cost of education. In California, where more than a third of working families earn less than $45,397 per year, and 55% of dependent community college students are from families with incomes below $30,000, the cost of community college education represents a whopping 30% or more of income (Tran, Siqueiros, & Dow, 2013; Community College Research Center, n.d.). Textbooks make up a large portion of this cost, up to 59% of the total cost of education (Goodwin, 2011). When forced to make choices due to financial constraints, these lower-income students may opt-out of purchasing expensive textbooks (Buczynski, 2007). Without access to learning materials, success is severely hampered for many college students.

At the same time, success and completion rates among California's community colleges are dishearteningly low. Only 48.2% of those students seeking a degree, certificate, and/or transfer who started community college in 2011-2012 completed within six years (California Community Colleges Chancellor's Office, 2018). The low number of college-educated Californians is having a negative impact not only on students' earning potential but on the state economy as well. The skills gap, the number of jobs requiring some college education or training and the number of prepared potential employees, is growing. The Public Policy Institute of

California (n.d.) projects that the demand for college graduates will outpace the supply by 2030; the economy needs 1.1 million more college graduates than the state will produce. To remedy this, California will need to produce more graduates from historically underrepresented groups, which typically lag behind other groups in terms of completion and are often overrepresented among students experiencing financial challenges.

Community college leaders now recognize access to free and open information online as a means to level the educational access and financial playing field for students. The California Community Colleges Chancellor's Office has promoted legislation and successfully advocated for funding to provide colleges money to develop and adopt OER to help address issues of success and completion, especially for underrepresented groups. Millions of state dollars are being invested in the development of free online educational resources, or OER, as an alternative to traditional textbooks, to relieve some of the financial burden experienced by students and remove barriers to student completion and access. However, little research on the impacts of OER in the community college sector exists, especially related to its impacts on credit hour intensity (units and enrollment).

One study across seven colleges including five in California showed that students who enrolled in courses using OER enrolled in a significantly higher number of credit hours than students in courses utilizing traditional textbooks (Robinson, 2015). Though the difference was relatively small (.27 credits), the results appeared to show that for some students, being relieved of the burden of textbook cost has a positive effect on their ability to pursue an additional number of courses, which, in turn, is linked to completion.

Credit hour intensity, or the number of credit hours (or units) in which students enroll per term, has important implications for students and colleges; higher credit intensity is positively

related to higher completions. Higher credit intensity can also equate to more funding for colleges whose budgets are determined based upon the number of student credit hours. Therefore, to build upon the limited previous research, this study's focus was to determine what impact enrollment in classes utilizing OER might have on credit intensity. The researcher wanted to determine whether one large, urban southern California community college with students who enrolled in any classes utilizing OER enrolled in a higher number of credit hours than those who did not. The second purpose was to determine whether the effect was additive – would students enroll in a greater number of credit hours when they enrolled in a greater number of classes utilizing OER? The study focused on the third and fourth terms in which a new statewide OER initiative was implemented, the Fall 2018 and Spring 2019 terms.

Review of the Methodology

The researcher employed an ex post facto quasi-experimental study design to explore the credit hour intensity of students in classes utilizing OER and those not enrolled in classes utilizing OER. The purpose was to determine whether there is a statistically significant difference in the number of credit hours in which students enroll between students who enroll in any classes utilizing OER and students who do not enroll in any classes utilizing OER. Additionally, the researcher sought information on whether enrollment intensity increased along with an increase in OER-utilizing class enrollments. More specifically, the researcher sought to determine whether there is a statistically significant difference in the number of credit hours in which students enroll between students who enroll in one class utilizing OER and students who enroll in two classes utilizing OER.

To achieve this, student demographic, class enrollment, and class schedule data from one large, urban, southern California community college were accessed. From this data, only data

from the Fall 2018 and Spring 2019 terms were utilized. From these two terms, the treatment groups were identified: students who enrolled in any credit-bearing classes utilizing OER for each term and both terms combined and students enrolled in two classes utilizing OER (versus one) in the Spring term. Via propensity score matching, matched control groups were created that mirrored the distribution of covariates of sex, age, and ethnicity in the treatment (OER) group. Each of these groups was compared via t-tests: any credit-bearing OER to no OER and one OER to two OER.

Summary of Findings

The results of the study indicate that there is a statistically significant difference in the number of credit hours in which students enroll between students who enroll in any courses utilizing OER and students who do not enroll in any courses utilizing OER; students who enroll in any credit-bearing classes utilizing OER enroll in a statistically significant higher number of credit hours than those who do not.

The study also revealed that there is a statistically significant difference in the number of credit hours in which students enroll between students who enroll in one course utilizing OER and students who enroll in two courses utilizing OER. In addition to students who take any classes utilizing OER take more credit hours than those who do not, the study revealed that the number of additional credit hours students attempt increases in a statistically significant manner when students enrolled in multiple classes utilizing OER.

Discussion of Findings

The first finding is that students who enroll in any credit-bearing classes utilizing OER enroll in a statistically significant higher number of credit hours than those who do not. Students attempt 1.16 more credit hours (units) when in OER classes. This difference was found across

each term and when both terms were combined, as well as when balanced propensity score-matched control groups were created for each term and the two terms combined. These findings show a very strong positive relationship between enrollment in classes utilizing OER and credit intensity.

The researcher also sought to determine if the effects are additive; that is when students enroll in multiple OER classes, do educators see a related increase in credit intensity? The answer is yes. Students who enrolled in two OER classes enrolled in 1.04 additional credit hours (units) than did those who enrolled in only one. This difference was found both prior to and after balanced propensity score-matched control groups were created. This difference is only slightly smaller than the difference found for students in any versus no OER (1.16). This provides both strong further evidence for the positive impact OER has on credit intensity, as well as evidence that additional OER offerings will lead to additional credit hour (units) enrollment.

The only other study of this type found by the researcher was conducted by Robinson, who found that across seven institutions implementing OER, there was a .37 credit hour increase related to OER enrollment (2015). The present findings indicate a much higher increase in credit hours. Therefore, these findings are important. They also indicate that studies focusing on limited populations are needed to get a fuller picture of OER's impacts, as well as that the impact of OER may vary across various contexts and institution types.

Findings Related to Literature

As discussed in Chapter two, most studies focusing on the impacts of the use of OER on course outcomes, grades, drop rates, and student and faculty perceptions found a positive or neutral relationship. With the ever-rising cost of textbooks, OER represents significant savings to students. This is especially important for community college students, whose socio-economic

status is lower than that of students at four-year and private institutions (Bailey et al., 2005; Fry & Cilluffo, 2019; Provasnik & Planty, 2008).

The historical intent of OER is social inclusion and equity, or the opportunity for all people to "access available education, professional, economic and/or political opportunities" to decrease poverty and oppression (Mancinelli, 2008, p. 243). This social purpose aligns with the focus of the California Community College system to make learning and college access and success more equitable for its uniquely underprivileged demographic. Via OER, students get free and open access to the educational materials they need to succeed, thus reducing the high cost of education. As cost is a barrier to course access, OER has the potential to reduce this barrier as well. Student surveys conducted by Ikahihifo et al. (2017) indicated that community college students reinvest savings they experience via OER in their education. The findings from Robinson's (2015) study and the present study reinforce these findings.

Significance of Findings

Why are these findings significant? First, increased credit intensity is associated with accelerated academic progress and an increased likelihood of persistence and completion (Calcagno et al., 2007). In this way, OER helps educators make good on the promise to help all students reach their goals. It also supports the goals of the individual institutions in which it is implemented, as well as those of the California Community Colleges Chancellor's Office (system office). It also makes real the intent of OER in widening access to education and eliminating economic inequities.

Second, increased enrollments can increase revenue for community colleges. Current California Community College funding is based primarily on the number of full-time equivalent students, or the number of credit hours of all students enrolled each term. A significant increase

in credit hours related to the use of OER can provide institutions with much-needed dollars to support educational programming, as well as to support the further development of OER and other student success efforts. Institutions whose funding is based in any part on completions may also experience financial benefit as increased credit intensity is positively associated with completion.

Additional Findings

An additional finding that was not a focus of this study was that students who enrolled in OER classes tended to be younger, female and Hispanic. Hispanic students and female students (of various ethnicities and status as Foster Youth, LGBT and or disabled) are among the student groups at the study institution that experience disproportionate impact, and indeed at many community colleges. Disproportionate impact for this discussion is defined as a particular population of students significantly underperforming the highest performing group of students. Since Hispanic females, for example, experience disproportionate impact in terms of college-level English and math completion and transfer (Long Beach City College, 2019a), OER may be of specific benefit to this group. Though beyond the scope of this study, if OER implementation grows and enrollment by Hispanic females persists, improved outcomes for this group and others affected are possible. This may, in turn, strengthen the state economy by improving graduation rates for historically underrepresented populations.

Implications

These findings provide strong evidence for further investment and support of OER in the community colleges, particularly at institutions with demographic profiles similar to that of the study institution. Whether colleges wish to see increased credit hour enrollment for reasons of its

relation to student persistence and completion and/or for reasons related to funding, OER may be a powerful tool for accomplishing these ends.

Aside from this, the utilization of OER reduces the cost of higher education to the students who need it most and widens access to education. In addition, it fosters the development of a growing community of practitioners sharing knowledge in ways that will help our students gain the skills they need to navigate today's increasingly connected and open world.

Recommendations for Future Research

Because of its recent emergence in the community college system, there are limited studies on the effects of OER overall and there is a need for more given the state dollars being spent on its implementation and the potential positive impacts as found in this study. This is only the second study investigating the link between credit-hour intensity and enrollment in classes utilizing OER found by the researcher. Given the difference in the findings of both studies and their limitations, it is recommended that additional studies be conducted.

Also, since the OER movement is in its nascency in California and at the study institution, it allowed for a somewhat limited data set; additional studies should be conducted as the movement progresses and there are larger data sets to explore. For example, some colleges have now developed "Zero Textbook Cost" degree programs, in which students have no-cost textbook options for every course in these programs. Whether the effects of OER seen in the results of this study will be seen when offered across entire programs will be a question worthy of investigation.

Additionally, one might conduct qualitative studies in which students are queried as to how direct the relationship is between knowing the course has a free textbook (OER) and their enrollment in additional credit hours.

Another area that might be given closer consideration is OER's relationship to equitable student completions and OER's effects on various student groups. Investigating the nexus of ethnicity and income in the community colleges would be helpful. While researchers understand the poverty rates of community college students related to other sectors of higher education fairly well, they know less about how poverty affects the success of students in various disproportionately impacted student groups. Because of OER's ability to reduce the cost of education, studies such as this may yield findings helpful for these students.

Conclusion

As a result of this study's findings, the researcher recommends continued investment in the development of OER for community college students, as the return on investment may be great in terms of improved equitable outcomes for students. If, as suggested in the literature, the increase in credit hour intensity leads to increased completion, the return on investment may be doubly attractive to colleges whose funding is based on credit intensity and/or based in any part on the number of student award completions.

Equally important is the continued investment in deeper thought as to what this phenomenon of free and open educational resources means for society both at the local level and worldwide. When one considers the historical development of OER as an effort to alleviate global economic deprivation and all that comes with it, one cannot help but be inspired by the work taking place to support and foster OER development. From the comfort of our air-conditioned offices here in the United States, it is challenging to get a palpable sense of education's positive effects on the lives of the men, women, and children in remote areas of the world where it is most needed. However, if one narrows one's focus closer to home and has the opportunity to study the positive effects of OER on historically oppressed peoples that make up

one's own larger neighborhood, the impact makes clear one's ability to make a significant positive impact on the lives of the students educators and education researchers aim to serve. Taking the opportunity to conduct studies such as this reinvigorates one's passion for the challenging work of public education. It also provides new-found respect for those advocating for these efforts and the real effects free and open education can provide.

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Appendices

Appendix A: Institutional Review Board Approval National American University

NATIONAL AMERICAN UNIVERSITY

Central Administration
Institutional Review Board

Memorandum

Date: October 8, 2019

To: Heidi Neu Stephens, Researcher
CC: Dr. Noreen Thomas
From: National American University Institutional Review Board
RE: Protocol/Project Title: Open Education Resources and Enrollment Intensity in One Southern California Community College

10-8-19
F. Lynn Moore, PhD

Effective October 8, 2019, the National American University Review Board (IRB) Chair, F. Lynn Moore, Ph.D., based on review of the IRB application and the prior approval of the Long Beach City College IRB Committee, approved the application request for the above mentioned research protocol.

This IRB approval provides permission to begin the data collection activities as outlined in the IRB-approved project and supporting documents. As a reminder, you are to include this letter, along with a copy of the Long Beach City College IRB Committee approval, as appendices in your final dissertation document.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. The researcher is to report within five business days to the IRB any unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined in the NAU IRB procedures.

Protocol Information

Approved as:	Exempt
Protocol Approval Date:	October 8, 2019
Protocol Expiration Date:	October 8, 2020
Continuing Review Due Date*	September 8, 2020

*Date a Continuing Review application is due to IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

Colorado
Centennial
Colorado Springs
Colorado Springs South

Indiana
Indianapolis

Kansas
Garden City
Overland Park
Wichita
Wichita West

Minnesota
Bloomington
Brooklyn Center
Burnsville
Minnetonka
Rochester
Roseville

Missouri
Independence
Lee's Summit
Kansas City

Nebraska
Bellevue

New Mexico
Albuquerque
Albuquerque West

Oklahoma
Tulsa

South Dakota
Ellsworth AFB
Rapid City
Sioux Falls
Watertown

Texas
Allen Service Center
Austin
Austin South
Georgetown
Houston
Lewisville
Mesquite
Richardson
Round Rock Graduate Center

Appendix B: Institutional Review Board Approval Long Beach City College

Long Beach City College • Long Beach Community College District
4901 East Carson Street • Long Beach, California 90808

October 4, 2019

To: Heidi Neu-Stephens

From: Heather Van Volkinburg, Dean of Institutional Effectiveness at LBCC

Re: Request to Conduct Research at Long Beach City College

Your request to conduct research at Long Beach City College is approved for your project entitled "Open Educational Resources and Enrollment Intensity in One Southern California Community College." This approval is based upon approval and adherence to the steps documented in your application to LBCC and your Institutional Review Board (IRB) application/approval to protect human subjects from National American University.

Best wishes for a successful research study. We look forward to your findings.

Warmly,

Heather Van Volkinburg
Dean of Institutional Effectiveness
Long Beach City College
562-938-4623
hvanvolkinburg@lbcc.edu

Appendix C: Data Overview Total Sample – All Students Fall 2018 and Spring 2019

Enrollment File - number of Students per term

term	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1605	25315	51.71	25315	51.71
1615	23639	48.29	48954	100

		Number of Student Attempting OER Classes	Mean number of units attempted
Fall 2018	No Classes	25145	9.12
	1 OER class	170	11.77
Spring 2019	No Classes	22295	8.81
	1 OER class	1272	11.03
	2 OER classes	72	12.74

Appendix D: Fall 2018 and Spring 2019 Students Who Completed Any OER versus No OER

Fall 2018 and Spring 2019 Combined: Looking at students who did not complete any OER classes compared to students who completed at least one OER class
No propensity Score Matching
Demographics of Students that do not take OER classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
B	1	0	1	0
F	15655	55.45	15656	55.45
M	12398	43.91	28054	99.36
U	180	0.64	28234	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	3483	12.34	3483	12.34
Black/African-American	4063	14.39	7546	26.73
Filipino	76	0.27	7622	27
Hispanic	15266	54.07	22888	81.07
Other/Unknown	564	2	23452	83.06
White	4782	16.94	28234	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	339	1.2	339	1.2
18-22	13077	46.32	13416	47.52
23-29	8541	30.25	21957	77.77
30-49	5047	17.88	27004	95.64
50 & Older	1230	4.36	28234	100

Demographics of Students that take at least one OER class

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	860	57.76	860	57.76
M	615	41.3	1475	99.06
U	14	0.94	1489	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	159	10.68	159	10.68
Black/African-American	189	12.69	348	23.37
Filipino	1	0.07	349	23.44
Hispanic	898	60.31	1247	83.75
Other/Unknown	17	1.14	1264	84.89
White	225	15.11	1489	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	6	0.4	6	0.4
18-22	950	63.8	956	64.2
23-29	370	24.85	1326	89.05
30-49	150	10.07	1476	99.13
50 & Older	13	0.87	1489	100

Null Hypothesis: Mean number of units attempted by students who do not take an OER class is equal to mean number of units attempted by students who take at least 1 OER class
Alt Hypothesis: Mean number of units attempted by students who do not take an OER class is LESS THAN mean number of units attempted by students who take at least 1 OER class

T Test using total sample - both Fall and Spring

cohort	N	Mean	Std Dev	Std Err	Minimum	Maximum
0	124235	10.8431	3.9033	0.0111	0.5	31
1	5376	12.3416	3.4452	0.047	1	22.5
Diff (1-2)		-1.4985	3.8854	0.0541		

cohort	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		10.8431	10.8214	10.8648	3.9033	3.888	3.9187
1		12.3416	12.2495	12.4337	3.4452	3.3813	3.5116
Diff (1-2)	Pooled	-1.4985	-Infty	-1.4095	3.8854	3.8705	3.9004
Diff (1-2)	Satterthwaite	-1.4985	-Infty	-1.4191			

Method	Variances	DF	t Value	Pr < t
Pooled	Equal	129609	-27.69	<.0001
Satterthwaite	Unequal	5987.9	-31.04	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	124234	5375	1.28	<.0001

Appendix E: Fall 2018 Students Who Completed Any OER versus No OER

Demographics of Students that do not take OER classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
	166	0.69	166	0.69
F	13178	54.84	13344	55.53
M	10549	43.9	23893	99.43
U	137	0.57	24030	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	2925	12.17	2925	12.17
Black/African-American	3288	13.68	6213	25.86
Filipino	56	0.23	6269	26.09
Hispanic	13330	55.47	19599	81.56
Other/Unknown	465	1.94	20064	83.5
White	3966	16.5	24030	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	224	0.93	224	0.93
18-22	12430	51.73	12654	52.66
23-29	6614	27.52	19268	80.18
30-49	3844	16	23112	96.18
50 & Older	918	3.82	24030	100

Demographics of Students that take at least one OER class

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	106	62.35	106	62.35
M	61	35.88	167	98.24
U	3	1.76	170	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	15	8.82	15	8.82
Black/African-American	27	15.88	42	24.71
Hispanic	106	62.35	148	87.06
Other/Unknown	1	0.59	149	87.65
White	21	12.35	170	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
18-22	122	71.76	122	71.76
23-29	37	21.76	159	93.53
30-49	10	5.88	169	99.41
50 & Older	1	0.59	170	100

Null Hypothesis: Mean number of units attempted by students who do not take an OER class is equal to mean number of units attempted by students who take at least 1 OER class
Alt Hypothesis: Mean number of units attempted by students who do not take an OER class is LESS THAN mean number of units attempted by students who take at least 1 OER class

T Test - All Students Fall 2018

cohort	N	Mean	Std Dev	Std Err	Minimum	Maximum
0	67276	10.9374	3.8313	0.0148	0.5	24.5
1	613	12.6754	2.9982	0.1211	1	19.5
Diff (1-2)		-1.7379	3.8246	0.1552		

cohort	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		10.9374	10.9085	10.9664	3.8313	3.811	3.8519
1		12.6754	12.4376	12.9132	2.9982	2.8392	3.1762
Diff (1-2)	Pooled	-1.7379	-Infty	-1.4827	3.8246	3.8044	3.8451
Diff (1-2)	Satterthwaite	-1.7379	-Infty	-1.537			

Method	Variances	DF	t Value	Pr < t
Pooled	Equal	67887	-11.2	<.0001
Satterthwaite	Unequal	630.35	-14.25	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	67275	612	1.63	<.0001

Appendix F: Spring 2019 Students Who Completed Any OER versus No OER

Demographics of Students that do not take OER classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
	139	0.66	139	0.66
B	1	0	140	0.66
F	11647	55.27	11787	55.93
M	9143	43.39	20930	99.32
U	143	0.68	21073	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	2626	12.46	2626	12.46
Black/African-American	2887	13.7	5513	26.16
Filipino	56	0.27	5569	26.43
Hispanic	11454	54.35	17023	80.78
Other/Unknown	421	2	17444	82.78
White	3629	17.22	21073	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	226	1.07	226	1.07
18-22	10110	47.98	10336	49.05
23-29	6211	29.47	16547	78.52
30-49	3642	17.28	20189	95.81
50 & Older	884	4.19	21073	100

Demographics of Students that take at least one OER class

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
	11	0.82	11	0.82
F	765	56.92	776	57.74
M	557	41.44	1333	99.18
U	11	0.82	1344	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	146	10.86	146	10.86
Black/African-American	166	12.35	312	23.21
Filipino	1	0.07	313	23.29
Hispanic	806	59.97	1119	83.26
Other/Unknown	16	1.19	1135	84.45
White	209	15.55	1344	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	6	0.45	6	0.45
18-22	847	63.02	853	63.47
23-29	336	25	1189	88.47
30-49	142	10.57	1331	99.03
50 & Older	13	0.97	1344	100

Null Hypothesis: Mean number of units attempted by students who do not take an OER class is equal to mean number of units attempted by students who take at least 1 OER class
Alt Hypothesis: Mean number of units attempted by students who do not take an OER class is LESS THAN mean number of units attempted by students who take at least 1 OER class

T Test all students Spring 2019

cohort	N	Mean	Std Dev	Std Err	Minimum	Maximum
0	56959	10.7316	3.9838	0.0167	0.5	31
1	4763	12.2987	3.4966	0.0507	2	22.5
Diff (1-2)		-1.567	3.9483	0.0596		

cohort	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		10.7316	10.6989	10.7643	3.9838	3.9608	4.0071
1		12.2987	12.1993	12.398	3.4966	3.4277	3.5682
Diff (1-2)	Pooled	-1.567	-1.6649	-1.4691	3.9483	3.9264	3.9705
Diff (1-2)	Satterthwaite	-1.567	-1.6547	-1.4793			

Method	Variances	DF	t Value	Pr < t
Pooled	Equal	61720	-26.31	<.0001
Satterthwaite	Unequal	5846.2	-29.38	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	56958	4762	1.3	<.0001

Appendix G: Propensity Score Matched Fall 2018 and Spring 2019 Students Who Enrolled in Any OER versus No OER

Demographics of Students that do not take OER classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	853	57.56	853	57.56
M	623	42.04	1476	99.6
U	6	0.4	1482	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	158	10.66	158	10.66
Black/African-American	191	12.89	349	23.55
Filipino	1	0.07	350	23.62
Hispanic	891	60.12	1241	83.74
Other/Unknown	16	1.08	1257	84.82
White	225	15.18	1482	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	6	0.4	6	0.4
18-22	943	63.63	949	64.04
23-29	368	24.83	1317	88.87
30-49	151	10.19	1468	99.06
50 & Older	14	0.94	1482	100

Demographics of Students that take at least one OER class

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	860	57.76	860	57.76
M	615	41.3	1475	99.06
U	14	0.94	1489	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	159	10.68	159	10.68
Black/African-American	189	12.69	348	23.37
Filipino	1	0.07	349	23.44
Hispanic	898	60.31	1247	83.75
Other/Unknown	17	1.14	1264	84.89
White	225	15.11	1489	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	6	0.4	6	0.4
18-22	952	63.94	958	64.34
23-29	368	24.71	1326	89.05
30-49	150	10.07	1476	99.13
50 & Older	13	0.87	1489	100

Null Hypothesis: Mean number of units attempted by students who do not take an OER class is equal to mean number of units attempted by students who take at least 1 OER class
Alt Hypothesis: Mean number of units attempted by students who do not take an OER class is LESS THAN mean number of units attempted by students who take at least 1 OER class

T Test all students both Fall and Spring

cohort	N	Mean	Std Dev	Std Err	Minimum	Maximum
0	4368	11.1835	3.7318	0.0565	1	22
1	5376	12.3416	3.4452	0.047	1	22.5
Diff (1-2)		-1.1581	3.5765	0.0729		

cohort	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		11.1835	11.0728	11.2942	3.7318	3.6552	3.8118
1		12.3416	12.2495	12.4337	3.4452	3.3813	3.5116
Diff (1-2)	Pooled	-1.1581	-1.2779	-1.0383	3.5765	3.527	3.6275
Diff (1-2)	Satterthwaite	-1.1581	-1.2789	-1.0373			

Method	Variances	DF	t Value	Pr < t
Pooled	Equal	9742	-15.9	<.0001
Satterthwaite	Unequal	9002.1	-15.77	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	4367	5375	1.17	<.0001

Appendix H: Propensity Score Matched Fall 2018 Students Who Enrolled in Any OER versus No OER

Demographics of Students that do not take OER classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	106	62.35	106	62.35
M	64	37.65	170	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	15	8.82	15	8.82
Black/African-American	27	15.88	42	24.71
Hispanic	106	62.35	148	87.06
Other/Unknown	1	0.59	149	87.65
White	21	12.35	170	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
18-22	122	71.76	122	71.76
23-29	37	21.76	159	93.53
30-49	10	5.88	169	99.41
50 & Older	1	0.59	170	100

Demographics of Students that take at least one OER class

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	106	62.35	106	62.35
M	61	35.88	167	98.24
U	3	1.76	170	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	15	8.82	15	8.82
Black/African-American	27	15.88	42	24.71
Hispanic	106	62.35	148	87.06
Other/Unknown	1	0.59	149	87.65
White	21	12.35	170	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
18-22	122	71.76	122	71.76
23-29	37	21.76	159	93.53
30-49	10	5.88	169	99.41
50 & Older	1	0.59	170	100

Null Hypothesis: Mean number of units attempted by students who do not take an OER class is equal to mean number of units attempted by students who take at least 1 OER class
Alt Hypothesis: Mean number of units attempted by students who do not take an OER class is LESS THAN mean number of units attempted by students who take at least 1 OER class

T Test All Students Fall 2018

cohort	N	Mean	Std Dev	Std Err	Minimum	Maximum
0	530	11.3887	3.3364	0.1449	2	18
1	613	12.6754	2.9982	0.1211	1	19.5
Diff (1-2)		-1.2867	3.1595	0.1874		

cohort	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		11.3887	11.104	11.6734	3.3364	3.1469	3.5503
1		12.6754	12.4376	12.9132	2.9982	2.8392	3.1762
Diff (1-2)	Pooled	-1.2867	-Infty	-0.9782	3.1595	3.035	3.2947
Diff (1-2)	Satterthwaite	-1.2867	-Infty	-0.9758			

Method	Variances	DF	t Value	Pr < t
Pooled	Equal	1141	-6.87	<.0001
Satterthwaite	Unequal	1073.3	-6.81	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	529	612	1.24	0.0107

Appendix I: Propensity Score Matched Spring 2019 Students Who Enrolled in Any OER versus No OER

Demographics of Students that do not take OER classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
	6	0.45	6	0.45
F	765	56.92	771	57.37
M	567	42.19	1338	99.55
U	6	0.45	1344	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	146	10.86	146	10.86
Black/African-American	166	12.35	312	23.21
Filipino	1	0.07	313	23.29
Hispanic	806	59.97	1119	83.26
Other/Unknown	16	1.19	1135	84.45
White	209	15.55	1344	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	6	0.45	6	0.45
18-22	847	63.02	853	63.47
23-29	336	25	1189	88.47
30-49	142	10.57	1331	99.03
50 & Older	13	0.97	1344	100

Demographics of Students that take at least one OER class

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
	11	0.82	11	0.82
F	765	56.92	776	57.74
M	557	41.44	1333	99.18
U	11	0.82	1344	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	146	10.86	146	10.86
Black/African-American	166	12.35	312	23.21
Filipino	1	0.07	313	23.29
Hispanic	806	59.97	1119	83.26
Other/Unknown	16	1.19	1135	84.45
White	209	15.55	1344	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	6	0.45	6	0.45
18-22	847	63.02	853	63.47
23-29	336	25	1189	88.47
30-49	142	10.57	1331	99.03
50 & Older	13	0.97	1344	100

Null Hypothesis: Mean number of units attempted by students who do not take an OER class is equal to mean number of units attempted by students who take at least 1 OER class
Alt Hypothesis: Mean number of units attempted by students who do not take an OER class is LESS THAN mean number of units attempted by students who take at least 1 OER class

T Test All students Spring 2019

cohort	N	Mean	Std Dev	Std Err	Minimum	Maximum
0	3838	11.1552	3.7827	0.0611	1	22
1	4763	12.2987	3.4966	0.0507	2	22.5
Diff (1-2)		-1.1435	3.627	0.0787		

cohort	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		11.1552	11.0354	11.2749	3.7827	3.6999	3.8693
1		12.2987	12.1993	12.398	3.4966	3.4277	3.5682
Diff (1-2)	Pooled	-1.1435	-Infty	-1.0141	3.627	3.5736	3.6821
Diff (1-2)	Satterthwaite	-1.1435	-Infty	-1.013			

Method	Variances	DF	t Value	Pr < t
Pooled	Equal	8599	-14.53	<.0001
Satterthwaite	Unequal	7915.9	-14.41	<.0001

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	3837	4762	1.17	<.0001

Appendix J: Spring 2019 Students Who Enrolled 1 OER versus 2 OER Classes

Demographics of Students that take One OER classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
	11	0.86	11	0.86
F	728	57.23	739	58.1
M	522	41.04	1261	99.14
U	11	0.86	1272	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	139	10.93	139	10.93
Black/African-American	158	12.42	297	23.35
Filipino	1	0.08	298	23.43
Hispanic	763	59.98	1061	83.41
Other/Unknown	14	1.1	1075	84.51
White	197	15.49	1272	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Under 18	6	0.47	6	0.47
18-22	792	62.26	798	62.74
23-29	324	25.47	1122	88.21
30-49	138	10.85	1260	99.06
50 & Older	12	0.94	1272	100

Demographics of Students that take 2 OER Classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	37	51.39	37	51.39
M	35	48.61	72	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	7	9.72	7	9.72
Black/African-American	8	11.11	15	20.83
Hispanic	43	59.72	58	80.56
Other/Unknown	2	2.78	60	83.33
White	12	16.67	72	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
18-22	55	76.39	55	76.39
23-29	12	16.67	67	93.06
30-49	4	5.56	71	98.61
50 & Older	1	1.39	72	100

Null Hypothesis: Mean number of units attempted by students who take 1 OER class is equal to mean number of units attempted by students who take 2 OER classes
Alt Hypothesis: Mean number of units attempted by students who take 1 OER class is LESS THAN mean number of units attempted by students who take 2 OER classes

T Test all students Spring 2019

cohort1	N	Mean	Std Dev	Std Err	Minimum	Maximum
0	4406	12.1964	3.482	0.0525	2	22.5
1	357	13.5602	3.4337	0.1817	4	20
Diff (1-2)		-1.3638	3.4784	0.1914		

cohort1	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		12.1964	12.0936	12.2993	3.482	3.4108	3.5563
1		13.5602	13.2028	13.9176	3.4337	3.199	3.706
Diff (1-2)	Pooled	-1.3638	-Infty	-1.0489	3.4784	3.41	3.5497
Diff (1-2)	Satterthwaite	-1.3638	-Infty	-1.052			

Method	Variances	DF	t Value	Pr < t
Pooled	Equal	4761	-7.12	<.0001
Satterthwaite	Unequal	417.56	-7.21	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	4405	356	1.03	0.7378

Appendix K: Propensity Score Matched Spring 2019 Students Who Enrolled 1 OER versus 2 OER Classes

Demographics of Students that take 1 OER Classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
	2	2.78	2	2.78
F	37	51.39	39	54.17
M	32	44.44	71	98.61
U	1	1.39	72	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	9	12.5	9	12.5
Black/African-American	8	11.11	17	23.61
Hispanic	43	59.72	60	83.33
Other/Unknown	2	2.78	62	86.11
White	10	13.89	72	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
18-22	55	76.39	55	76.39
23-29	12	16.67	67	93.06
30-49	5	6.94	72	100

Demographics of Students that take 2 OER Classes

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	37	51.39	37	51.39
M	35	48.61	72	100

eth	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Asian/PI	7	9.72	7	9.72
Black/African-American	8	11.11	15	20.83
Hispanic	43	59.72	58	80.56
Other/Unknown	2	2.78	60	83.33
White	12	16.67	72	100

age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
18-22	55	76.39	55	76.39
23-29	12	16.67	67	93.06
30-49	4	5.56	71	98.61
50 & Older	1	1.39	72	100

Null Hypothesis: Mean number of units attempted by students who take 1 OER class is equal to mean number of units attempted by students who take 2 OER classes
Alt Hypothesis: Mean number of units attempted by students who take 1 OER class is LESS THAN mean number of units attempted by students who take 2 OER classes
T Test All students Spring 2019

cohort1	N	Mean	Std Dev	Std Err	Minimum	Maximum
0	262	12.5248	3.2865	0.203	3	20.5
1	357	13.5602	3.4337	0.1817	4	20
Diff (1-2)		-1.0354	3.3722	0.2743		

cohort1	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		12.5248	12.125	12.9246	3.2865	3.0271	3.5949
1		13.5602	13.2028	13.9176	3.4337	3.199	3.706
Diff (1-2)	Pooled	-1.0354	-Infty	-0.5835	3.3722	3.1941	3.5715
Diff (1-2)	Satterthwaite	-1.0354	-Infty	-0.5865			

Method	Variances	DF	t Value	Pr < t
Pooled	Equal	617	-3.77	<.0001
Satterthwaite	Unequal	575.78	-3.8	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	356	261	1.09	0.4519