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IMPACTS OF OPEN EDUCATIONAL RESOURCES ON
ENROLLMENT RATES, WITHDRAWAL RATES, AND
ACADEMIC PERFORMANCE IN THE VIRGINIA
COMMUNITY COLLEGE SYSTEM

by

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B. S. December 1983, University of Virginia

A Research Paper Submitted to the Faculty of
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OLD DOMINION UNIVERSITY
July 2016

Approved by:

Philip A. Reed (Co-director)

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ABSTRACT

IMPACTS OF OPEN EDUCATIONAL RESOURCES ON ENROLLMENT RATES, WITHDRAWAL RATES, AND ACADEMIC PERFORMANCE IN THE VIRGINIA COMMUNITY COLLEGE SYSTEM

Marcella Milhous Gale
Old Dominion University, 2016
Co-directors: Dr. Philip A. Reed and Dr. John M. Ritz

The problem of this study was to evaluate the enrollment rates and academic performance of students in courses at Central Virginia Community College (CVCC) that utilize Open Educational Resources (OER) to help determine if the use of such materials should be encouraged and expanded in the Virginia Community College System. The population for this study consisted of students enrolled in at least one course at CVCC during the Fall 2015 and Spring 2016 semester, where there were courses that used OER as the course textbook. At the end of each semester, CVCC records enrollment, drop, and academic performance information for all enrolled students. These data were provided by CVCC's Office of Institutional Research.

The first research question of this study asked if the enrollment rate in courses at CVCC that use OER differs from other sections of the same course that use textbooks students are required to obtain. This question was examined with contingency tables. The second research question of this study asked if replacing a required text with OER increases the completion rate in those courses as compared to non-OER courses. A Chi-square analysis was used. The third research question of this study asked if CVCC students' academic performance was affected by the use of OER. Multiple t-tests were performed to examine the question.

A statistically significant difference in enrollment rates was found in two of the ten courses studied. The difference in withdrawal rates for all courses and subjects in aggregate was found to be statistically significant. A statistically significant difference in student academic performance was found in 12 out of 20 comparisons made.

The results and conclusions of this study are at odds with other studies done in the subject area. The enrollment rate in OER taught courses in these subjects did not differ from the enrollment rate in non-OER taught courses. Students withdrew from OER sections at a significantly higher rate than from non-OER sections. Student performance of this sample in aggregate was extremely significantly affected by the use of OER.

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TABLE OF CONTENTS

	Page
LIST OF TABLES	vii
LIST OF FIGURES	ix
Chapter	
I. INTRODUCTION	1
Statement of the Problem.....	2
Research Questions	2
Background and Significance	3
Limitations	4
Assumptions.....	4
Procedures for Collecting data.....	5
Definition of Terms	6
Summary and Overview	7
II. REVIEW OF LITERATURE.....	9
College Textbook Costs.....	9
How Students Pay for Textbooks.....	10
Alternatives to Purchasing Textbooks.....	10
A Possible Solution	11
Faculty and Administration Concerns	11
Effects of Textbook Costs on Course Completion Rates	12
The Rise of OER in Response.....	13
Lack of Research to Support Current Implementation of OER	13
Summary.....	15
III. METHODS AND PROCEDURES	16
Population	16
Instrument Design	16
Methods of Data Collection	17
Statistical Analysis	17
Summary.....	19
IV. FINDINGS	20
Overview of Data Collected.....	20
Enrollment Rates	21
Withdrawal Rates	26

Chapter	Page
Student Performance.....	27
Summary.....	40
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	41
Summary.....	41
Conclusions.....	43
Recommendations	45
REFERENCES	47
APPENDICES	
A. Letter Requesting Data	50
B. Letter Requesting Information	51

LIST OF TABLES

Table	Page
1. Letter Grade Point Value Assignments	18
2. Enrollment for MTH 163 Spring	22
3. Enrollment for MTH 164 Spring	22
4. Enrollment for Business Fall	23
5. Enrollment for Economics Spring.....	23
6. Enrollment for English Spring	24
7. Enrollment for History Spring	24
8. Enrollment for Political Science Spring	25
9. Enrollment for Psychology Fall	25
10. Enrollment for Psychology Spring	26
11. Aggregate Enrollment Data	26
12. Aggregate Withdrawal Data	27
13. Student Academic Performance in HIS 122 Fall and Spring	28
14. Student Academic Performance in History Spring	29
15. Student Academic Performance in ITE 115 Fall and Spring.....	29
16. Student Academic Performance in Information Technology Essentials Spring.....	30
17. Student Academic Performance in MTH 163 Spring	30
18. Student Academic Performance in MTH 164 Spring	31
19. Student Academic Performance in Math Spring.....	31

Table	Page
20. Student Academic Performance in MUS 121 Fall and Spring	32
21. Student Academic Performance in Business Fall	33
22. Student Academic Performance in Economics Fall.....	33
23. Student Academic Performance in Economics Spring.....	34
24. Student Academic Performance in Economics Fall and Spring	34
25. Student Academic Performance in English Spring.....	35
26. Student Academic Performance in Lab Science Fall	36
27. Student Academic Performance in Lab Science Spring.....	36
28. Student Academic Performance in Political Science Spring.....	37
29. Student Academic Performance in Psychology Fall.....	37
30. Student Academic Performance in Psychology Spring.....	38
31. Student Academic Performance in Psychology Fall and Spring	38
32. Student Academic Performance in All Courses Fall and Spring	39

LIST OF FIGURES

Figure	Page
1. Analysis of means for student academic performance in all courses for the Fall and Spring semesters	39

CHAPTER I

INTRODUCTION

Although the unemployment rate in the United States has been dropping steadily from 2009, a somewhat hidden statistic is troubling. The number of employable Americans who have ceased looking for work is at an all-time high, greatly reducing the pool of employees required to keep pace with the nation's workforce needs (Gordon, 2015). According to some reports, people are entering the job market at the slowest pace since 1990 (Zumbrun, 2014). One of the factors contributing to the reluctance of workers to enter the job market is that the vast majority of low and middle-skill jobs have been replaced with jobs requiring more education, career skills, and problem-solving ability than the unemployed possess (Gordon, 2015).

The shortage of skilled and educated workers is a daunting issue for the state of Virginia. The Virginia Community College System (VCCS) estimates that in the next ten years, Virginia will need to fill 1.5 million jobs requiring a postsecondary credential of an associate degree, certification, or license. In order to meet the demand, the VCCS Chancellor spearheaded a six-year strategic plan entitled *Complete 2021*. The goal is to triple the number of credentials awarded to students by the year 2021 (VCCS, 2014). The multi-faceted plan includes the *Zx23 Project*, which seeks to encourage and enable students to obtain degrees with zero textbook costs at all 23 colleges in the system (Sebastian, 2015). This initiative is expected to increase the credentialing rate by removing the barrier of textbook costs which have become a large portion of the overall cost of an education.

In a recently released study, Senack and Donoghue (2016) found the cost of textbooks has increased over four times the inflation rate since 2006, which equates to a 73% increase. The average price of a college textbook now lies between \$200 and \$400, bringing the total spent on

textbooks in the United States to over \$3 billion per school year. At this level, the cost of books rivals the cost of tuition at lower-priced institutions. The staggeringly high cost of textbooks has been shown to disproportionately affect community college students, who use financial aid to pay for textbooks at a rate of 50%, as compared to 28% of students attending four year institutions. Students or unemployed workers considering earning a degree, credential, or license to increase their employability must also include the cost of textbooks in their decision-making, unless they have the choice of earning a degree with zero textbook costs, or a Z-degree.

Utilizing a \$200,000 grant from the William and Flora Hewlett Foundation, the VCCS implemented a plan to provide Z-degrees through the use of Open Educational Resources. The one-year grant is expected to save 50,000 community college students \$5 million in the first year in textbook costs and set the VCCS on the path to expanding the Z-degree offerings in the future (VCCS, *Virginia's Community Colleges*, 2015). Vital to the success of this plan is the enrollment, retention, and academic success of students in courses that use OER as the course text. This study evaluated these three metrics for all courses offered at Central Virginia Community College for the 2015-2016 academic.

Statement of the Problem

The problem of this study was to evaluate the enrollment rates and academic performance of students in courses at Central Virginia Community College (CVCC) that utilize Open Educational Resources (OER) to help determine if the use of such materials should be encouraged and expanded in the Virginia Community College System.

Research Questions

The objectives of this study were to explore the following questions:

RQ₁: Does the enrollment rate in courses at CVCC that use OER differ from other sections of the same courses that use textbooks students are required to obtain?

RQ₂: Does replacing a required text with OER increase the completion rate in those courses as compared to non-OER courses?

RQ₃: Is CVCC students' academic performance affected by the use of OER?

Background and Significance

The definition and establishment of a body of resources known as OER was accomplished by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 2002 when it convened a Forum on the Impact of Open Courseware for Higher Education in Developing Countries (UNESCO, 2002). Since that time, the availability and quantity of OER has grown, and it is considered the “top Key Trend in terms of likely significance for higher education from 2013-18” (Shear, Means, & Lundh, 2015, p. 1).

The Zx23 Project used state and grant funds to support and train faculty and staff at 16 VCCS schools. The goal was to encourage faculty adoption of OER as the texts for as many courses as possible, in order to eventually build Z-degrees at all 23 schools in the system (Sebastian, 2015). At the time of this writing, there is no mandated use of OER at any of the schools and therefore faculty must be convinced of the benefits, as well as assured of the lack of negative effects of adopting the resources.

Many of the faculty in the VCCS are not aware of the source, availability, or proper use of OER. With regard to the general post-secondary culture of textbook adoption, “environmental and policy barriers have slowed the development and adoption of open educational resources” and there are “skewed perceptions about learning materials that value frills over efficacy” (Senack & Donoghue, 2016, p. ii). Other recent research emphasizes the need for further

examination of the issue, reporting that the efficacy of using OER as opposed to traditional resources is still largely unverified (Hilton, Robinson, Wiley & Ackerman, 2014). There is a need to answer the questions of this study before the goal of the VCCS to provide Z-degrees at every community college in the state can be realized.

Limitations

This research study had the following limitations:

1. This study considers OER to be “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 and 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” (Hewlett Foundation, n.d., p. 1).
2. The study was limited to comparisons of CVCC courses during the 2015 – 2016 academic year that used traditional textbooks to the departments and subjects that implemented courses using OER as the course textbook (e.g., BIO 102 General Biology II, BUS 221 Business Statistics I, ECO 202 Principles of Economics II – Microeconomics, ENG 112 College Composition II, HIS 122 United States History II, ITE 115 Introduction to Computer Applications, MTH 163 and 164 Pre-Calculus II, MUS 121 Music Appreciation I, PLS 212 US Government II, PSY 200 Principles of Psychology).

Assumptions

This research study was based on the following assumptions:

1. CVCC collects data on enrollment and grades awarded in the same manner across all courses.
2. Individual colleges in the VCCS have the same reporting standards for enrollment and grade data.
3. Faculty using OER are not biased regarding student outcomes.
4. Other factors beyond the use of OER affecting enrollment rates and retention in equivalent sections, such as students dropping a course for reasons not related to the course materials or switching sections of a course due to scheduling conflicts, did not skew the data.
5. Other factors beyond the use of OER affecting academic outcomes in equivalent sections, such as student performance issues due to personal circumstances or faculty inadequacies, did not skew the data.

Procedures for Collecting Data

The data required for this study were collected by CVCC as part of the standard record-keeping procedure of the institution. CVCC collects statistical information for each semester, including the subject of all courses, the number of sections offered, the number of students who successfully completed each of these courses, the grade earned, and the number of students who dropped or were dropped from the course. The required textbook material or OER for each course was recorded. The researcher contacted CVCC's Office of Institutional Research to obtain the data necessary for this study.

The first research question of this study asks if the enrollment rate in courses at CVCC that use OER differ from other sections of the same courses that use textbooks students are

required to obtain. The second research question of this study asks if replacing a required text with OER increased the completion rate in those courses as compared to non-OER courses. Chi-square tests of independence were performed on the data collected to address both of these questions in order to determine if students enrolled in OER courses more often and dropped them less often than comparable sections using traditional textbook materials. Individual academic subjects were examined, as well as the enrollment and drop rates in all OER and comparable non-OER sections combined.

The third research question of this study asks if CVCC students' academic performance was affected by the use of OER. A t-test was used to determine if there was a significant difference between the mean grades in OER and comparable non-OER sections of the courses. Individual academic subjects were examined, as well as the OER and comparable non-OER sections combined.

Definition of Terms

The following terms used throughout this study are defined as follow:

1. **Open Educational Resources (OER) as defined by the William and Flora Hewlett**

Foundation: "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 and 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" (Hewlett Foundation, n.d., p. 1).

2. **Z-Degree:** A degree obtained from an institution of higher learning that requires a student to spend zero dollars on textbooks (Sebastian, 2015).

3. **Zx23:** A one-year grant to support the VCCS's goal of scaling Z-Degrees to all 23 VCCS colleges (Sebastian, 2015).

Summary and Overview

This study examined student enrollment and retention rates, as well as academic outcomes in CVCC courses using OER as the textbook for the 2015-2016 academic year, and it was organized into five chapters. Chapter I introduced the reader to the problem, which was to compare the number of students enrolled in and dropped from sections of courses using OER, to those that used traditional course materials such as textbooks. The academic performances of these same groups were also compared. It outlined the concerning issues of projected Virginia workforce shortfalls, both in regard to number of potential employees available, as well as the education and skill level of those individuals. The study was guided by the examination of the enrollment rate in courses at CVCC that use OER and determined if there was a difference from other sections of the same courses that use textbooks which students are required to obtain. Also examined was the question of whether replacing a required text with OER reduced the withdrawal rate in those courses as compared to non-OER courses. Finally, a final grade comparison was made to determine if CVCC students' academic performance was affected by the use of OER. The study was limited by the definition of OER as material available at no cost through information and communication technologies used for non-commercial purposes and by the courses taught at CVCC using OER. The data for the study were obtained from CVCC for the 2015-2016 academic year and they included the enrollment, drop, and grade information from courses using OER, as well as from all sections that did not.

A review of literature is provided in Chapter II in an attempt to identify the current state of OER usage, the efficacy of these materials, and the gaps in the literature justifying further

research. Chapter III details the methods and procedures used to collect the data required to complete the study. The findings of the study are presented in Chapter IV. Chapter V is a summary of the research, in addition to the conclusion and the recommendations of the study.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter is to review the literature related to the use of OER in college classrooms. The sections in this chapter include: College Textbook Costs, How Students Pay for Textbooks, Alternatives to Purchasing Textbooks, A Possible Solution, Faculty and Administration Concerns, Effects of Textbook Costs on Course Completion Rates, The Rise of OER in Response, Lack of Research to Support Current Implementation of OER, and Summary.

College Textbook Costs

The use of OER in academic institutions since early in the 21st century has arisen from a confluence of need and availability. In one generation, costs associated with earning a secondary degree at public, four year colleges and universities have risen by 250%, while in that same time period, the average family income has risen only 16% (Washington & Salmon, 2014). A disproportionate amount of the increase has come from the unfettered rise in the costs of traditional textbooks, which have risen at a rate four times higher than inflation (Hilton et al., 2014). A 2016 study by the Student Public Interest Research Group (PIRG) identified several reasons for high textbook prices. One is the nature of the textbook industry, which is a centralized publishing system where a few major publishers develop a majority of the content. Another is that in order to reduce the time to print, the industry relies on a legacy system which produces less effective teaching materials (Senack & Donoghue, 2016). As over 20 million American college students needed textbooks for college classes in the 2015-2016 academic year (Konczal, 2015), the issue affects quite a large portion of the population.

How Students Pay for Textbooks

Many of the students buying the pricey textbooks do not have the money to pay for them. The current estimate is that \$3.15 billion a year of financial aid is used to fund their purchase (Senack & Donoghue, 2016). The same study estimates that students who take out loans for college expenses pay an additional \$34.72 for every \$150 textbook, by the time the loan is paid back. Seventy percent of college graduates carry an average debt of \$25,000 and textbook costs have contributed significantly to this figure (Konczal, 2015). These numbers are even more alarming when they are compared to the cost of tuition at community colleges. In some cases, the cost of textbooks equals or exceeds the cost of tuition (Fischer, Hilton, Robinson, & Wiley, 2015). Textbook prices that hit the average college student hard, have an even greater effect on the community college population. In 2005, 55% of community college students were from the two lowest income quartiles, and in 2008, textbooks accounted for 59% of the total cost of attending community college (Hilton et al., 2014). The cost of traditional textbooks during four semesters earning an associate's degree adds as much cost to that degree as an additional semester (Senack & Donoghue, 2016). For most students attending a community college, an extra semester's worth of expenses is highly burdensome.

Alternatives to Purchasing Textbooks

When faced with the problem of purchasing a textbook they cannot afford, students must make a choice. The obvious first option is to not enroll in the course at all. Senack's (2014) study of high textbook prices surveyed 2,039 students from 33 states and 156 different campuses and it was found that for almost half of the students surveyed textbook costs limited the number of classes they were able to enroll in each semester. A Florida Student Textbook Survey reported 31% of students chose not to take a course for this reason (Donaldson, Nelson, & Thomas,

2012). If a student is attending college with the goal of obtaining a degree, “it is especially concerning that this process may be being undermined by high textbook costs” (Senack, 2014, p. 5).

In many of the smaller community colleges, and sometimes in the larger ones, an interruption in the flow of courses necessary to graduate results in getting out of semester sync with course offerings, and it can delay graduation by years. Early research findings indicate that OER can affect a shortening of the time to obtain a degree, in that students who completed courses using OER in one semester were found to enroll in a significantly higher number of credits the next (Fischer et al., 2015).

A Possible Solution

Students who are financially or otherwise motivated to complete their degrees as soon as possible may choose to enroll in a course anyway, even if they cannot afford the required course materials. In 2011, a Student PIRG survey found that 70% of the students questioned had skipped buying a book due to the cost (Senack, 2014). The study further states that the students do not enter this situation flippantly, in that 94% of them who had not purchased a textbook worried that doing so would result in a lower course grade than they otherwise would have been able to achieve. Courses where the text is an OER eliminate this conundrum altogether. If the academic performance of students using OER matches or improves the academic performance of those using traditional texts, then these resources can help eliminate the academically risky behavior of going the course alone without a textbook.

Faculty and Administration Concerns

Many educators who are encouraged to adopt OER in their classrooms are concerned that doing so requires them to engage in another type of risky behavior. OER has been shown to

undergo adequate peer review for content and accuracy for its intended use, but not for usability or impact in the classroom (Algers & Ljung, 2015). Of major concern is the academic performance of students who are taught using openly sourced materials. The Student PIRG (2016) study counters this concern with the claim that faculty who value fancy textbooks and the associated instructor and student resource materials possess skewed perceptions of the efficacy of such materials. Educational institutions are better equipped to mitigate the risk-taking necessitated by high textbook prices through the adoption of OER, but further study is needed to ensure positive academic outcomes.

Effects of Textbook Costs on Course Completion Rates

Students are often willing to take the risk of beginning a course without the required materials because of the drop and withdrawal system available to them at most institutions of higher learning. In traditional 16-week courses in the VCCS, a student generally has two weeks to drop a course with full tuition refund, and two months to withdraw from the course without negatively affecting their cumulative grade point average. The strategy is to try it and see if they manage with free, similar, or supporting materials and videos available on the internet or to occasionally borrow the book from a classmate. If the strategy is unsuccessful, they drop or withdraw from the course. Compounding the problem is the unfortunate fact that financial aid checks, which can be used to pay for textbooks, frequently arrive after the drop deadline (Wiley, 2015). In the study conducted by Fischer et al. (2015), a significantly higher rate of completion was found in a narrow set of academic subjects for students enrolled in courses utilizing OER. These findings are encouraging, in that the use of OER may improve this metric among financially needy students; however, the narrow set of subjects in which improvement was shown, as well as the small number and tight geographic location of the campuses involved

necessitates further study on the efficacy of OER in mitigating students dropping courses due to lack of supporting materials.

The Rise of OER in Response

There exists a large and growing body of resources that have collectively come to be known as OER, which is proliferating at a rate faster than the evaluation of them. The Hewlett Foundation defines OER as “high quality teaching, learning, and research resources that are free for others to use and re-purpose” (Hewlett Foundation, 2015, p. i). At approximately the same time in 2002 when UNESCO was conceptualizing OER, the Hewlett Foundation took up the cause of mitigating textbook prices by championing the use of no cost materials in colleges and universities. The entire concept was relatively unknown at the time, so the early task was to invest in anchor institutions whose presence and viability were necessary to move from idea to realization (Hewlett Foundation, 2015). Perhaps the most significant contribution was to the Creative Commons Corporation (CC) that has to date licensed more than a billion works (Kramer, 2016). CC defines OER as “teaching, learning, and research materials in any medium that reside in the public domain or have been released under an open license that permits their free use and re-purposing by others” (Creative Commons, n.d., *Education / OER*, para. 1). The Hewlett Foundation claims that because of their work supporting organizations such as CC, and similar work of other foundations such as Gates and Ford, 2015 was the year that OER moved from an eccentric curiosity to mainstream adoption in academia (Kramer, 2016).

Lack of Research to Support Current Implementation of OER

The explosion of available materials over the past decade created a situation where the use of OER has run ahead of the proven efficacy and sufficiency of the materials. In addition to the licensing activity of Creative Commons, Rice University’s OpenStax produces textbooks that are

already being used in over 1,000 courses worldwide, and MIT's OpenCourseWare receives an average of a million visits each month (Hewlett Foundation, 2015). The trend is predicted to continue, bolstered by a \$10 million unrestricted grant for general operating expenses pledged to CC by the Hewlett Foundation in 2016 (Kramer, 2016; Shear, Means, & Lundh, 2015). Despite the rapidly increasing adoption of OER in classrooms, by the end of 2015, only six studies of varying rigor had been conducted that compare the effect of student performance in courses using OER with similar courses that did not use OER (Fischer et al., 2015). The lack of vetting of materials is worrisome to some faculty who are being encouraged to adopt OER, because "numerous studies demonstrate that the curriculum and its tools, including textbooks, need to be dissected and discussed in the larger contexts and framework of a discipline" (National Research Council, 1999, p. 188).

Proponents of the OER movement expect the metrics examined in this study, namely enrollment rate, completion rate, and academic performance of students, as well as many others, to all improve as the practice becomes more common and widespread (Wiley, 2015). The effect is predicted to be especially dramatic on community college campuses. In addition to the demographics of these students, which differ from those of college students in general, Wiley (2015) points out that community colleges do not employ a "full-time" enrollment status, and thus these students pay for every single credit hour taken. As such, they are expected to enroll in OER classes at a higher rate. The same article claims that similar, positive effects on drop rate and academic outcome will be realized through the adoption of OER. Lumen Learning, an organization which supports institutions endeavoring to replace traditional textbooks with OER, has its first research paper supporting these conjectures currently under review (Wiley, 2015).

Preliminary studies indicate that OER may have a positive impact on student enrollment rates (Pitt, 2015). Fischer et al. (2015), whose study included six community colleges, as well as three 4-year institutions, found that students whose faculty utilized OER performed as well or better than students whose faculty required commercial textbooks, across three key measures of student success: course completion, final grade of C- or higher, and course grade. Unfortunately, much of the research on the topic to date has dealt with attitudes and availability, instead of concrete outcomes. “OER may ultimately be the genuine equalizer for education and for empowering social inclusion in a pluralistic, multicultural, and imperfect world” (Olcott, 2012, p. 283). All of these factors are shining a light on the need for further research into the use of OER in colleges, especially in the highly affected community college settings, in order to wisely promote and use this promising new resource.

Summary

Chapter II, Review of Literature, began by explaining how and why college textbook costs are creating problems for students. The remainder of the chapter was organized around the problem statement and research questions. Student enrollment rates were addressed in the section covering the unfortunate ways in which students are dealing with the issue. The possibility of addressing the issue by utilizing OER and the concerns this solution raises among faculty and administrators were discussed. Next, high textbook costs were shown to adversely affect course completion rates. The low number of research studies on the use of OER as a solution to drop rates of students who cannot afford the course materials was exposed. Finally, the rapid rise of the availability and use of OER without supporting evidence of corresponding academic performance highlighted the need for further study.

CHAPTER III

METHODS AND PROCEDURES

The problem of this study was to evaluate the enrollment rates and academic performance of students in courses at Central Virginia Community College (CVCC) that utilize Open Educational Resources (OER) to help determine if the use of such materials should be encouraged and expanded in the Virginia Community College System. This research was a descriptive study. The following sections detail the population studied, and the methods and procedures used to gather the data for the study. Finally, the statistical methods used to analyze the data are explained.

Population

The population for this study consisted of students enrolled in at least one course at a CVCC during the Fall 2015 and Spring 2016 semester, where there were courses that used OER as the course textbook. The VCCS consists of 23 colleges across the state with a total enrollment for the 2014-2015 academic year of 262,073 students (VCCS, *VCCS Annual Enrollment*, 2015). Sixteen out of the 23 schools are participating in the Zx23 pilot program. Data were collected from one of these schools, Central Virginia Community College. This study was limited to students in courses taken for academic credit, not those taken as part of an industry credentialing program. Courses which assigned grades on a pass/fail basis were not included.

Instrument Design

This study was conducted in order to help guide the VCCS on the adoption of OER for the required course material. The larger goal of the VCCS is to establish associate's degrees that do not require the purchase of textbooks, known as Z-degrees. As such, it was necessary to use data collected by a VCCS school as part of their standard record-keeping procedure. Central Virginia

Community College (CVCC) is one of the colleges in the VCCS working to establish such Z-degrees. At the end of each semester, CVCC records enrollment, drop, and academic performance information for all enrolled students. The data includes department, course, and section identifiers. The names of faculty participating in the Z-degree project each semester is made available by the VCCS (Sebastian, 2015). The researcher obtained the sample data for the Fall 2015 and Spring 2016 semesters. Data were provided for all courses taught at CVCC during the two semesters and included the enrollment number, the number of withdrawals, and the final course grade. The data were sorted as belonging to an OER or non-OER section using information from professors regarding course materials.

Methods of Data Collection

The researcher requested access to the data from the VCCS Vice Chancellor for Academic Services and Research in Richmond, VA. The Vice Chancellor reported that system-wide data would not be accessible, but were available at the individual college level. Data for Central Virginia Community College were provided by CVCC's Office of Institutional Research for the Fall 2015 and Spring 2016 semesters. See Appendix A for the letter requesting data.

Statistical Analysis

The first research question of this study asked if the enrollment rate in courses at CVCC that use OER differs from other sections of the same course that use textbooks students are required to obtain. Contingency tables (2x2) utilizing Fisher's exact test were used to determine if there was a difference in frequency of enrollment in the two types of sections. Available seats were counted for each section and compared to the number of seats filled. A separate analysis was done on each of the individual courses or sections that were taught with OER, and were

compared to corresponding courses or sections which did not. An aggregate comparison was also made.

The second research question of this study asked if replacing a required text with OER increases the completion rate in those courses as compared to non-OER courses. A Chi-square analysis with Yates correction was used to determine if there was a difference in frequency of dropping the course in the two types of sections. An analysis was done in aggregate comparing withdrawals from non-OER courses to withdrawals from OER courses.

The third research question of this study asked if CVCC students' academic performance was affected by the use of OER. Multiple t-tests were performed to determine if there was a significant difference between the two sample means of final grades awarded in the sections using conventional textbooks as opposed to those using OER as the text. An analysis was done on individual subjects as well as in aggregate. Table 1 shows the grade point assignment given to reported letter grades. The college in the study does not employ the use of minuses.

Table 1

Letter Grade Point Value Assignments

Grade	Points
A	4
B	3
C	2
D	1
F	0

Summary

This chapter described the population included in the study and the method used to collect the data. The population for this study consisted of students enrolled in at least one course at CVCC in the Fall 2015 and Spring 2016 semesters. The data for the study were obtained from CVCC and were collected as part of their standard record keeping procedure. The information presented in this chapter allowed the reader the ability to gain a thorough understanding of the population studied, the procedures used to collect the data, and the statistics used to analyze the data. Chapter IV presents the findings of the analysis.

CHAPTER IV

FINDINGS

The purpose of this chapter is to report the findings of the research study. The problem of this study was to evaluate the enrollment rates and academic performance of students in courses at Central Virginia Community College that utilize Open Educational Resources to help determine if the use of such materials should be encouraged and expanded in the Virginia Community College System. Data for the study was obtained from CVCC, one of the colleges in the VCCS. An overview of the source and format of the data collected, and the method used to format data entries is given. An investigation of enrollment rates compares available seats filled in classes taught using OER with those taught using traditional texts on either a class or subject basis as data were available. Next, a single comparison of the number of completions and withdrawals in OER and non-OER taught courses is presented. The chapter concludes with an analysis of student performance in various courses and subjects, as well as an overall comparison of final grades in all classes that utilized OER to those that employed traditional texts.

Overview of Data Collected

The data consisted of an entry for each student enrollment in all classes conducted at CVCC during the Fall 2015 and Spring 2016 semesters. The total number of entries was 21,167. Each entry included the student outcome at the conclusion of the semester. Outcomes were reported as a letter grade A through F, or a W indicating the student withdrew or was administratively withdrawn from the class. There was no identifying field present in the data entries indicating whether the course had been taught using traditional textbook materials or OER; therefore, each professor participating in the Zx23 project was contacted and asked to identify sections taught with OER. See Appendix B for the letter requesting information. All

entries were sorted by subject, course, and section, then further divided into non-OER and OER. All student and professor identifiers were deleted, and each sorted entry contained only an A, B, C, D, F, or W. Letter grades were assigned point values as shown in Table 1, and total completions and withdrawals for each section were tallied.

Enrollment Rates

Research Question 1 asked if the enrollment rate in courses in the VCCS system that use OER differ from other sections of the same courses that use textbooks students are required to obtain. Contingency tables (2x2) utilizing Fisher's exact test were used to analyze H_0 : There is no significant difference in the enrollment rate of courses taught with traditional texts and those taught with OER. Results of the comparisons made are given in Tables 2 - 11. Where possible, comparisons were made at the course level. If course level comparison data were not available, the OER courses were compared to non-OER courses in the same subject area. Although data were available from the Biology Department, they are not included in the individual subject or course enrollment comparisons because all biology courses are taught with OER at CVCC. The section concludes with an aggregate comparison of all data.

Two math courses offered both types of sections and could therefore be compared at the course level. The difference in enrollment rates for Pre-Calculus Math 163 sections that used OER and non-OER in the Spring semester was found to be not statistically significant. The two-tailed P value equaled 0.1606. Enrollments for Math 163 are shown in Table 2.

Table 2

Enrollment for MTH 163 Spring

	Enrolled	Seats Available	Percentage
Non-OER	77	100	77%
OER	25	50	50%
Total	102	150	68%

The difference in enrollment rates for Pre-Calculus Math 164 sections that used OER and non-OER in the Spring semester was found to be not statistically significant. The two-tailed P value equaled 0.6371. Enrollments for Math 164 are shown in Table 3.

Table 3

Enrollment for MTH 164 Spring

	Enrolled	Seats Available	Percentage
Non-OER	340	525	65%
OER	19	25	76%
Total	359	550	65%

The remainder of enrollment comparisons were made at the subject level, as there were no corresponding sections taught with non-OER and OER materials. The difference in enrollment rates for Business courses that used OER and non-OER in the Fall semester was found to be not statistically significant. The two-tailed P value equals 0.9048. Enrollments for Business courses are shown in Table 4.

Table 4

Enrollment for Business Fall

	Enrolled	Seats Available	Percentage
Non-OER	77	100	77%
OER	25	50	50%
Total	102	150	68%

The difference in enrollment rates for Economics courses that used OER and non-OER in the Spring semester was found to be statistically significant. The two-tailed P value equals 0.0370. Enrollments for Economics courses are shown in Table 5.

Table 5

Enrollment for Economics Spring

	Enrolled	Seats Available	Percentage
Non-OER	77	100	77%
OER	25	50	50%
Total	102	150	68%

The difference in enrollment rates for English courses that used OER and non-OER in the Spring semester was found to be not statistically significant. The two-tailed P value equals 0.6607. Enrollments for English courses are shown in Table 6.

Table 6

Enrollment for English Spring

	Enrolled	Seats Available	Percentage
Non-OER	1490	1620	92%
OER	99	100	99%
Total	1589	1720	92%

The difference in enrollment rates for History courses that used OER and non-OER in the Spring semester was found to be not statistically significant. The two-tailed P value equals 0.1875. Enrollments for History courses are shown in Table 7.

Table 7

Enrollment for History Spring

	Enrolled	Seats Available	Percentage
Non-OER	276	364	76%
OER	81	84	96%
Total	357	448	80%

The difference in enrollment rates for Political Science sections that used OER and non-OER in the Spring semester was found to be statistically significant. The two-tailed P value equals 0.0113. Enrollments for Political Science courses are shown in Table 8.

Table 8

Enrollment for Political Science Spring

	Enrolled	Seats Available	Percentage
Non-OER	55	96	57%
OER	141	144	98%
Total	196	240	82%

The difference in enrollment rates for Psychology sections that used OER and non-OER in the Fall semester was found to be not statistically significant. The two-tailed P value equals 0.5301. Enrollments for Psychology courses are shown in Table 9.

Table 9

Enrollment for Psychology Fall

	Enrolled	Seats Available	Percentage
Non-OER	402	432	93%
OER	18	24	75%
Total	420	456	92%

The difference in enrollment rates for Psychology sections that used OER and non-OER in the Spring semester was found to be not statistically significant. The two-tailed P value equals 0.8787. Enrollments for Psychology courses are shown in Table 10.

Table 10

Enrollment for Psychology Spring

	Enrolled	Seats Available	Percentage
Non-OER	438	500	88%
OER	20	25	80%
Total	458	525	87%

The difference in enrollment rates for all courses and subjects addressed above in aggregate was found to be not statistically significant. The two-tailed P value equals 0.5197.

Results are shown in Table 11.

Table 11

Aggregate Enrollment Data

	Enrolled	Seats Available	Percentage
Non-OER	3561	4228	84%
OER	496	614	81%
Total	4057	4842	84%

In total, the enrollment data in ten OER and non-OER courses and sections were studied. A statistically significant difference was found in Economics and Political Science courses taught in the Spring 2016 semester. The difference in enrollment rates for the remaining courses was found to be not statistically significant.

Withdrawal Rates

Research Question 2 asked if the withdrawal rate in courses in the VCCS system that use OER differ from other sections of the same courses that use required textbooks. A single Chi

Square analysis with Yates correction was used to analyze H_0 : There is no significant difference in the withdrawal rate of courses taught with traditional texts and those taught with OER. The data are considered in aggregate, comparing completions to withdrawals in all courses taught with traditional textbook materials to all courses taught using OER as the text.

The difference in withdrawal rates for all courses and subjects in aggregate was found to be statistically significant. The two-tailed P value equals 0.0250. Withdrawal rates are shown in Table 12.

Table 12

Aggregate Withdrawal Data

	Completed	Withdrew	Percentage
Non-OER	19272	1581	8.2%
OER	1895	187	9.9%
Total	21167	1768	8.4%

Student Performance

Research Question 3 asked if VCCS students' academic performance was affected by the use of OER. Letter grades were assigned numerical values corresponding to the values assigned by the college system when computing student grade point average as shown in Table 1 for the analysis of student performance. Withdrawals were not considered in these analyses. The method of analysis was comparison of means using unpaired t-tests. Results of the comparisons made are given in Tables 13 – 32. Where multiple sections of a course were offered with the choice of traditional materials or OER, individual courses were compared. Where all sections of a course were taught with OER, those scores were compared to other courses in the same department. Comparisons were made by semester and as well as in aggregate. Individual course comparisons

are presented first, followed by department comparisons. The number of instructors for each category is included in the tabulated data. The section concludes with an aggregate comparison of all data.

HIS 122, United States History II, was taught using both non-OER and OER materials in both the Fall and Spring semesters. The difference in the means is extremely statistically significant. The two-tailed P value is less than .0001. Results are shown in Table 13.

Table 13

Student Academic Performance in HIS 122 Fall and Spring

Group	Non-OER	OER
Mean	2.92	2.15
SD	1.13	1.39
SEM	0.07	0.16
N	244	74
Number of Instructors	10	1

History courses taught using OER were compared to all other non-OER history courses for the Spring semester. The difference in the means is very statistically significant. The two-tailed P value equals .0012. Results are shown in Table 14.

Table 14

<i>Student Academic Performance in History Spring</i>		
Group	Non-OER	OER
Mean	2.68	2.15
SD	1.3	1.39
SEM	0.06	0.16
N	478	74
Number of Instructors	9	1

ITE 115, Introduction to Computer Applications and Concepts, was taught using both non-OER and OER materials in both the Fall and Spring semesters. The difference in the means is not statistically significant. The two-tailed P value equals .9304. Results are shown in Table 15.

Table 15

<i>Student Academic Performance in ITE 115 Fall and Spring</i>		
Group	Non-OER	OER
Mean	3.18	3.14
SD	1.18	1.46
SEM	0.25	0.39
N	22	14
Number of Instructors	1	1

Note. In this case, the instructor was the same person for both.

When the ITE course taught with OER is compared to all other non-OER ITE courses, the difference in the means is not quite statistically significant. The two-tailed P value equals .0688.

Results are shown in Table 16.

Table 16

Student Academic Performance in Information Technology Essentials Spring

Group	Non-OER	OER
Mean	2.46	3.14
SD	1.31	1.46
SEM	0.11	0.39
N	135	14
Number of Instructors	6	1

MTH 163, Pre-Calculus I, was taught using both non-OER and OER materials in the Spring semester. The difference in the means is not statistically significant. The two-tailed P value equals .05739. Results are shown in Table 17.

Table 17

Student Academic Performance in MTH 163 Spring

Group	Non-OER	OER
Mean	1.91	2.09
SD	1.36	1.11
SEM	0.17	0.24
N	67	22
Number of Instructors	2	1

MTH 164, Pre-Calculus II, was taught using both non-OER and OER materials in the Spring semester. The difference in the means is extremely statistically significant. The two-tailed P value equals .0009. Results are shown in Table 18.

Table 18

<i>Student Academic Performance in MTH 164 Spring</i>		
Group	Non-OER	OER
Mean	2.86	1.88
SD	1.14	1.26
SEM	0.06	0.31
N	327	16
Number of Instructors	10	1

Math courses taught with OER were compared to all other non-OER math courses for the Spring semester. The difference in the means is very statistically significant. The two-tailed P value equals .0050. Results are shown in Table 19.

Table 19

<i>Student Academic Performance in Math Spring</i>		
Group	Non-OER	OER
Mean	2.57	1.97
SD	1.28	1.17
SEM	0.04	0.19
N	983	38
Number of Instructors	24	2

MUS 121, Music Appreciation I, was taught using both non-OER and OER materials in the Fall and Spring semesters. The difference in the means is not statistically significant. The two-tailed P value equals .6122. Results are shown in Table 20.

Table 20

Student Academic Performance in MUS 121 Fall and Spring

Group	Non-OER	OER
Mean	2.89	2.79
SD	1.16	1.04
SEM	0.11	0.16
N	121	43
Number of Instructors	1	1

Note. In this case, the instructor was the same person for both.

All sections of BUS 221, Business Statistics I, were taught using OER materials in the Fall semester. All other business courses were taught using non-OER. The difference in the means is not statistically significant. The two-tailed P value equals .8901. Results are shown in Table 21.

Table 21

<i>Student Academic Performance in Business Fall</i>		
Group	Non-OER	OER
Mean	2.52	2.48
SD	1.24	1.25
SEM	0.07	0.24
N	314	27
Number of Instructors	14	1

The results for the Economics Department are given in three separate tables, due to the variation in the significance levels. All economics courses were taught using both non-OER and OER materials in the Fall semester. The difference in the means is not statistically significant. The two-tailed P value equals .4255. Results are shown in Table 22.

Table 22

<i>Student Academic Performance in Economics Fall</i>		
Group	Non-OER	OER
Mean	2.55	2.72
SD	1.3	1.33
SEM	0.14	0.15
N	85	81
Number of Instructors	1	1

All economics courses were taught using both non-OER and OER materials in the Spring semester. The difference in the means is very statistically significant. The two-tailed P value equals .0019. Results are shown in Table 23.

Table 23

<i>Student Academic Performance in Economics Spring</i>		
Group	Non-OER	OER
Mean	1.93	2.62
SD	1.12	1.46
SEM	0.14	0.17
N	68	78
Number of Instructors	2	2

Due to the statistically significant results from the economics courses both semesters, the aggregate results are given in Table 24. The difference in the means is very statistically significant. The two-tailed P value equals .0096.

Table 24

<i>Student Academic Performance in Economics Fall and Spring</i>		
Group	Non-OER	OER
Mean	2.27	2.67
SD	1.26	1.39
SEM	0.1	0.11
N	153	159
Number of Instructors	2	2

Sections of ENG 112, College Composition II, which were taught using OER were compared to all English courses which used non-OER materials. The difference in the means is not statistically significant. The two-tailed P value equals .7343. Results are shown in Table 25.

Table 25

Student Academic Performance in English Spring

Group	Non-OER	OER
Mean	2.88	2.84
SD	1.16	1.03
SEM	0.03	0.11
N	1266	87
Number of Instructors	27	1

All sections of all biology courses were taught with OER for both semesters in the data, while no sections of physics or chemistry were taught with OER. All three courses are part of the science department and contain a lab component, and were therefore considered comparable. The difference in the means in lab sciences for the Fall semester is extremely statistically significant. The two-tailed P value is less than .0001. Results are shown in Table 26.

Table 26

Student Academic Performance in Lab Science Fall

Group	Non-OER	OER
Mean	2.85	2.42
SD	1.18	1.29
SEM	0.07	0.05
N	269	638
Number of Instructors	9	22

The difference in the means for lab sciences in the Spring semester is extremely statistically significant. The two-tailed P value is less than .0001. Results are shown in Table 27.

Table 27

Student Academic Performance in Lab Science Spring

Group	Non-OER	OER
Mean	2.87	2.45
SD	1.03	1.24
SEM	0.07	0.05
N	252	633
Number of Instructors	10	22

Sections of PLS 212, United States Government II, which were taught using OER were compared to all Political Science courses which used non-OER materials. The difference in the means is statistically significant. The two-tailed P value equals .0232. Results are shown in Table 28.

Table 28

Student Academic Performance in Political Science Spring

Group	Non-OER	OER
Mean	3.31	3.6
SD	0.86	0.73
SEM	0.12	0.06
N	54	139
Number of Instructors	3	1

Sections of PSY 200, Principles of Psychology, which were taught using OER were compared to all Psychology courses which used non-OER materials. The difference in the means for the Fall semester is not statistically significant. The two-tailed P value equals .6679. Results are shown in Table 29.

Table 29

Student Academic Performance in Psychology Fall

Group	Non-OER	OER
Mean	2.58	2.44
SD	1.34	1.1
SEM	0.07	0.26
N	364	18
Number of Instructors	9	1

Sections of PSY 200, Principles of Psychology, which were taught using OER were compared to all psychology courses which used non-OER materials. The difference in the means

for the Spring semester is statistically significant. The two-tailed P value equals .0150. Results are shown in Table 30.

Table 30

<i>Student Academic Performance in Psychology Spring</i>		
Group	Non-OER	OER
Mean	2.85	2.12
SD	1.19	1.62
SEM	0.06	0.39
N	409	17
Number of Instructors	9	1

Since the significance level differed between the two semesters, a comparison was made for the psychology data in aggregate. The difference in the means in aggregate is statistically significant. The two-tailed P value equals .0474. Results are shown in Table 31.

Table 31

<i>Student Academic Performance in Psychology Fall and Spring</i>		
Group	Non-OER	OER
Mean	2.72	2.29
SD	1.27	1.36
SEM	0.05	0.23
N	773	35
Number of Instructors	9	1

A final student academic performance comparison was made of all grades from classes taught using traditional textbooks to all grades from classes taught using OER for both the Fall and Spring semesters combined. The difference in the means in aggregate is extremely statistically significant. The two-tailed P value is less than .0001. Results are shown in Table 32.

Table 32

Student Academic Performance in All Courses Fall and Spring

Group	Non-OER	OER
Mean	2.91	2.54
SD	1.23	1.28
SEM	0.01	0.03
N	19272	1895

A graphical analysis of means for student academic performance in all courses for the Fall and Spring semesters is shown in Figure 1.

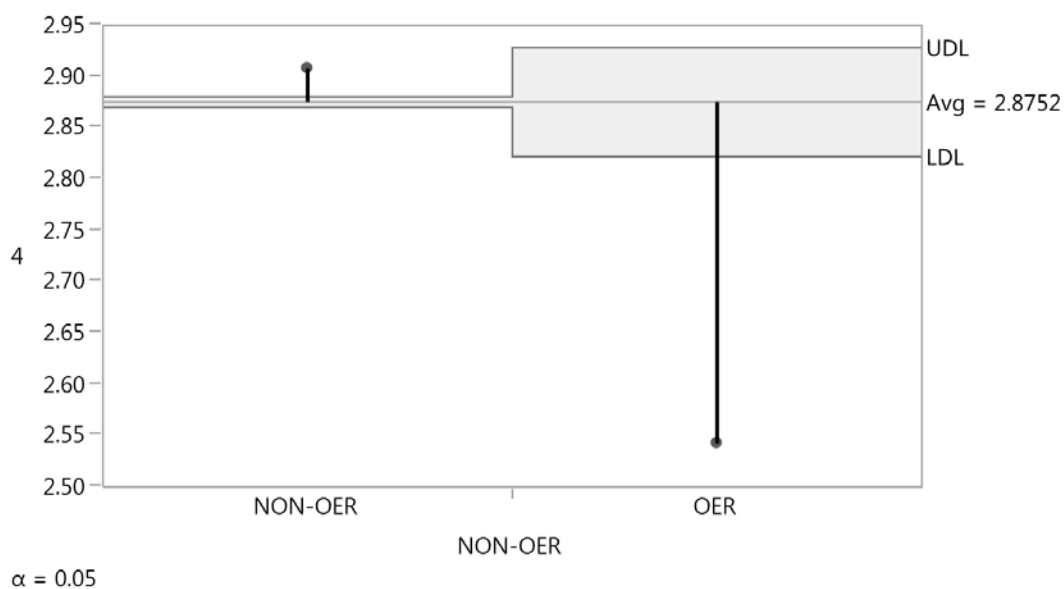


Figure. 1. Analysis of means for student academic performance in all courses for the Fall and Spring semesters.

In total, the Academic performance data in 20 OER and non-OER courses and sections were studied. A statistically significant difference was found in Political Science and Psychology courses taught in the Spring 2016 semester, as well as in Psychology for both semesters combined. A very significant difference was found in History, Math, and Economic courses taught in the Spring 2016 semester, as well as in Economics for both semesters combined. An extremely significant difference was found in HIS 122, MTH 164, Lab Sciences for both semesters, and for all courses in aggregate. The difference in enrollment rates for the remaining courses was found to be not statistically significant.

Summary

The findings for the study were presented in Chapter IV. Data for the study were obtained from CVCC, one of the schools in the VCCS participating in the Zx23 project. The data consisted of an entry for each student enrollment in all classes conducted at CVCC during the Fall 2015 and Spring 2016 semesters. The data were sorted by subject, course and section. Professors participating in the Zx23 project were contacted and asked to identify sections taught using OER. Numerical values were assigned to the letter grades awarded to students, and completions, withdrawals, and available seats in the classrooms were tallied. Numerous comparisons between courses taught with traditional materials and those taught using OER were made with regard to enrollment, withdrawal, and student performance. A level of significance was reported for each comparison. In Chapter V, a summary of the research will be presented. Conclusions will be drawn from the statistical analyses of the data and recommendations will be made.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter will provide a summary, draw conclusions based on the findings, and make recommendation for use and further research. A summarization will provide an overview of the study. The research questions will be examined based on the findings in Chapter IV in order to draw conclusions. Finally, a recommendation will be made regarding the use of the findings and the need for further study of the subject.

Summary

The state of Virginia is facing a critical shortage in the next ten years of the educated and skilled workers it will need to fill 1.5 million jobs requiring a postsecondary credential of an associate degree, certification, or license (VCCS, 2014). The community college system is well-positioned to provide the education and training needed to prepare people to fill these jobs.

Although the tuition at community colleges is relatively low, the high cost of traditional textbooks can add as much cost to a degree as an extra semester. One solution to this problem is to provide zero textbook cost degrees. Colleges are beginning to offer classes using free textbooks known as Open Educational Resources (OER). In order to study the effects and effectiveness of OER on community college students, three research questions were established:

RQ₁: Does the enrollment rate in courses at CVCC that use OER differ from other sections of the same courses that use textbooks students are required to obtain?

RQ₂: Does replacing a required text with OER increase the completion rate in those courses as compared to non-OER courses?

RQ₃: Is CVCC students' academic performance affected by the use of OER?

There is a need to answer the questions of this study to inform the incorporation and expansion of the Z-degree program in the VCCS.

The population for the study consisted of students enrolled in at least one course at CVCC during the Fall 2015 and Spring 2016 semester, where the course instructor assigned a letter grade upon completion. Pass/fail and certification courses were not considered. The instrument used to collect the data was gaining access to student academic data recorded by the college each semester. Appeals and justifications were made to the officers of the school who authorized a copy be given in Excel format to the researcher.

The data were sorted by department, course, and section. A list of professors participating in the Zx23 project was obtained from the VCCS (Sebastian, 2015). These professors were contacted and asked to provide the course and sections numbers of the classes they taught using OER. Each data entry was reduced to a grade A – F or W and sorted into files by department. Non-OER and OER course results were placed in separate columns within these files. Letter grades were assigned corresponding numerical values, and completions and withdrawals were tallied. Available seats for courses that had at least one section taught with OER were counted from facility information on the college website (Central Virginia Community College, 2016). Enrollment data were analyzed with contingency tables (2x2) utilizing Fisher's exact test. Withdrawal data were analyzed using a Chi-square analysis with Yates correction. Student academic performances within subject areas were analyzed using unpaired t-tests, performed with GraphPad software (GraphPad, 2016). Due to limitations on the size of the data entered, the final aggregate unpaired t-test on the effects of OER on student performance was performed with JMP (JMP Statistical Discovery, 2016).

Conclusions

Based on the analysis of the student data obtained from CVCC, the following conclusions were drawn:

Research Question 1: Does the enrollment rate in courses at CVCC that use OER differ from other sections of the same courses that use textbooks students are required to obtain?

According to the findings, two out of ten comparisons showed significance in the difference of enrollment rate between non-OER and OER sections. For economics in the Spring semester, the chi-square value exceeds the critical value ($4.68 > 3.840$, $p < .05$) so it can be concluded that there was a difference between the enrollment rate in sections of economics taught using traditional textbooks and those using OER. More specifically, students enrolled in OER sections at a significantly lower rate than in non-OER sections.

For political science in the Spring semester, the chi-square value exceeds the critical value ($6.79 > 6.640$, $p < .01$) so it can be concluded that there was a difference between the enrollment rate in sections of political science taught using traditional textbooks and those using OER. More specifically, students enrolled in OER sections at a significantly higher rate than in non-OER sections.

All other subjects examined, as well as the aggregate comparison of MTH 163, MTH 164, Fall business, Spring economics, Spring English, Spring history, Spring political science, and Fall and Spring psychology showed no significant difference in the enrollment rates. We can conclude that the enrollment rate in OER taught courses in these subjects does not differ from the enrollment rate in non-OER taught courses. H_0 is accepted.

Research Question 2: Does replacing a required text with OER increase the completion rate in those courses as compared to non-OER courses?

According to the findings, there is a significant difference in the completion rate of courses taught with traditional texts and those taught with OER. The chi-square value exceeds the critical value ($5.021 > 3.840$, $p < .05$) so it can be concluded that there was a difference between the withdrawal rate in sections of courses taught using traditional textbooks and those using OER, and H_0 is rejected. More specifically, students withdrew from OER sections at a significantly higher rate than from non-OER sections.

Research Question 3: Is CVCC students' academic performance affected by the use of OER?

According to the findings, there was no significant difference in the academic performance of students in eight of the 20 subjects studied: ITE 115 Fall and Spring, Information Technology Essentials Spring, MTH 163 Spring, music Fall and Spring, business Fall, English Spring, and psychology Fall. We can conclude that the use of OER did not affect student performance in the sample studied.

The sample in three subjects showed a significant difference in academic performance results. In political science courses in the Spring, the calculated t exceeds the critical value ($2.288 > 1.960$, $p < .05$). In psychology courses in the Spring, the calculated t exceeds the critical value ($2.443 > 1.960$, $p < .05$). In psychology courses in aggregate, the calculated t exceeds the critical value ($1.985 > 1.960$, $p < .05$). Mean grades were higher in OER taught political science sections, while mean grades were lower in OER taught psychology sections. We can conclude that the use of OER significantly affected student performance of this sample in these subjects.

Four subjects showed a very significant difference in academic performance results. In history courses in the Spring, the calculated t exceeds the critical value ($3.257 > 2.576$, $p < .01$). In math courses in the Spring, the calculated t exceeds the critical value ($2.815 > 2.576$, $p < .01$). In

economics courses in the Spring, the calculated t exceeds the critical value ($3.157 > 2.576$, $p < .01$). In economics courses in aggregate, the calculated t exceeds the critical value ($2.605 > 2.576$, $p < .01$). Mean grades were higher in OER taught economics sections, while mean grades were lower in OER taught history and math sections. We can conclude that student performance of this sample in these subjects is very significantly affected by the use of OER.

Four subjects as well as the data in aggregate showed an extremely significant difference in academic performance results. In HIS 122 in the Fall and Spring, the calculated t exceeds the critical value ($4.879 > 3.291$, $p < .001$). In MTH 164 in the Spring, the calculated t exceeds the critical value ($3.3642 > 3.291$, $p < .001$). In lab science courses in the Fall, the calculated t exceeds the critical value ($4.640 > 3.291$, $p < .001$). In lab science courses in the Spring, the calculated t exceeds the critical value ($4.763 > 3.291$, $p < .001$). In all courses in aggregate, the calculated t exceeds the critical value ($3.657 > 3.291$, $p < .001$). In all cases of extreme significance, mean grades were lower in OER taught sections than in sections taught with traditional texts. We can conclude that student performance of this sample in these subjects and in aggregate is extremely significantly affected by the use of OER.

Recommendations

The results and conclusions of this study are at odds with other studies done in the subject area. There are several factors which may have contributed to these findings. Due to the lack of access to system-wide data, the study was limited to data from only one college in the VCCS. In many cases, only one professor in a department offered sections using OER materials.

Differences in results cannot be attributed solely to teaching materials in these instances. The greatest anomaly arose from the fact that the entire Biology Department at CVCC uses OER materials, and thus accounted for a large proportion of the OER data. The researcher was unable

to perform comparisons within the department for this reason. The differences in enrollment rate, withdrawal rate, and student performance between biology and the other lab sciences may be due to subject matter as well as types of textbooks used. The aggregate results may have been skewed by this situation as well. In addition, there were no identifiers in the catalog or online enrollment screens alerting students to the required textbook materials for the period covered in the data. Thus, students were required to check the online campus bookstore link for the course, travel to the physical bookstore, or contact the professor for the course to obtain required textbook information.

The researcher recommends the following, based on the data collected from CVCC:

- 1) Further research should be conducted on the use of OER at all of the colleges in the VCCS participating in the Zx23 project.
- 2) Research should be conducted to identify academic subjects that are more suited to the use of OER, so that the emphasis for their use can be appropriately placed.
- 3) This research should be repeated once an OER identifier has been added to the course sign-up process.
- 4) The administrators of the VCCS Z-degree project should use the results of this study as a point of feedback for the initiative.
- 5) Faculty considering the continuing use or adoption of OER should use the results of this study as a point of feedback.

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Appendix A

Letter Requesting Data

Marcella Gale
Central Virginia Community College
SME Division
3506 Wards Rd.
Lynchburg, VA 24502

4/10/2016

Dr. Cat Finnegan
Asst. Vice Chancellor for Institutional Effectiveness
Virginia Community College System
300 Arboretum Place, Suite 200
Richmond, Virginia 23236
Dear Dr. Cat Finnegan:
Dear Dr. Finnegan,

My name is Marcella Gale, and I am an adjunct professor for the SME Division and the XLR8 STEM Academy at CVCC. I am currently working on an M.S. in Occupational and Technical Education from ODU, and OER is the subject of my thesis paper. I chose the topic because of the Z-degree initiative, and because of the grateful students I have who appreciated my choice of OER for a course I teach.

I am currently seeking to gain access to enrollment, drop and academic performance data for the VCCS at the close of the current semester. Here are my research questions:

RQ1: Does the enrollment rate in courses in the VCCS system that use OER differ from other sections of the same courses that use textbooks students are required to obtain?

RQ2: Does replacing a required text with OER increase the completion rate in those courses as compared to non-OER courses?

RQ3: Is VCCS students' academic performance affected by the use of OER?

My thesis adviser is Dr. John Ritz (jritz@odu.edu) of the ODU Department of STEM Education and Professional Studies. Dr. Juville Dario-Becker, CVCC's OER Facilitator, suggested I contact Dr. Morrissey, who in turn directed me to you and your review committee.

I would greatly appreciate your assistance in obtaining the data I need in order to complete my thesis this summer.

Sincerely,

Marcella Gale

Appendix B

Letter Requesting Information

Dear OER Faculty,

I know most of you already, but for those I don't, my name is Marci (formerly Brown) Gale, and I am an adjunct faculty member for the SME Division and the STEM Academy here at CVCC. I am currently working on a thesis for my master's degree in Career and Technical Education from ODU. My topic is "Impacts of Open Educational Resources on Enrollment Rates, Withdrawal Rates, and Academic Performance in the Virginia Community College System". CVCC has provided me with enrollment, withdrawal and grade data from the Fall 2015 and Spring 2016 semesters, but there is not a field indicating which sections were taught with OER. I have all necessary approvals and permissions to use the data for my study. I would appreciate your taking a moment to let me know which subjects and sections you taught these semesters utilizing OER.

Thank you so much for your time - I appreciate it immensely!

Marcella (Brown) Gale

Adjunct Professor

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