STUDENT USAGE OF OPEN EDUCATIONAL RESOURCE LEARNING MATERIALS IN ALGEBRA 2

By

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Abstract

The cost of college course materials has increased dramatically in recent years. Traditional publishers advocate the use of lower-cost digital and custom editions, but both options have limitations in their ability to save students money (Senack & Donoghue, 2016). Open-educational resources (OER) are openly-licensed materials that may be used for free for educational purposes. OER are gaining in popularity as a viable alternative to traditionally published materials. Students have reported finding OER to be of equal or better quality when compared to traditional materials, and course outcomes have not been negatively impacted when OER materials are adopted (Colvard, Watson, & Park, 2018).

The purpose of this study was to describe the implementation of OER resources in a developmental Algebra 2 class for community college students who have declared non-STEM majors. The resources included a student workbook, associated videos, and an online homework tool which were cultivated to align with the Algebra 2 learning outcomes. Surveys and interviews were used to examine student and faculty perceptions of the OER materials. Final exam data indicated that there were no significant differences in the outcomes of students who used the OER resources and those who used the traditional resources.

Students generally had positive reactions to the OER materials used in this study, particularly the videos. Interestingly, students used the OER online homework tool in more ways than students used the traditional online homework tool. Faculty believed that students interacted with the OER materials with greater frequency than students who used traditional materials. In addition to the positive reactions, areas for improvement of the OER materials were noted. Specifically, students described a lack of written worked examples in the online and print materials, while also acknowledging the benefits of the available video worked examples.

The results of this study will be used to inform course material adoption decisions at the study location. The findings build confidence that OER materials are a viable option for community college mathematics course and provide direction when selecting and developing such materials.

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Chapter 1: Introduction

Community colleges are open-access institutions. As such they have programs specifically designed for students who may have gaps in their academic foundations. Those developmental programs typically include courses in mathematics and English, which are designed to teach specific basic skills. For many students, such classes prove to be a barrier rather than an access point to higher education. Nationwide, 68% of two-year college students take at least one developmental course in English or mathematics (Jaggars & Stacey, 2014). Referrals to developmental mathematics occur at a higher rate than do referrals to developmental English, with 59% of students referred in math and 33% in English (Bailey, Jeong, & Cho, 2010). Of students who take at least one developmental course, only 28% earn an associate degree or higher within eight years, whereas 43% of students not referred to developmental coursework complete a degree in eight years (Attewell, Lavin, Domina, & Levey, 2006; Jaggars & Stacey, 2014). Given these low degree attainment rates, there is a nationwide effort underway to improve college completion rates, and developmental education reform is a fundamental element of this effort.

County College is a diverse mid-sized community college located in the northeastern region of the United States that shares many characteristics with community colleges throughout the country, including dismal outcomes in developmental mathematics. In an effort to better understand outcomes for developmental students, County College's mathematics department analyzed the math course progression of the 2009 cohort of new students who placed into the lowest level of developmental mathematics. Four years later only 14% of the 971 students had completed at least one college-level math course at County College. At the time, students in the lowest placement cohort were required to complete up to five developmental courses before

enrolling in a college-level course. As of the end of the 2016-2017 academic year, developmental class pass rates, defined as the percentage of students on the day-10 roster who earn a grade of C or higher, remained in the 50-60% range.

In the 2017-2018 academic year, Algebra 1 with Support, Algebra 1, Algebra 2 with Support, and Algebra 2 comprised the set of developmental mathematics courses offered at County College. Students in a Support class also enrolled in a traditional section of Algebra 1 or Algebra 2; the Support class met immediately following the Algebra 1 or Algebra 2 class. For sections with a Support component, approximately half of the students were co-enrolled in the Support section; the other half were not required to enroll in a Support co-requisite course. This Support co-requisite model was County College's approach to acceleration in developmental mathematics.

In addition to Support and traditional offerings, County College's Algebra 2 was split into two versions, differentiated by the content of the intended college-level courses. Students with majors in science, technology, engineering, or mathematics (STEM) fields, along with some business majors took the STEM version of Algebra 2 designed to prepare them for pre-calculus. Students in other majors' college-level courses enrolled in the non-STEM version of the course. The non-STEM Algebra 2 class was designed to equip students for a college level course in statistics or mathematical structures. Students in allied health fields such as radiography and some in pre-nursing programs also enrolled in non-STEM Algebra 2. The Algebra 2 content in each version was customized to prepare students for their target college-level mathematics courses. The Support classes and the major-driven versioning of Algebra 2 were both examples of policy changes County College made to improve student outcomes in developmental

mathematics. Despite these changes, Algebra 2 pass rates continued to hover around 60%, and Algebra 2 was often seen as a barrier to degree completion.

Students in Algebra 2 attended approximately three and one-half hours of class per week; students in Algebra 2 Support attended an additional two hours. As is the case nationwide in developmental courses, most instruction in Algebra 2 focused on drill and practice, with an emphasis on skill-building (Goldrick-Rab, 2007; Grubb, 2013). Collaborative assignments were available on a shared file system for use in Algebra 2 non-STEM classes, but the faculty did not typically use them. While drill and practice instruction may result in skill efficiency and procedural knowledge, it does not facilitate conceptual understanding of the underlying mathematics (Hiebert & Grouws, 2007).

Outside of class, Algebra students were expected to work in Assessment and LEarning in Knowledge Spaces (ALEKS) (ALEKS, 2017), a mastery-based online homework tool. Based on a pre-test, the ALEKS system created a customized learning path for each student; the learning path was a linear progression through the required material, and students had little autonomy in selecting topics (Cho & Heron, 2015). ALEKS included worked examples for all problems and video explanations for some items, and a student had to answer three questions of the same type in a row to progress to the next topic. Although the developmental coordinators selected the content, and the progression of topics was pre-established by the ALEKS system. One result of the rigidity of the ALEKS learning path was that students often were spending time outside of class working on a section of their learning path not aligned with the current in-class subject matter. Faculty rarely assigned additional homework problems or readings from the textbook. Internal analyses of ALEKS data at County College indicated that, on average, a typical student spent less than two hours per week working in ALEKS.

Current technology affords opportunities to explore blended learning environments beyond the use of an online homework delivery tool, such as ALEKS. Such learning environments have shown to be more effective than entirely face-to-face or entirely online environments (Means, Toyama, Murphy, & Baki 2013). Definitions of blended learning environments vary, but they converge on the idea that "blended learning mixes e-learning with more traditional types of learning" (Harding, Kaczynski, & Wood 2005, p. 56). In mathematics, e-learning elements may include videos of worked examples and short video explanations along with online assessment tools. The provision of such supplementary materials may facilitate a higher level of student control of their learning than in the use of a single homework management tool.

In addition to the challenges of developmental education, the costs of textbooks and course materials such as homework tools, like ALEKS, have increased dramatically in recent years. Between 2007 and 2014, the average cost of a new textbook increased 44%, from $57 to $82, and the average price of used textbooks increased 20%, from $49 to $59 (College Board, 2016). A survey conducted by Student PIRGs found that students who used financial aid to pay for textbooks spent approximately $300 per semester on course materials (Senack & Donoghue, 2016). For a community college student, the average cost of textbooks over four semesters can be equivalent to an entire semester of tuition (Senack & Donoghue, 2016). Although textbooks may be a small portion of a student's overall budget, students are sensitive to their cost. A survey of over 22,000 Florida college and university students found that, due to textbook costs, 66.6% reported not purchasing a required textbook, and 47.6% indicated that they have at times taken fewer classes (Florida Virtual Campus, 2016). When students do not purchase textbooks, they decrease their potential for success in class, and taking fewer classes can prolong the time

required to earn a degree. Traditional publishers advocate the use of digital textbooks and custom editions of textbooks as cost-saving options, but both options have limitations in their ability to save students money (Senack & Donoghue, 2016).

Open-educational resources (OER), including textbooks and e-learning tools, are gaining in popularity as an alternative to traditionally published materials. An analysis by Student PIRGs (Senack, 2015) concluded that "if every student had just one of their traditional textbooks replaced with an OER or an open textbook, it would save students in this country more than 1 billion dollars annually" (p. 14). The William and Flora Hewlett Foundation funds OER-driven programs and research and describes 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 and repurposing by others. OER include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge. (The William and Flora Hewlett Foundation, 2015, p. 2)

Khan Academy is an example of an OER utilized in both academic and non-academic settings. Khan Academy materials are licensed under a Creative Commons Attribution-Non Commercial License (CC BY-NC), which means that they may be shared with or without adaptation, as long as they are attributed to Khan Academy and not used for commercial purposes (Creative Commons, 2017a; Khan Academy, 2017). In addition to video libraries such as Khan Academy, OER textbooks are also available. OpenStax, a nonprofit organization based at Rice University, currently has a library of more than 20 books that may be accessed digitally for free or purchased from Amazon or through a college's bookstore for generally under $60 (Fenton, 2016).

A myriad of other repositories exists for sourcing OER, and as more faculty adopt them, their availability will continue to expand. For example, in addition to larger-scale distribution and publication of OER, such as by Khan Academy and OpenStax, faculty members are independently and collaboratively creating materials and licensing them with Creative Commons (CC) licenses. CC licenses are free licenses that facilitate a creator's ability to permit others to share and use, with or without editing, their work (Creative Commons, 2017b). Given the ability to both reuse and revise OER, this type of publication provides an opportunity for collaboration within and between schools.

Scottsdale Community College (SCC) embarked on such an effort in the spring of 2012 when the mathematics department "created a cohesive strategy for using open educational resources" (Hilton, Gaudet, Clark, Robinson, & Wiley, 2013, p. 39). This approach resulted in the use of OER in five different mathematics courses in the fall of 2015. In their Introductory and Intermediate Algebra classes, SCC utilized a student workbook, written by faculty, a web-based homework tool, and an OER textbook. The student workbook included examples that students could complete by watching videos, along with practice problems and other assessments (Hilton et al., 2013). This design was intended to provide flexibility and consistency, since each faculty member employed various pedagogies (D. (Gaudet) Slaughter, personal communication, August 12, 2017).

Further, many sections of Introductory and Intermediate Algebra at SCC were taught by adjunct faculty, and the customized materials provided clear direction as to what content is included in the course (D. (Gaudet) Slaughter, personal communication, August 12, 2017). In an evaluation of the OER implementation, Hilton et al. (2013) estimated that students saved between $100,000 and $255,375 in one semester, with similar or better success rates than before

the use of OER in all but one of the classes. SCC has continued to revise and use the materials from the initial 2012 program, and the faculty has concluded that the initial adverse results for that one class were due to external factors ((D. (Gaudet) Slaughter, personal communication, August 12, 2017).

Embodying the collaborative spirit of OER, faculty at Housatonic Community College (HCC) in Connecticut have revised and implemented the materials used in Introductory Algebra and Intermediate Algebra at SCC (J. Nohai-Seaman, personal communication, July 12, 2017). The majority of Introductory and Intermediate class sections at HCC use the remixed OER materials, including face-to-face, hybrid, and online sections. In my capacity as developmental coordinator in the County College Mathematics Department, I collaborated with Professor Nohai-Seaman from HCC to further revise the HCC versions of the workbooks for use in non-STEM Algebra 2 at County College.

Similar to the HCC implementation, the County College iteration included the workbook, the associated worked example videos, and a digital OpenStax textbook. It also provided for the use of homework assignments in MyOpenMath, which was a free online homework tool. Many of the problems in the assignments included associated explanatory videos. The resources were available in Canvas, which was the learning management system (LMS) used at County College, in MyOpenMath, or on both platforms.

The workbook included lessons tailored to the content of the non-STEM version of Algebra 2. Lessons contain minimal expository text; however, they did contain essential definitions and mathematical notation along with worked and to-be-worked examples. The to-be-worked example problems were media-based examples, which were accompanied by explanatory videos. Other example problems were in the form of written worked examples,

similar to what is found in a traditional textbook. When accessing the media-based examples, students could have tried to complete the problems before watching the associated video, worked on the problems while watching the video, or not watched the video at all. Related practice problems provided students an opportunity to practice further and master the material. Each lesson also included an end-of-lesson assessment to help students consolidate the fundamental concepts. These components were similar to those found in a traditional textbook, but the learning experience may be more interactive than how students typically engage with a mathematics textbook.

Purpose of the Study

The high cost of textbooks and low success rates in developmental mathematics are two issues faced by community colleges across the nation. Serving as a developmental mathematics coordinator, I am particularly concerned with student success in Algebra 2. I believe we are missing an opportunity if we do not take advantage of the affordances of OER to offer students customized, accessible, low-cost materials. Since classes only meet twice a week, students need to devote time to learning the concepts outside of class. As a faculty, we may hypothesize that the materials we select for a class will facilitate student learning. However, the only way for us to know how students are engaging with course materials was to ask them.

The purpose of the proposed mixed methods study was to describe student usage of customized Algebra 2 OER learning materials, including video-based examples, related practice problems, an online homework platform, and a traditional OER textbook. The research questions that guided this study were:

1. How do students use the components of the Algebra 2 OER learning materials?

2. What do students perceive to be the benefits and disadvantages of the components of the Algebra 2 OER learning materials?
3. How do faculty perceive the effectiveness of the Algebra 2 OER learning materials as a support for student learning?
4. Do students' grades on the standard departmental final exam differ when faculty assigns the Algebra 2 OER learning materials in place of commercial textbooks and associated homework tools?

In addition to providing empirical evidence on the usage of the Algebra 2 OER learning materials, this study also provided a framework that can be used to evaluate the implementation of learning materials in other mathematics courses at County College.

Chapter 2: Literature Review

The literature review provides an understanding of the study's context, a developmental mathematics class, the current state of research on OER, and the elements of the OER materials that were investigated in this study. Given the low success rates of students referred to developmental coursework, developmental education is an area of great concern in higher education. The supporting literature explores placement in developmental courses and long term outcomes for students who are initially referred to remediation. The subsequent sections examine how students use their mathematics textbooks and provide background on open educational textbooks. Since examples are major components of most developmental mathematics textbooks, the literature on the use of written and video worked examples is also explored. In addition to text and video-based elements, the OER materials included a web-based homework component. Thus, this review also includes an overview of research on web-based homework, of which there are a myriad of options offered by traditional publishers. The review concludes with an examination of the tetrahedron model of student – artifact – instructor – mathematics interactions, which provides the theoretical underpinnings for the study.

Developmental Education Placement and Outcomes

At the post-secondary level, developmental education has been in formal existence since 1849 at the University of Wisconsin (Arendale, 2005; Dotzler, 2003). Before the expansion of comprehensive high schools, developmental education provided an alternate path to higher education for middle-class students; the need for developmental education increased with the passage of the G.I. Bill of Rights of 1944 (Arendale, 2005; Dotzler, 2003). The primary function of developmental education in it is initial conception was to build a specific academic skill set. That function has expanded into developmental programs which are often comprehensive,

including academic coursework, academic support such as tutoring, and non-academic support such as targeted advising programs.

Although community colleges are open-access institutions, new students have traditionally been assessed for placement purposes upon enrollment, unless they provide standardized tests scores, such as the ACT or SAT, that meet a minimum threshold (Gerlaugh, Thompson, Boylan, & Davis, 2007; Parsad, Lewis, & Greene, 2003). That placement assessment is typically in the form of a standardized test, such as the Accuplacer (Gerlaugh et al., 2007). The accuracy of this single test score as the primary placement mechanism has been a subject of ongoing concern and discussion in the community college sector, and the use of multiple measures for placement has become more prevalent.

As part of this conversation, Scott-Clayton, Crosta, and Belfied (2014) defined the concepts of underplacement and overplacement. Given different placement policies at different institutions, they were able to examine the outcomes for students with similar academic profiles but different initial placements. Students referred to a developmental course who would have passed a college-level course without first taking that developmental course were determined to be "underplaced," and the subset of such students likely to earn a B or higher in the college-level course were called "severely underplaced" (Burdman, 2012; Scott-Clayton et al., 2014). On the other hand, students who were assigned to a college-level course but were predicted to earn a D were "overplaced" while those predicted to fail were "severely overplaced" (Burdman, 2012; Scott-Clayton et al., 2014). When the score of a placement test was used without other validating measures, students were more likely to be underplaced than overplaced (Scott-Clayton et al., 2014).

With a dataset that included a large urban community college with six campuses and a statewide community college system with over 50 colleges, Scott-Clayton et al. (2014) examined the placement of over 48,000 students. Of those, 6,061 were placed via the ACCUPLACER, and they found that 12.3% of students were severely overplaced in mathematics and 14.3% were severely underplaced in mathematics (Scott-Clayton et al., 2014). In both instances, using the high school GPA along with the test score would have resulted in a more accurate placement outcome (Scott-Clayton et al., 2014). While many community colleges in New Jersey are now exploring the use of multiple measures, such as the ACCUPLACER score in conjunction with high school GPA, in placement, developmental classes contain a mix of students who were placed appropriately and those who were underplaced or severely underplaced.

Students who have successfully completed their developmental coursework have experienced college-level outcomes similar to those of students who did not require remediation (Aycaster, 2001; Bahr, 2008). In a study of 85,894 first-year students enrolled at 107 community colleges, Bahr (2008) used credential attainment and transfer as indicators of success and found that students referred to developmental mathematics succeeded at the same rate as their college-ready counterparts if they remediated successfully. Such success after transferring confirmed an earlier result found by Aycaster (2001) in a smaller-scale study of two-year colleges in the Virginia Community College (VCC) system. VCC students who completed their developmental mathematics did at least as well as their non-developmental classmates upon enrolling in a college-level course (Aycaster, 2001). Aycaster also found that retention rates for developmental students were higher than for their college-ready classmates, and faculty interviews indicated that smaller class sizes and specialized advising were possible explanations for the difference. The small sample in this study makes it impossible to validate those possible reasons. An

alternative hypothesis would be that students who succeed in their developmental coursework were underplaced initially and would have succeeded without remediation.

Despite positive outcomes for students who completed their developmental course of study, the majority of students have not succeeded in that endeavor. Bahr (2008) found that 75% of students in the 107 community college sample did not remediate successfully, and Bailey et al. (2010) found that 67% of students did not complete the developmental sequence to which they were referred. An analysis of 2,870 students' data from the Beginning Postsecondary Students (BPS) Longitudinal Study Providing provided further evidence to the claim that students do not complete their developmental coursework (Crisp & Delgado, 2014). That sample contained students who began their post-secondary education at a two-year college in 2003-2004, and Crisp and Delgado (2014) concluded that students intending to transfer to a four-year school were less likely to do so if referred to developmental coursework (Crisp & Delgado, 2014). This body of evidence on developmental outcomes indicates that some students who remediate successfully may have been underplaced, and would have succeeded without remediation, while others were appropriately assigned to developmental coursework, completed the developmental sequence, and had successful academic careers. However, a large number of students have been referred to developmental courses, and most of them have not succeeded in completing their developmental courses, much less a certificate or college degree.

Mathematics Textbook Usage by Students

Most developmental mathematics classes use a traditional textbook, sometimes in conjunction with an online homework platform. Many developmental mathematics students are also referred to developmental reading or writing courses, but the reading and interpretation of a mathematics text is not a learning objective for a developmental reading class (Gerlaugh et al.,

2007). No research has been done on how developmental mathematics students use their textbooks to support their learning, but there is evidence that college students in general may not be able to read and interpret their mathematics texts with fluency (Fan, Zhu, & Miao, 2013; Ní Shé, Mac an Bhaird, Ní Fhloinn, & O'Shea, 2017; Rezat, 2013; Weinberg & Wiesner, 2011; Weinberg, Wiesner, Benesh, & Boester, 2012). Mathematical textbook writing follows a specific style that often includes multiple concepts in one sentence along with minimal redundancy in explaining those concepts (Shepherd, Selden, & Selden, 2012). This style of mathematics textbook prose might contribute to such difficulty and reluctance.

Even first-year college students with strong reading abilities have difficulty effectively reading their textbooks and have reported that, unless incentivized to do, they often do not read their math textbooks (Shepherd et al., 2012). Shepherd et al. (2012) observed eleven students with strong reading abilities, as indicated by their ACT scores, while they read aloud and responded to think-aloud prompts. The students also attempted to apply what they read to straight-forward problems related to the readings. They were often not able to complete those related tasks due to insufficient or incorrect prior knowledge and a lack of attention to the details in the expository text (Shepherd et al., 2012). Thus, even when students in introductory math classes do read their textbook, they may not effectively learn from that reading activity.

Perhaps stemming from the difficulties that students find when trying to read a mathematics text, students have reported using the expository elements of the textbook, such as the introduction or summary, far less frequently than the examples and homework problems (Weinberg et al., 2012). Surveying 1156 students in introductory level mathematics courses at three different universities, Weinberg et al. (2012) found that students more frequently used their textbooks to practice what they did in class rather than using them to prepare for an

upcoming class. While mathematics textbooks are designed to support specific usage patterns comprised of reading text and worked examples followed by independent practice, students do not often comply with those intended usage patterns (Rezat, 2013; Shepherd et al., 2012; Weinberg & Wiesner, 2011; Weinberg et al., 2012).

Although this body of research is not extensive, studies conducted with a variety of methodologies and in various contexts suggest that students tend to be limited in how they use their textbooks. Lithner (2003) described the actions of three students as they engaged with their mathematics textbook, and all three focused on identifying similarities as a problem-solving technique. Rezat's (2013) investigation of German secondary students found that while they may have employed different strategies, their primary goal was to identify examples similar to what the teacher had done in class. Similarly, although only eleven students were observed by Shepherd et al. (2012), they all struggled to apply their readings to straightforward examples. These qualitative observations have been validated by a more extensive survey of university students in which they reported using their textbooks primarily to work on practice problems while referring to similar worked examples within the text (Weinberg et al., 2012). The expository portions of mathematics textbooks are being underutilized, and superficial learning strategies are being employed when students focus on similar procedural examples.

Open Educational Resource Perceptions and Outcomes

Since the early 2000s, OER have emerged and developed as an area of interest in higher education. What has become the series of OpenStax OER textbooks was initially conceived in 2000 by Richard Baraniuk and his colleagues at Rice University (Johnstone, 2005). The textbook work at Rice University was followed by MIT announcing their online OpenCourseWare project in the spring of 2001 (Johnstone, 2005). The United Nations

Educational, Scientific, and Cultural Organization (UNESCO) coined the term OER in 2002 and further defined OER in 2004 (Johnstone, 2005). Interest in OER grew through the first decade of the 21st century, and by 2010, research was emerging on the clear financial benefits of OER (Bliss, Robinson, Hilton, & Wiley, 2013; Colvard, Watson, & Park, 2018; Hilton et al., 2013; Schaffert, 2010). The research presented in this section will focus on the community college sector, although a larger body of research has been performed at four-year universities with similar findings.

Moving beyond investigations of the financial benefits of OER, a robust strand of OER research has examined student and faculty perceptions of OER, both at four-year and two-year institutions. One of the earliest studies to report on perceptions of OER at a community college was conducted in 2012 at Scottsdale Community College (Hilton et al., 2013). In the 2012 study, over 2000 students used OER in 65 math sections taught by 42 instructors. Students were surveyed, and 83% of them reported that the materials supported their work in class, and 78% indicated that the materials supported their work outside of class. A slightly lower percentage, 76%, said that they would recommend the use of the materials to their classmates. A small sample of 15 faculty members also responded to a survey about their perceptions, and of those, 13 felt that the materials supported their students' work inside and outside of class (Hilton et al., 2013).

Also in 2012, over 80 instructors across eight community colleges serving primarily at-risk students in a variety of disciplines, including mathematics, implemented OER and were surveyed about their experiences (Bliss et al., 2013). Only six percent of students surveyed at the conclusion of the study felt that the OER textbooks were worse than traditional materials. Although a few students reported content-related concerns, the primary reason students disliked

the OER materials was difficulty with the technology required to access the materials. Some of the benefits of the open textbooks cited by students included the low cost, convenient online access, and positive thoughts on the content (Bliss et al., 2013).

More recently, Illowsky, Hilton, Whiting, and Ackerman (2016) examined student perceptions of both the precursor to the OpenStax textbook *Introductory Statistics*, and the first edition of the textbook, once it was available. While OER are derived from a myriad of sources and vary in their design, the OpenStax textbooks have been adopted at over 5000 colleges and universities to date (OpenStax, 2018a). The initial study took place from 2013 through 2014 at a large suburban community college (Illowsky et al., 2016). In a survey with 231 respondents, students reported using the textbook as often as they would use any other textbook, with 65% reporting using it twice a week or more. Only 13% rated the quality of the textbook as being worse than other textbooks. Validating that result, 19% of students reported that they would intentionally avoid a section of a future course that used an OER textbook. On the other hand, 50% would specifically select an OER section while 32% had no preference. By 2015, the revised version of the OpenStax textbook *Introductory Statistics* was available and adopted. In a smaller survey of 94 students, 93% of the respondents reported that the revised version of the text was of similar or better quality to a traditional textbook (Illowsky et al., 2016). While students have been satisfied with initial OER offerings, one benefit of OER materials is that student feedback can be readily incorporated into updated versions as was done in the multi-stage examination of *Introductory Statistics*.

While financial savings and student satisfaction with OER are well documented, a smaller body of research examines student outcomes when OER are used. The outcome metrics used included exam scores, pass rates, failure rates, and persistence, which is typically indicated

by total credits taken (Colvard et al., 2018; Hilton, 2016). The findings have been mixed (Hilton, 2016; Hilton et al., 2013; Fisher, Hilton, Robinson, & Wiley, 2015). When OER were implemented in mathematics courses at Scottsdale Community College, pass rates remained consistent in all but one of the courses (Hilton et al., 2013). The authors hypothesized that the lack of success in the one course was due to factors not related to the OER materials (Hilton et al., 2013). In a multi-institutional study across five disciplines, Fisher et al. (2015) also found mixed results in pass rates. The study aggregated the data of 4,218 students enrolled in four-year universities with 12,599 students enrolled in community colleges. Of those, 4,909 students used OER materials in one or more of the 15 courses included in the study (Fisher et al., 2015). In one business course, with a total enrollment of approximately 225 across the traditional materials sections and OER sections, the students in the sections using the conventional materials had higher pass rates. In all other courses, comprised of classes in biology, mathematics, English, and psychology, student outcomes were either the same regardless of the course materials or the OER sections outperformed the non-OER sections (Fisher et al., 2015). Collectively, the work on outcomes indicates that students in classes using OER have achieved similar outcomes to those in classes using traditional materials.

Building upon that consensus, a more recent study examined success metrics for students disaggregated by financial need, race, and enrollment status (part-time or full-time) (Colvard et al., 2018). With the support of the Center for Teaching and Learning at a large research university, OER were implemented in eight large enrollment classes (Colvard et al., 2018). As a whole, students in the OER sections were more likely to pass than those in the non-OER sections. The pass rate was calculated as the complement to the DFW rate, which was the percent of students earning Ds, Fs, or Ws (withdrawal). Given the support of the Center for

Teaching and Learning in the implementation of OER, it was possible that these outcomes were the result of an increased focus on pedagogy or instructor interest in OER (Colvard et al., 2018). However, this potential limitation in the OER implementation analysis was mitigated by the fact that the study extended over 13 semesters, and it is likely that the Center for Teaching and Learning's involvement waned over time.

After examining the overall success rates, Colvard et al. (2018) disaggregated the data to consider students with higher financial need, minority students, and part-time students. Pell grant eligibility is often used a proxy for financial-need, and Colvard et al. (2018) compared outcomes based on students' Pell-eligibility status. Pell-eligible students saw a greater increase in average course grade and a larger decrease in the percentage of students who earned a D, F, or W than the non-Pell-eligible students. Similarly, while both white and non-white students benefited from the use of OER, non-white students made more significant gains in the measured outcomes. The same was also true when part-time students were compared to full-time students (Colvard et al., 2018). These findings indicate that in addition to supporting student learning as well as or better than traditional materials, the use of OER may be one mechanism through which colleges and universities can close the achievement gap for specific populations.

Worked Examples in Mathematics

In mathematics, worked examples are commonly found in textbooks and online homework platforms. Such examples typically include the problem statement along with a procedure that can be used to solve the problem (Atkinson, Derry, Renkl, & Wortham, 2000). Although some explanation of the procedure may be included with the worked example, it is rarely a complete explanation (Atkinson et al., 2000; Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Renkl, 2014). When paired with problem-solving activities, worked examples have been

shown to support procedural skill acquisition (Atkinson et al., 2000). In other words, students should not merely read and review the worked examples, but they should also engage in related problem solving activities after reading a worked example (Atkinson et al., 2000). Many math textbooks adhere to this logic. A worked example is often followed by one or more problems for a student to try, and the answers to those problems are readily available. After a series of examples and problems, a textbook section will typically conclude with a more substantial problem set, which may even direct students back to specific worked examples.

Since the 1980s, a large body of research has developed on the use of worked examples to support learning in algebra (Cooper & Sweller, 1987; Sweller & Cooper, 1985). Worked examples were not a new phenomenon in mathematics the 1980s. However, at that time, research began exploring the prioritization of worked examples over traditional problem-solving activities for the acquisition of symbolic manipulation skills (Cooper & Sweller, 1987; Sweller & Cooper, 1985). An initial series of experiments examined using worked examples as an alternative to traditional instruction of algebraic transformations. The experiments provided evidence that, at least for algebraic transformations, the extensive use of worked examples outperformed traditional instruction in stronger schema acquisition and rule automation (Cooper & Sweller, 1987; Sweller & Cooper, 1985). In these experiments, students in the worked example conditions were given worked examples paired with a similar practice problem, and students in the problem-solving conditions were given practice problems to complete after a period of instruction. On the whole, students in the worked example conditions performed better than their counterparts on measures of time, accuracy, and transfer (Cooper & Sweller, 1987; Sweller & Cooper, 1985).

In addition to examining differences between the use of problem-solving and worked examples, the experiments also explored variables such as the ability levels of subjects, the amount of time engaged in the acquisition activities, and the difficulty of the algebraic transformation problems (Cooper & Sweller, 1987; Sweller & Cooper, 1985). In the initial experiments, the same number of problems were used in the worked example and problem-solving groups, resulting in the time spent on the learning activities varying accordingly. Although the worked example groups were more efficient and accurate in solving similar problems, this did not lead to a marked difference in performance on transfer problems. However, when time spent in the acquisition phase was equalized between groups, the worked example groups outperformed the problem-solving groups (Cooper & Sweller, 1987; Sweller & Cooper, 1985). This led to the conclusion that the use of worked examples may speed up the cognitive processes necessary for the automation of skills and such automation is essential for the effective transfer of those skills to new domains (Cooper & Sweller, 1987).

One limitation of these initial experiments on the use of worked examples was that the students deemed low-performing were actually higher performing than students found in some high schools in the United States. Carroll (1994) built upon this work by conducting two experiments in an urban high school in which 82% of students performed below the median on a standardized mathematics exam. In these experiments, students worked on translating English phrases into mathematical symbols, a concept which is challenging for many beginning algebra students. During the acquisition phase, the worked example group attempted practice problems paired with similar worked examples. The conventional group tried to solve twice as many problems without the benefit of the worked examples. In this context, the worked example group also outperformed the conventional group on the acquisition phase activities. Further,

once the worked examples were removed, the worked example group still outperformed the traditional group. Of particular interest was that English language learners also benefited from the use of worked examples. These findings expanded the applicability of worked examples from algebraic transformations to algebraic applications and to a wider range of student populations.

In modern algebra textbooks, worked examples are evident in all content areas, and how students approach reading such worked examples impacts the success of their learning. Since worked examples often have limited or incomplete explanation of the reasoning behind the procedures, students must generate their own justifications to fully understand the example (Chi et al., 1989; Renkl, 1997). In the field of physics, Chi et al. (1989) observed eight college students and two college graduates as they studied three worked examples and applied them when solving isomorphic problems. All of the students had similar backgrounds in physics and the same pre-requisite knowledge. Based on the results of the problem-solving activities, the researchers classified the students as either Good students or Poor students. Good students used self-explanation when examining worked examples (Chi et al., 1989). Poor students did not generate as many self-explanations, were not as adept at identifying comprehension failures, and re-read prior examples rather than pinpointing the useful aspects of those examples (Chi et al., 1989). Carroll (1994) also found that weaker students did not self-explain during their use of worked examples, but they still benefited from the availability of similar examples during problem-solving activities and on subsequent post-tests. In other words, worked examples supported student learning by involving students in the learning process, even students who were deemed weak by standardized measures.

Renkl (1997) extended Chi et al.'s work by focusing on the quality of self-explanations produced by students in the context of probability-based calculations. A larger sample of 36 students was observed, which strengthened the generalizability of the results (Renkl, 1997). Successful students were classified as either anticipative reasoners or principle-based explainers. These categories were defined based on the spontaneous talking aloud the students were prompted to do during the experiment. Learners who engaged in anticipative reasoning built on their prior knowledge to compute probabilities before they were presented in the worked example; they predicted upcoming operations. Those who engaged in principle-based explanations and worked to apply meaning to the steps of the examples were more successful than the anticipative reasoners on the post-test. Similar to the observations of Chi et al. (1989), the less successful students engaged with the worked examples superficially and were not adept at identifying their misconceptions or lack of understanding (Renkl, 1997). When using worked examples as a learning tool, students do not need to be strong in a variety of self-explanation mechanisms to benefit from the use of worked examples; however, they do need to engage with the material in a meaningful way.

Video Worked Examples

Given the availability of new technologies in the 21st century, worked examples have moved from textbooks to online platforms. As part of that transition, Crippen and Earl (2004, 2007) examined the efficacy of embedding text-based worked examples when they were provided into an online quizzing system. The provided examples were used both as a means to explore unfamiliar problem types and to validate work on completed problems (Crippen & Earl, 2004, 2007). They found that found that students referred to and responded positively to engaging with worked examples in an online platform (Crippen & Earl, 2004, 2007).

As video-based technology has become widely available, video-based screencasts of course content have been more prevalent. Such podcasts can be sorted into three pedagogical categories: (a) receptive viewing, such as a recorded lecture; (b) student-generated; and (c) problem-solving explanations through the use of worked examples (Kay, 2012). Kay defined worked example videos as short clips with a specific problem-solving focus. Worked example videos may be presented in different formats, but one of the more common forms has been the viewer watching a pen or other device write the steps while a narrator explains the work. Other presentations have incorporated the inclusion of the narrator's head in the corner of the screen or the narrator writing on a board with the entire upper torso visible. While it may seem that different presentations would increase or decrease the cognitive load used to understand the example, each of these types of videos all have been shown to be effective (Hoogerheide, Loyens, & Van Gog, 2014).

Worked example videos, when viewed outside of class, have been shown to "have a positive impact on student attitudes, behavior, and learning performance" (Kay & Kletskin, 2012, p. 620). Specifically, when students used worked example video podcasts for a variety of learning activities, such as preparing for class and reviewing for assessments, they have found such videos to be enjoyable and motivating (Kay, 2012). Further, such videos have been linked to outcomes such as higher test scores (Kay, 2012).

Students have proven willing to engage with video podcasts linked to course material or future assessments, even when they were not required or linked to graded assignments (Kay & Kletskin, 2012; Yorganci, 2016). Kay and Kletskin (2012) and Yorganci (2016) examined the use of optional worked example videos as a way to address gaps in prior knowledge in mathematics students, both at the calculus level (Kay & Kletskin, 2012) and the vocational level

(Yorganci, 2016). The videos included an explained example problem, followed by a problem for the student to complete (Kay & Kletskin, 2012; Yorganci, 2016). The step-by-step solution to the student problem was also included, with prompts for the student to pause the video and work out the problem before continuing (Kay & Kletskin, 2012; Yorganci, 2016). Students reported finding the videos useful, and they experienced significant gains in knowledge after engaging with them (Kay & Kletskin, 2012; Yorganci, 2016). Students also stated that the videos facilitated their ability to pace their learning and contributed to their self-confidence and that they were preferable to more static presentations of the content (Kay & Kletskin, 2012; Yorganci, 2016).

Providing additional evidence that video worked examples support student learning, Kinnari-Korpela (2015) investigated the use of short video lectures, including worked examples as a key content element, with first-year engineering students at the Tampere University of Applied Sciences in Finland. Of the 45 students who responded to an end-of-semester survey, 93% reported that they had learned from the videos, and 43% said that the videos had increased their motivation. Specifically, students stated that the worked examples were particularly valuable, but several did note that the videos cannot entirely replace classroom instruction (Kinnari-Korpela, 2015).

Web-Based Homework

Web-based homework has become ubiquitous in college mathematics classes in the United States. Most, if not all, of the major publishers have linked their textbooks to one or more online homework platforms, which often come at a cost of upwards of $100 (Carns, 2016). OpenStax has also developed partnerships with several web-based homework providers for less expensive options linked to their OER textbooks (OpenStax, 2018b). Some research on the

effectiveness of web-based homework has concluded that it is linked to increased student achievement, but other studies have found no statistical effect on student achievement (Butler & Zerr, 2015; Jacobson, 2006; Lunsford & Pendergrass, 2016). In other words, the research has not conclusively stated that web-based homework is superior to pen-and-paper homework.

Despite the mixed results about the effectiveness of web-based homework, students have reported satisfaction with online homework systems (Butler & Zerr, 2005; Hauk & Segalla, 2005; Jacobson, 2006; Jonsdottir, Bjornsdottir, Stefansson, 2017; Lenz, 2010, Leong, 2014). Much of the research on web-based homework in college mathematics has included students' self-reported attitudes about such platforms. This research has been based in a variety of contexts, including two-year community colleges, large public universities, and small private universities, and in all levels of mathematics ranging from developmental classes to transferable classes such as calculus, statistics, or discrete mathematics.

Across these contexts, students have reported that the immediate feedback followed by the ability to retry a problem is one significant benefit of such tools (Butler & Zerr, 2005; Hodge, Richardson, & York, 2009; Lenz, 2010; Leong, 2014). Such immediate feedback has been shown to incentivize students to spend more time on their homework (Butler & Zerr, 2005; Lunsford & Pendergrass, 2016). Within web-based homework platforms, there are many on-demand support mechanisms such as embedded videos, worked examples, step-by-step instructions, and links to textbook content. Students have also said that factor contributing to their satisfaction with the tools include the embedded help, convenience, and ease of self-monitoring grades (Hauk & Segalla, 2005; Lenz, 2010; Leong, 2014). In general, when web-based homework has been compared to traditional paper and pencil homework, students have overwhelmingly prefered the web-based approach.

Instructors have also reported that online homework tools have practical advantages. Faculty members who have supported the use of such systems have reported that one significant advantage is the ability to assign graded homework without taking on a potentially significant grading burden, thus saving time (Hauk & Segall, 2005; Hodge et al., 2009; Lenz 2010). Instructors have also been able to use the reports and tools within the systems to monitor student progress and potentially pinpoint broad topics where students are struggling (Lunsford & Pendergrass, 2016). When faculty members have shown a positive view of the web-based homework systems, students have also shown a stronger preference to such systems over more traditional models (Hauk & Segalla, 2005).

While web-based homework has advantages over textbook-based homework, it also has disadvantages for both faculty and students. When faculty have only assigned web-based homework, they were limited to the types of problems included in the system, which tended to be those with discrete solutions (Lenz, 2010). They also have had little interaction with the written work of students, limiting their ability to pinpoint misconceptions (Lenz, 2010). Students were also at a potential disadvantage when their only feedback from the system was whether a solution was correct or not (Lenz, 2010; Leong, 2014). Despite student satisfaction with the web-based tools, students have reported difficulty inputting mathematical notation, but online homework tools have significantly improved in that respect in the last decade (Butler & Zeer, 2005; Hauk & Segalla, 2005; Jacobson, 2006; Leong, 2014).

Although a positive correlation between mathematics test scores and web-based homework use has not been established, students have attempted more problems when assigned web-based homework in lieu of traditional homework (Butler & Zerr, 2005, Hodge et al., 2009; Jonsdottir et al., 2017; Lenz, 2010). The increase in the number of attempted problems could be

attributed to a link between web-based homework and motivation, to the ease of completing multiple problems due to the instantaneous feedback, or some combination of the two. For example, when data were collected from seven sections of finite mathematics with different homework treatments, students whose sections used web-based homework, either entirely or in part, attempted more problems than students in the textbook-based sections (Lenz, 2010).

While in some instances web-based homework has been linked to attempting and correctly solving more procedural problems, it remains unclear if that result would hold should the types of problems in a web-based system be expanded beyond the procedural problems typically found in such systems. Jonsdottir et al. (2017) explored student usage of and outcomes when a web-based homework platform in was used in statistics classes. Initially, they observed that students completed more web-based homework problems than paper-and-pencil problems. However, as they systematically increased the difficulty of their web-based homework platform over the course of several years, the researchers found that students completed fewer online homework problems. They concluded that more students preferred a blend of paper and web-based homework when the online problems were more challenging than what may traditionally be found in such systems (Jonsdottir et al., 2017).

Conceptual Framework: Didactical Tetrahedron

A conceptual framework is used to describe what will be studied along with the relationships between those elements (Miles, Huberman, & Saldaña, 2014). This study examined the relationship between students and OER learning materials, which was mediated by the instructor's relationship with and implementation of those materials. Such a multi-faceted relationship has been described by Olive et al. (2009) and Rezat and Sträßer (2012) as a "tetrahedron model of the didactical situation" (see Figure 1). Rezat (2008) referred to the

mathematics textbooks as an artifact, and he explained that decision by declaring, "the mathematics textbook can be regarded as an artifact in the broad sense of the term. It is historically developed, culturally formed, produced for certain ends and used with particular intentions" (Rezat, 2008, p. 177). In this study, the OER resources served the same function as the traditional textbook and were thought of as the artifact.

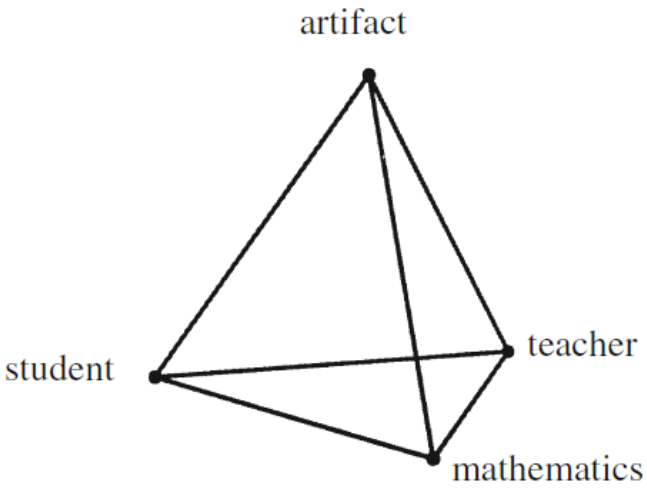


Figure 1. Tetrahedron model of instructional relationships reprinted from Rezat & Sträßer (2012, p. 645)

The tetrahedron model was an extension of the traditional didactical triangle that underpinned previous research in the field of mathematics education (Schoenfeld, 2012; Sträßer, 2007). The didactical triangle was described by the mathematics – instructor – student face of the tetrahedron in Figure 1 (Schoenfeld, 2012; Sträßer, 2007). That triangular face may be used to address questions such as:

- What is the mathematics, and what version of it is the focus of classroom activities?
- Who is the learner, and what does he or she bring to the classroom?
- How does the teacher mediate between the learner and mathematics, shaping the learner's developing understanding of mathematics? (Schoenfeld, 2012, p. 587)

However a single-faced model does not incorporate other influences on how students learn mathematics such as classroom artifacts, including textbooks, assignments, and problem-solving activities, or social forces, including tutors, peer groups, and family members.

An entire issue of ZDM (no. 5, 2012), which is a peer-reviewed journal of mathematics education published as theme-based issues, was devoted to the triangular relationship between mathematics, students, and teachers. The issue included discussion of previously expanded on versions of the triangle along with new conceptions of the triangular and tetrahedron model (Goodchild & Sriraman, 2012). One of the models examined within the issue considered the role of technology in the mathematical educational system described by the didactic triangle (Olive et al., 2009). The reframed model initially considered technology as an element to be accommodated within the triangle (Olive et al., 2009). However, that iteration of the model proved insufficient and was expanded from the didactic triangle to the didactic tetrahedron (Olive et al., 2009). In the tetrahedron technology was the fourth node, and technology – student – teacher was the fourth face of the model (Olive et al., 2009).

Rezat and Sträßer (2012) generalized the Olive et al. (2009) model by replacing technology as the fourth node with the more general notion of artifact. They further extended the tetrahedron model to a more expansive socio-didactical tetrahedron, which included social elements such as tutors, the relevance of mathematics to society, and the institution (Olive et al., 2009; Rezat & Sträßer, 2012). This socio-didactical tetrahedron can also be used to underpin research examining the interactions within the classroom through a socio-cultural lens (Goodchild & Sriraman, 2012). That model would be more appropriate for a study investigating a department and institution's enactment of a curriculum, while the simplistic tetrahedron model better describes the relationships underpinning the current research.

For this study, the relationships illustrated on two of the faces of the tetrahedron shown in Figure 1 guided the research questions. The exploration of student use of the materials was depicted on the student – artifact – mathematics face. This face "depicts the instrument mediated activity of learning mathematics," and in this case, the instrument comprised the OER materials (Rezat & Sträßer, 2012, p. 645). Through that lens, student use and perception of the OER resources were examined along with results on the final examination. The faculty evaluation and implementation of the materials were depicted on the instructor – artifact – student face. How the instructor views the materials and employs them in the classroom impacted how students interact with those materials. While the instructor-student – mathematics face and the instructor – artifact – mathematics face complete the description of the relationships in the teaching and learning of mathematics, they were not addressed by the research questions examined in this study.

Conclusion

Community college students referred to developmental mathematics have faced many unique challenges, one of which has been the cost in time and dollars of their developmental coursework. The use of OER has mitigated some of those costs. Given that the literature indicated students often purchase mathematics textbooks that they do not utilize, an opportunity has existed to design OER that leverage elements of traditional textbooks while eliminating unused or ineffictive elements. By their open nature, such OER materials can be further strengthened through the inclusion of video worked examples and web-based homework, all with the goal of supporting students learning. Understanding the perceptions and usage of these materials in a specific context may offer insights into how they can be improved upon for future use.

Chapter 3: Methodology

The study employed a mixed methods design to examine how students used their course materials. This section includes descriptions of the research design, study site, OER materials, study participants, data collection procedures and analysis, and limitations.

Research Design

This study used a mixed methods design to answer the research questions. Quantitative and qualitative data sources provided different lenses through which to view the use of the OER materials, and examining different types of data facilitated the corroboration of the findings, which resulted in a better understanding of the phenomenon as well as higher confidence in the conclusions (Creswell, 2014; Johnson & Onwuegbuzie, 2004). Fundamental to the selection of a mixed methods design were the research questions; Johnson and Onwuegbuzie (2004) posit that "many research questions and combinations of questions are best and most fully answered through mixed research solutions" (p. 18). As illustrated in Figure 2, different data sources were used to address each research question, thus supporting the use of a mixed methods design.

Research Question	Data Source(s)
How do students use the components of Algebra 2 OER learning materials?	Student survey data Student interviews
What do students perceive to be the benefits and disadvantages of the components of the Algebra 2 OER learning materials?	Student survey data Student interviews
How do faculty perceive the effectiveness of Algebra 2 OER learning materials as a support for student learning?	Faculty survey data
Do students' grades on the standard departmental final exam differ when faculty assigns the Algebra 2 OER learning materials in place of commercial textbooks and associated homework tools?	Final exam data

Figure 2. Research questions and data sources

A quasi-experimental design with non-equivalent control groups was employed to examine differences between students who used the OER materials and those who did not. The

Algebra 2 OER resources were utilized in five sections. Data was collected from those five sections in addition to the sections that used the traditional (non-OER) materials. Students and faculty in the sections that used OER comprised the experimental sections, and the sections that used the non-OER textbook were the control sections. Given the nature of college course registration, the random assignment of students and faculty was not possible (Creswell, 2014; Hagedorn, Sagher, & Siadat, 2000).

The quantitative elements included the results of faculty and student surveys as well as final exam grades. The qualitative aspect explored the use and perceptions of the Algebra 2 OER through open-ended responses on faculty and student surveys and student interviews. Faculty and student voices were considered together to contribute to an understanding of the efficacy of the enacted materials, and a synthesis of the quantitative and qualitative data sources addressed the research questions being explored in this study (see Figure 2).

Site Description

County College is a diverse mid-sized community college located in the northeastern region of the United States. In the fall of 2017, the County College student body was composed of approximately 11,000 students enrolled for credit, with 47% of those enrolled full-time (Office of the Secretary of Higher Education, 2018). The student body was 53% female and 47% male (Office of the Secretary of Higher Education, 2018). It was an Hispanic-serving institution (HSI) with 32% of its fall 2017 student body identifying as Hispanic; 30% as White (non-Hispanic), 16% as Asian, 11% as Black, and 3% as two or more races (Office of the Secretary of Higher Education, 2018). Of the full-time students, 40% received need-based financial aid in the form of Pell Grants (Office of the Secretary of Higher Education, 2018). Tuition and fees at County College were higher than the national average. For the 2016-2017

academic year, a full-time student's tuition and fees were $4395 at County College, whereas the national average was $3520 (College Board, 2016; Office of the Secretary of Higher Education, 2018). County College's tuition increased 31% from the fall of 2006 through the fall of 2016, which mirrored the national in-district average increase (College Board, 2016; Office of the Secretary of Higher Education, 2018). Thus, the effects of the drastic increases in higher education costs have impacted students at County College, just as they have affected students nationwide.

Despite the availability of used and rental books, County College students also faced high textbook costs, particularly in courses that required an online homework component. At the County College bookstore, in the fall of 2017, the price of the Algebra 2 textbook bundled with the online homework access code, was $182.65. Instead of purchasing the complete package, students had the option of buying a standalone access code, which included a digital textbook, from the bookstore for $137.15 or directly from the publisher for approximately $100. Financial aid could not be applied to purchases directly from the publisher, and the faculty was prohibited from directing students directly to the publisher. As a result, students may not have been aware of the lowest cost option of purchasing directly from the publisher.

OER Materials

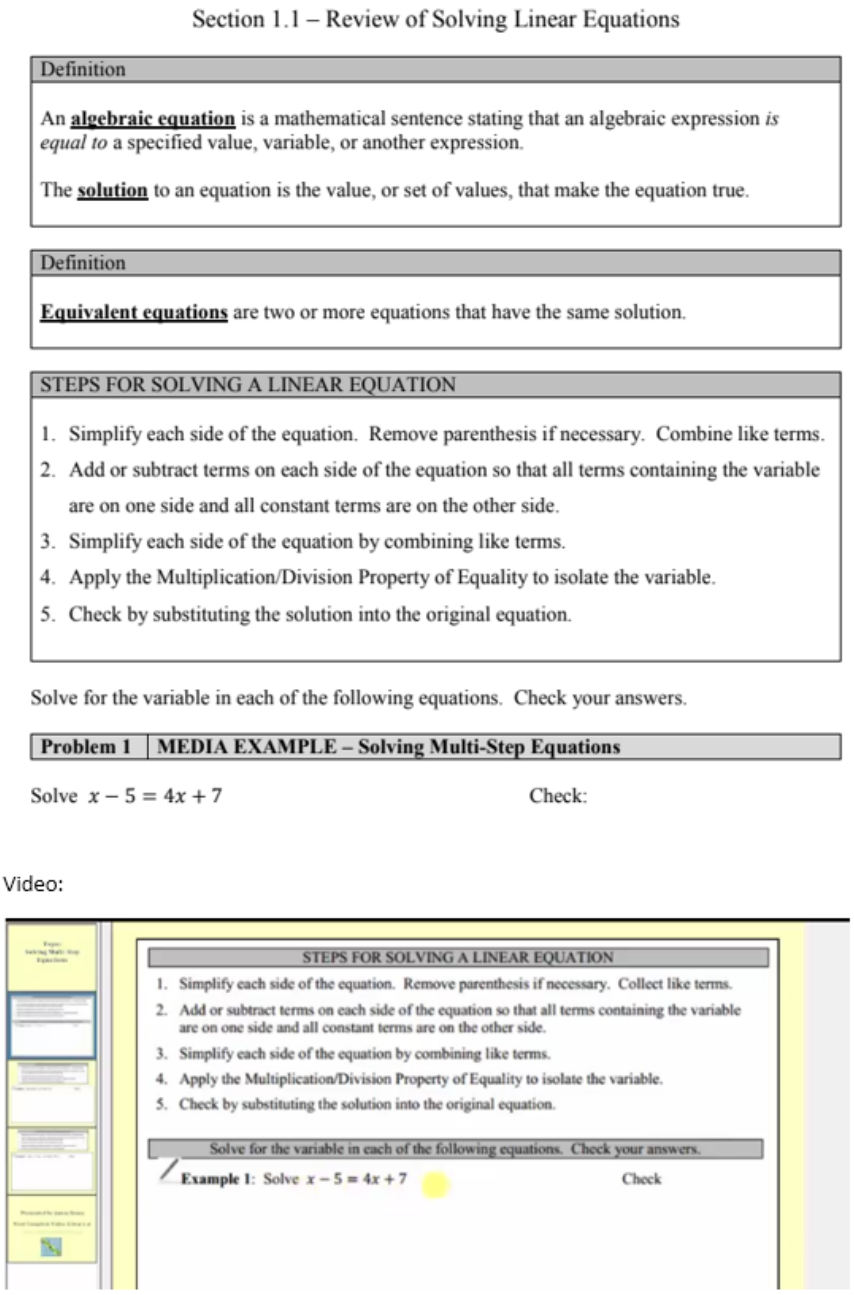
The OER materials used in this study were derived from materials originally developed by a team at Scottsdale Community College (SCC). They were implemented in the Fall Semester 2012 at SCC and have continued as the basis for the current materials used in many mathematics classes at SCC (Hilton et al., 2013; D. (Gaudet) Slaughter, personal communication, August 12, 2017). The materials developed by the faculty at SCC were further cultivated and modified for use at Housatonic Community College (HCC) (J. Nohai-Seaman,

personal communication, July 12, 2017). I obtained a copy of the materials used at HCC in the 2016 – 2017 academic year and modified those for use at County College. The materials were piloted in one section of Algebra 2 in the Fall Semester 2017 and revised for final use in this study, which was conducted in the Spring Semester 2018. A link to the full workbook and an example workbook page are available in Appendix A.

The print component of the OER materials was a workbook, which was available for free online or for approximately $40 in the County College bookstore. The workbook included Worked Examples, Media Examples, You Try Problems, Practice Problems, and summative Assessments. Solutions to all of the problems were made available online. The workbook also included definitions and algebraic procedures. The Media Examples in the workbook were linked to video explanations of those examples, and the links were provided through both the County College learning management system (LMS) and the online homework tool. Figure 3 illustrates an example page and associated video from the workbook. The You Try problems did not have an associated video, but the solutions were available to students electronically. Similarly, answers to the Practice Problems and the summative Assessments were also provided to the students. The problem solutions included some of the procedures involved in solving the problems, but they were not robust worked solutions.

In the online homework tool, the majority of the problems included video worked examples. Students could also send a message to the instructor about a specific problem. The message included the exact problem on which the student was working along with any message text the student included. Figure 4 provides an example of a problem in the online homework tool, with the options to “Jump to the Solution” or “Message the instructor about this question” located below the problem. To assist with the typing of mathematical notation, a mathematics

keypad was also available (see Figure 5). Once an assignment's due date had passed, students could use the assignment as a review mechanism, without impacting their grade. Instructors were permitted to modify questions, include additional quesitons, or remove questions from assignments.



Section 1.1 – Review of Solving Linear Equations

Definition

An **algebraic equation** is a mathematical sentence stating that an algebraic expression *is equal to* a specified value, variable, or another expression.

The **solution** to an equation is the value, or set of values, that make the equation true.

Definition

Equivalent equations are two or more equations that have the same solution.

STEPS FOR SOLVING A LINEAR EQUATION

1. Simplify each side of the equation. Remove parenthesis if necessary. Combine like terms.
2. Add or subtract terms on each side of the equation so that all terms containing the variable are on one side and all constant terms are on the other side.
3. Simplify each side of the equation by combining like terms.
4. Apply the Multiplication/Division Property of Equality to isolate the variable.
5. Check by substituting the solution into the original equation.

Solve for the variable in each of the following equations. Check your answers.

Problem 1 **MEDIA EXAMPLE – Solving Multi-Step Equations**

Solve $x - 5 = 4x + 7$ Check:

Video:

STEPS FOR SOLVING A LINEAR EQUATION
1. Simplify each side of the equation. Remove parenthesis if necessary. Collect like terms.
2. Add or subtract terms on each side of the equation so that all terms containing the variable are on one side and all constant terms are on the other side.
3. Simplify each side of the equation by combining like terms.
4. Apply the Multiplication/Division Property of Equality to isolate the variable.
5. Check by substituting the solution into the original equation.
Solve for the variable in each of the following equations. Check your answers.
Example 1: Solve $x - 5 = 4x + 7$ Check

Figure 3. Sample workbook page

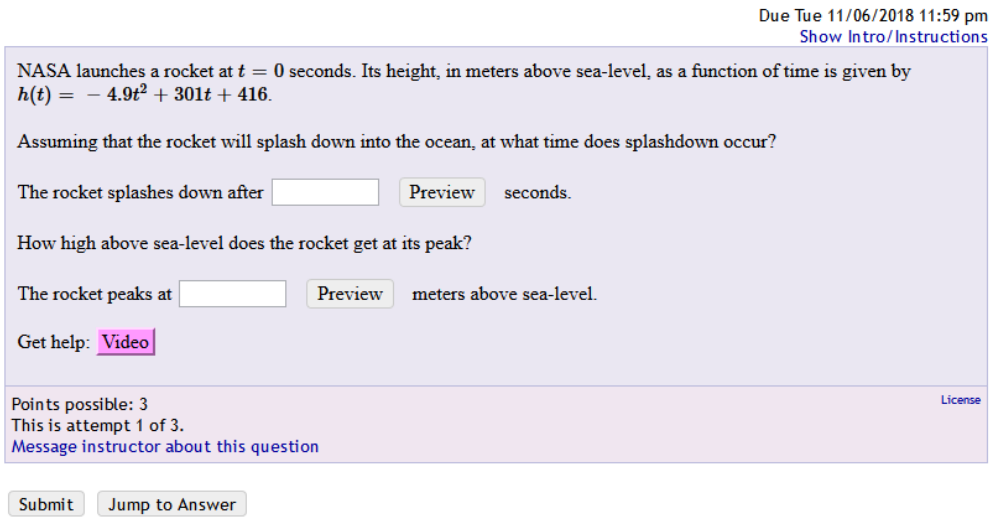


Figure 4. Example online homework problem

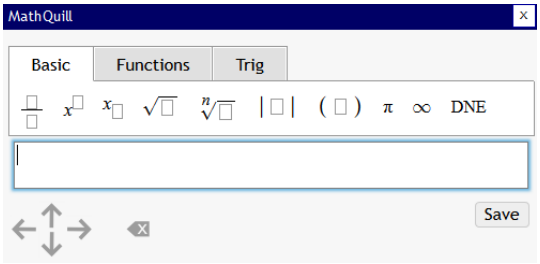


Figure 5. Mathematical notation tool

In addition to the resources cultivated from the HCC materials, a section of the materials covered introductory topics in statistics. These materials were drawn from the OER textbook *Statistics Using Technology*, Second Edition, by Kathryn Kozak (2015). As permitted by the Creative Commons license, and with subsequent permission from the author (K. Kozak, personal communication, October 10, 2017), relevant pages, examples, homework problems, and videos from *Statistics Using Technology* were included in the OER materials. The statistics materials were adapted to align with the design of the workbook and other course materials.

Students were also provided access to an online OER textbook, *Intermediate Algebra*, which was published by OpenStax College (OpenStax College, 2018). They were able to download the entire textbook as a PDF or access it online. Specific sections were linked in

modules in the LMS to direct students to the appropriate textbook sections. Figure 6 illustrates an example module, and the links to the OpenStax OER textbook were made available under the Chapter Readings heading.

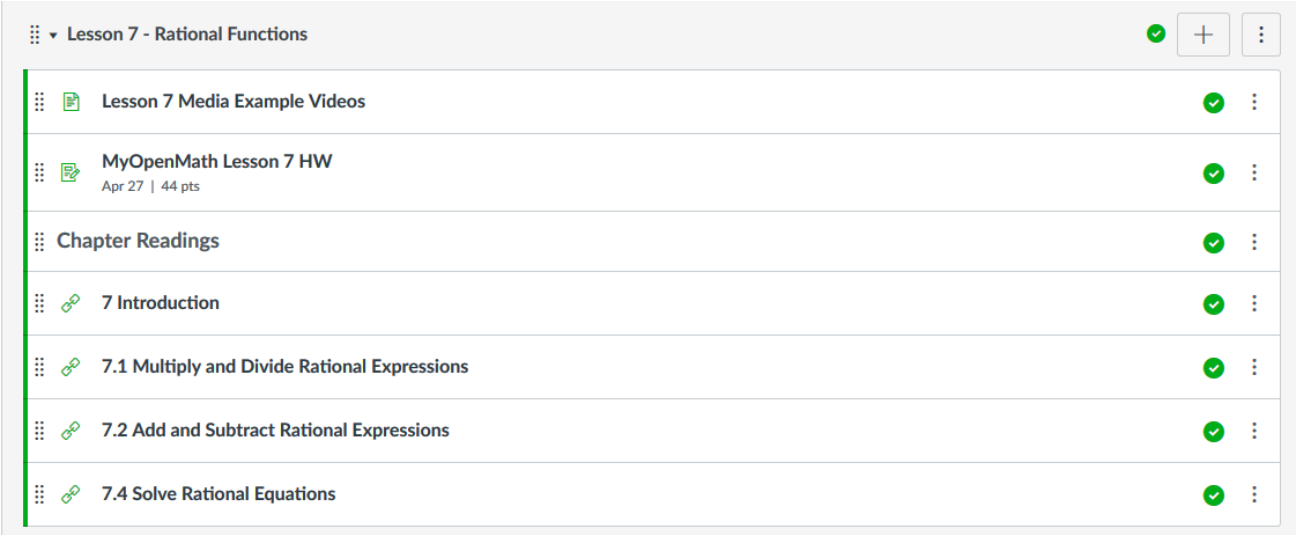


Figure 6. Example module in the LMS

All faculty teaching with the OER materials were provided a hard copy of the workbook, an account in the online homework tool, and a copy of the online homework template. They were able to modify the online homework tool to suit their needs. They were also provided a shell they could import into their course in the LMS. The shell included a sample syllabus, links to all of the course materials, and modules with links to the online textbook. The use of the LMS course shell was optional, and instructors were able to modify their implementation of the LMS shell to suit the needs of their class.

Participants

In the Spring Semester 2018, 27 sections of Algebra 2 were offered. Of those, 11 were designated as non-STEM sections. Since some faculty members taught multiple sections, nine instructors taught the 11 non-STEM sections; I taught two of the sections. All non-STEM Algebra 2 instructors were invited to use the OER materials, and three agreed to do so. A total

of five sections used the OER materials – the two sections that I taught, and one section taught by each of the other participating instructors. Consent for the use of their final exam data was requested from students in all of the non-STEM sections, including the non-OER sections. All students and faculty involved in any section of Algebra 2 received the surveys. All students in the OER sections were also invited to participate in the student interviews at the end of the semester.

Faculty. In the Spring Semester 2018, the County College mathematics department had 12 full-time faculty members, and the department's two administrators each taught two online calculus classes. At the time, I was in my sixth year at County College and was tenured. The other three full-time faculty members who taught a combined total of four of the non-STEM Algebra 2 sections had all worked at County College for longer than ten years and had taught the gamut of courses offered at the two-year level. All three were tenured, and they each typically taught one developmental class per semester. None of their sections of Algebra 2 included the Algebra 2 Support component, whereas both of my sections did include the Algebra 2 Support co-requisite class.

In the Spring Semester 2018, the County College mathematics department employed 70 adjunct faculty. Adjunct faculty were permitted to teach up to ten credits per semester, resulting in a course load of one to three classes. The adjunct faculty was drawn from a variety of professional backgrounds; they included working and retired middle and high school teachers and administrators, retired County College faculty, working and retired professionals from mathematics-related fields such as engineering and computer programming, and County College staff. They were provided little in the way of professional development. As a result, other than the teaching professionals, adjunct faculty members may have had little pedagogical knowledge

beyond their classroom experiences at County College. However, they were all dedicated to the success of their students, and many were willing to volunteer their time to attend department events or to discuss materials and curriculum.

Four faculty members used the OER materials. I was one of them, and one of the participating instructors was a full-time faculty member who has been at County College for over twenty years. The other two were adjunct faculty. One of those adjunct instructors was new to County College in the Fall Semester 2017, and the other had taught at County College for approximately eight years. I taught two sections of non-STEM Algebra 2 and used the OER materials in both sections. The three OER sections taught by me and the other full-time faculty member were offered on the County College Main Campus in during the day. One of the OER sections taught by an adjunct instructor was scheduled in the evening on the main campus, and the other ran during the day at a satellite center located in a city approximately 8 miles from the County College Main Campus.

Students. The spring 2018 County College Algebra 2 student population reflected the diversity of the County College student body and the heterogeneity of developmental students nationwide. Grubb (2013) defined five types of developmental students. "Refresher" students and students underplaced by the placement test may not need to be in a developmental course at all; they tend to grasp the concepts quickly. "Refresher" students were in class alongside students who needed comprehensive instruction in the course material because their academic foundation is not as strong as that of the "refresher" or underplaced student. Just as in any college classroom, students with learning disabilities and mental health problems also contributed to the heterogeneity (Grubb, 2013). One commonality amongst students in non-STEM Algebra 2 was that they had chosen a major that requires a minimum number of courses

in mathematics, and those required mathematics courses do not need to be algebraically based. The majority of students in non-STEM Algebra 2 were planning to take Statistics as their first, and possibly only, college-level mathematics course. Given this, students in developmental courses such as non-STEM Algebra 2 may not see the relevance of those courses to their intended major and long-term goals (Grubb, 2013). However, at County College such students were also aware that if they did not pass Algebra 2, they would not be permitted to register for their college-level course and continue to progress towards their certificate, degree, or transfer.

Procedure

Given both the quantitative and qualitative nature of the research questions, a mixed methods data collection strategy was required to address the questions (Creswell & Plano-Clark, 2007). The use of mixed methods also provided a mechanism by which different forms of data could be validated with each other (Creswell & Plano-Clark, 2007). For this study, the qualitative findings from open-ended survey questions and interviews helped confirm the quantitative findings from the closed-ended survey questions and final exam. Consent was obtained at the beginning of each survey and interview. In the first month of the semester, I also visited all non-STEM Algebra 2 sections to obtain consent for the use of final exam Scantron forms.

Final exam. The same non-STEM Algebra 2 final exam (see Appendix B) was given to all students, regardless of which course materials they used. This final exam was created based on the non-OER course materials and included questions from the test bank provided by the publisher of those materials. It was composed of 35 multiple choice questions, which were primarily procedural. All students were provided a departmental final exam review to help them prepare for the exam, and the standard class schedule included one class meeting dedicated to

reviewing for the exam. As a departmental policy, students were required to earn a minimum grade of 60% on the final exam and an overall average of 70% or higher to pass the class and be permitted to enroll in a transfer-level course.

Eight of the nine non-STEM Algebra 2 instructors administered the departmental exam. The instructor who did not administer the exam created his own exam, for which the data was not made available. Of the eight other instructors, the five adjunct instructors did not have access to the final exam until the last week of class, at which time it was provided to them by the departmental administrative assistant. The three full-time instructors had the opportunity to review a draft of the exam approximately one month before its administration.

The final exam was administered during the last class meeting of the semester. Students were permitted the use of a calculator. Students recorded their answers on a Scantron form, and partial credit was not assigned. The results of the final exam were used to answer the last research question, "Do students' grades on the standard departmental final exam differ when faculty assigns the Algebra 2 OER learning materials in place of commercial textbooks and associated homework tools?".

Student surveys. Anonymous student surveys were administered twice during the semester. Email was chosen as the delivery mechanism due to cost and efficiency considerations (Sue & Ritter, 2012). Faculty would have been reluctant to give up class time for in-class administration of the survey, and not all students were present in all class meetings. Emailing the survey ensured that all students enrolled in Algebra 2 had the opportunity to respond to it but increased the risk of low response rates. A context-specific technological challenge also increased the risk of low response rates. In January 2018, County College instituted a new Learning Management System (LMS). Under the prior system, all student communications

occurred within the old LMS. Under the new system, students were given an email account and separate access to a messaging tool within the LMS. Due to technical limitations, the initial survey was sent to the email account, not through the LMS messaging system. However, anecdotal evidence indicated that in the Spring Semester 2018, students preferred to use the LMS messaging system. An attempt to mitigate this technological issue was addressed in the administration of the second survey.

The survey protocol was derived from four sources. The first source was a study of students at eight community colleges in which Bliss et al. (2013) explored both cost and student perceptions of OER when they registered for a class utilizing OER materials. A sample student survey based on their work is found in Appendix C. The second source (see Appendix D) was a study that addressed how the use of OpenStax textbooks impacted student learning, from faculty and student perspectives. The results of the student survey were informally presented on the OER Hub (Pitt, 2014). The other two sources were drawn from research in student usage of textbooks, not limited to OER textbooks. Bode, Khorami, and Visscher (2014) used surveys to investigate how faculty and students perceived a Calculus e-book. Although the survey itself was not available, the lead author provided the spreadsheet of the results, from which the questions were inferred (M. Bode, personal communication, October 22, 2017). Weinberg et al. (2012) also examined how students use mathematics textbooks. Their survey protocol (see Appendix E) provided a framework to analyze different elements of the OER materials (Weinberg et al., 2012). Relevant questions from each of these sources were included in the student surveys.

The initial survey was composed of 46 questions (see Appendix F), and the administration of that survey began on Thursday, March 1, 2018. The administration of the

survey was timed to be before Spring Break, which began on Saturday, March 10. A snow day resulted in County College being closed on Wednesday, March 7 and Thursday, March 8. Faculty members were asked to inform their students about the survey, but the timing of the survey's delivery along with the inclement weather may have impacted their ability to do so. The survey link was e-mailed to the 511 students who were enrolled in Algebra 2 when the distribution list was generated on approximately February 26, 2018. All STEM sections and non-STEM sections were included. Of the total Algebra 2 population, 99 students were enrolled in the OER sections. Students were offered the opportunity to receive a $25 Amazon.com gift card as an incentive for participating. Four students were randomly selected to win a gift card. Sixty-seven students (13.1%) responded to the survey.

After the first survey administration, a brief review of the initial survey data was conducted, and it was determined that the differentiation between students using the OER materials and those using non-OER materials could be improved by updating the questions used as distinguishers. Some of the questions from the initial survey were also streamlined and revised to more specifically refer to elements of the course materials by name. The revised survey included 56 questions (see Appendix G). However, students would only be shown the subset of those questions specific to their course materials (OER or non-OER). It was sent via email on Monday, April 30, 2018, to the 446 students who were enrolled in Algebra 2 at the time. Of those students, 89 were using the OER materials. Instructors were also asked to notify their students, and a reminder was sent to students via the LMS messaging system. An additional four students were randomly selected to receive a $25 Amazon.com gift card. Forty-four students (9.9%) responded to the survey.

The surveys included both closed and open-ended questions. The results of the surveys were one data source used to address the first two research questions:

1. How do students use the components of the Algebra 2 OER learning materials?
2. What do students perceive to be the benefits and disadvantages of the components of the Algebra 2 OER learning materials?

Survey responses from OER students helped address both questions, and a comparison of the two groups supplemented the analysis of the second question.

Faculty survey. An anonymous faculty survey was administered once at the end of the semester. The survey was delivered via email for the same reasons that email was chosen for the student survey. Since faculty were not able to communicate with each other via the LMS and were accustomed to checking their email, a reminder via the LMS was not necessitated as it was for the student survey. Participation was voluntary, and faculty members were not incentivized to respond to the survey.

The faculty survey was derived from two sources. Two of those sources were in the field of OER research. In addition to examining the student perspective in their study at eight community colleges, Bliss et al. (2013) explored faculty perceptions of OER. The majority of questions from that survey (see Appendix H) were repurposed for the current study. Several questions were also taken from a survey (see Appendix I) on the faculty perception of how the use of OpenStax, a readily available OER textbook, contributed to student learning. The results of the OpenStax faculty survey were formally reported on by Pitt (2015).

The initial faculty survey for this study was composed of 22 questions (see Appendix J), and on Sunday, April 29, 2018, it was sent to the 17 instructors teaching Algebra 2. I was the eighteenth faculty member teaching Algebra 2, but I was not sent the survey. Of those, six were

full-time faculty and the other twelve were adjunct faculty. Three of the eighteen were using the OER materials, and the other 15 were using the traditional, non-OER, materials. I taught two sections of Algebra 2 with OER, but I did not receive or complete the survey. Given that only four instructors, including me, were using the OER materials, I did not want to introduce bias into the results given my role as both researcher and participant. Seven faculty members (41.2%) responded to the survey. Two of the responses were from the instructors using the OER materials, and the other five were from faculty using the non-OER materials.

The survey included both closed and open-ended questions. The results of the surveys were the sole data source used to address the third research question of, "how do faculty perceive the effectiveness of the Algebra 2 OER learning materials as a support for student learning?"

Student interviews. Student interviews were conducted after the semester ended. They were intended to help explain the results of the student survey and provide a deeper understanding of those results. The interview protocol was derived from the work of Weinberg et al. (2012) who examined how students use mathematics textbooks. Their interview protocol (see Appendix K) expanded upon the questions that were asked in their survey, which was also used as a basis for the surveys in this study (Weinberg et al., 2012). The only modifications to the interview protocol were to customize the questions to refer specifically to the particular elements of the OER resources used in this study. The final interview protocol consisted of 11 semi-structured questions and can be found in Appendix L.

Faculty members teaching with the OER materials were asked to recruit students for the interviews. An initial email was sent to the participating faculty on April 23 asking them to recruit student volunteers, and a follow-up email was sent on May 2. The follow-up email included a suggested message that faculty could send to their students electronically. I also

verbally recruited students in my own sections. Interviews were planned for the last day of the semester along with the two following days. Faculty informed students that the interviews would take no more than 30 minutes. Participation in the interview was incentivized by choice of a $10 Amazon.com gift card or a $10 Target gift card. Faculty were asked to inform students of this incentive as part of the recruiting process. All participants in interviews received a gift card of their choice, regardless of whether they previously received a gift card for completing the survey. Five students volunteered for interviews; four of them were in sections of Algebra 2 that I taught, and one was in my fulltime colleague's section.

The results of the interviews supplemented the student surveys to address the first two research questions:

1. How do students use the components of the Algebra 2 OER learning materials?
2. What do students perceive to be the benefits and disadvantages of the components of the Algebra 2 OER learning materials?

Data Analysis

Data was collected from faculty and students to examine the usage and perceptions of the Algebra 2 OER materials. Students and faculty were invited to participate in surveys, and volunteers were solicited to participate in interviews. Final exam data was aggregated for Algebra 2 sections using the non-OER materials and sections using the OER materials. Given that the data was collected at my place of employment, efforts were made to ensure that the participating faculty and students were not placed at risk, particularly faculty for job loss (Creswell, 2014). Faculty members were treated as collaborators whose input was used to modify the OER materials over the summer (Creswell, 2014). The revised materials, based on faculty input, were adopted in all Algebra 2 non-STEM sections in the Fall Semester 2018.

All data sources were analyzed separately first and then comparatively. The quantitative data consisted of three data sets: the faculty survey results, student survey results, and final exam data. As suggested by Creswell and Plano-Clark (2007), a descriptive analysis of the quantitative data was conducted, including calculating measures of central tendency and variability, examining the distribution of the data, correlations, and exploring cross-tabulations. The qualitative data consisted of open-ended survey questions and interview transcripts. Codes were developed to describe how faculty and students used and perceived the OER materials. Triangulation by the method and data type was used to validate the data.

Final exam. The results of the final exam were analyzed quantitatively to determine if there was a difference in final exam performance between the OER and non-OER non-STEM groups. By department policy, a standard final exam was given in all sections of developmental mathematics classes to ensure a standard minimum knowledge base. Students had 110 minutes to complete the 35 question exam, and students with accommodations were given extra time or other support as they were entitled through documentation from the Disability Services office. The exam was multiple choice with answers recorded on Scantron forms, and no partial credit was assigned. Faculty are asked to submit their final exams for assessment and item analysis purposes, and 131 non-STEM Scantron forms were submitted to the department. Data were examined from 78 students of the 131 who had previously given consent.

The final exam results were examined in three ways. First, the mean overall exam scores were compared between groups using a two-sample *t*-test. After that, a Scantron machine was used to conduct an item analysis on two sets of exams. The exams were segmented by course material type. One item analysis was done for exams taken by students who used the non-OER materials and another by students who used the OER materials. A two-sample *z*-test was used to

determine whether there were any differences between the groups in student performance on an individual question basis. A *z*-test was used because the comparison was of the proportion of correct responses to a particular question, not of sample means. Lastly, student scores were recorded anonymously in Excel and summarized by letter grade in a frequency table with the following classes: F (0 – 20 correct), D (21 – 24 correct), C (25 – 27 correct), B (28 – 31 correct), and A (32 – 35 correct). The proportions of students earning each letter grade were also compared using two-sample *z*-tests. These analyses were used to understand if there were any differences in exam performance between the two groups.

Student survey data. Both quantitative and qualitative data were collected through the student surveys. Given the number of questions on the student survey, a codebook was developed to help organize the data analysis. Sue and Ritter (2012) have recommended only deleting observations as a last resort. From the first survey, one observation was deleted because the student had only responded to the first three questions, resulting in a total of 67 observations to be analyzed. From the second survey administration, 13 observations were deleted because the respondents had not answered any of the questions specific to the course materials. From the second survey, a total of 44 observations were left to be analyzed.

After the incomplete observations were eliminated, students who used the OER materials were identified. Students who used the OER materials were also classified as STEM or non-STEM students based on their major and intended subsequent mathematics course. Student financial and academic characteristics were compared between the OER and non-OER groups. Since the comparisons were of poportions, *z*-tests were conducted to determine if there were differences between the OER and non-OER students.

OER student survey responses were also analyzed in further detail. That analysis was organized by research question with survey questions segmented based on which research question they addressed. Then quantitative analyses were conducted on the responses. Descriptive statistics were calculated, and statistical tests were conducted. As the level of measurement and data type indicated, statistical analyses included Cochran's Q-test and pairwise McNemar tests.

One set of questions in each survey was designed to elicit how students used the components of those materials. Responses to these questions were consolidated into three categories, which represented the three major elements of the OER materials: the workbook, the online homework tool, and the associated worked example videos. To determine if there were any significant differences between types of usage z-tests on proportions were conducted. These responses were also compared to the students who used the non-OER materials so investigate differences between the two types of course materials.

Open-ended responses were examined after the numerical data was analyzed. Students were given the opportunity to express what made their course materials better or worse than other course materials and what they liked least and most about the materials. For the OER students, the responses were coded using an evaluative coding scheme. The evaluative coding system provided a mechanism to understand judgments about the OER program (Miles, Huberman, & Saldaña, 2014). Given the small number of open-ended responses by OER students, the codes were developed inductively to incorporate all of the responses.

Faculty survey data. Only two of the survey responses were from faculty who used the OER materials. The other five were from faculty who used the non-OER materials. Responses to the following questions were examined:

- How often do you think most students used the materials for MAT-014 / Algebra 2 throughout the semester?
- Based on your experiences as an educator, to what extent do you agree with the following statements? "Use of the MAT-014 / Algebra 2 course materials ... " (followed by affirmative statements such as “Increased learners' participation in class discussions”)
- On average, how would you rate the quality of the materials used for MAT-014 / Algebra 2?

Descriptive statistics were calculated, and frequency distributions were created for both the OER and non-OER responses. The open-ended questions were coded inductively. From the coding process, four codes emerged. Responses to the open-ended questions were assigned to those codes to identify commonalities between responses.

Student interview data. Interviews were recorded, and the recordings were transcribed by an online professional transcription service. The transcriptions were reviewed for clarity and then imported into a qualitative data analysis tool. The transcripts were initially coded using the coding scheme that had emerged from the open-ended responses to the student survey questions. As additional themes emerged, codes were added to the coding scheme. For example, a code for the workbook did not arise from the open-ended survey responses, but the workbook was often referenced in the interviews, given the specificity of the questions, so a code was added. The interview questions did not elicit responses about student confidence or engagement; as a result, those codes were removed from the coding scheme.

Validity and Reliability

Given my positionality as both researcher and research participant, threats to validity emerged in this study. A key advantage of OER is the price, since many materials are available

for free. In the developmental courses at County College, online homework typically comprised up to 30% of the final grade. The high cost of the traditional publisher online homework tools has historically prevented some students from accessing those tools early in the semester or at all. As a faculty member, I have supported efforts to provide students access to their course materials on the first day of class. OER was identified as one way to accomplish this. To help ensure that I was not letting this bias impact my interpretation of the results, I continually referred back to the research questions, none of which were related to ease of access or affordability.

As the cultivator of the OER materials for the study, I may also have had an inherent interest in their success. The other full-time faculty member who participated in the study served as a peer debriefer (Creswell, 2014). At the conclusion of the study, we met as professional colleagues to discuss the strengths and weaknesses of the materials, and we worked together to modify them for future use. She also served as a check on reliability as we discussed her view on the students' perceptions of the materials and how they used them. To further strengthen the validity of the research, the data was triangulated across data sources, and all emerging themes were examined. While my experience as both researcher and participant had the potential to create bias, it also helped me develop an "in-depth understanding of the phenomenon under study" which could contribute to the validity of the findings (Creswell, 2014, p. 202).

In addition to addressing threats to validity, reliability was also taken into consideration. One definition of reliability is that it is "the extent to which a measure provides consistent results across repeated testing" (Sue & Ritter, 2012, p. 226). Several steps were taken to increase the reliability of the findings. The survey and interview questions were all derived from previous research, focused both on OER specifically and course material used in general. Before coding,

the interview transcripts were reviewed for potential transcription errors. Lastly, I reviewed all coding of the qualitative data to ensure that the code definitions did not drift (Creswell, 2014).

Chapter 4: Results

The results are organized by data source. The first section describes the analysis of the final exam data. The second section provides a detailed description of the student survey data, including both the quantitative and qualitative results. The third section provides a similar analysis of the faculty survey data. Finally, the student interview data is presented. The interviews were intended to help explain the survey results data and will be used in conjunction with the quantitative and qualitative survey data to develop the conclusions.

Final Exam

The non-STEM final exam was administered in nine of the 11 non-STEM sections. Of the 158 students enrolled in those sections at the end of the semester, 78 (49.3%) took the final exam and had consent forms on file for their data to be used in this study. There were no significant differences in the percentage of exams included in the analysis based on whether the students used OER or non-OER course materials. Table 1 illustrates the exam inclusion rate segmented by course material type.

Table 1

Final Exams: Percent Included

	Enrolled	*Included*	*Inclusion Rate*
OER	89	46	51.7%
Non-OER	69	32	46.3%

Descriptive statistics were obtained for the final exam scores for students using the OER materials and for the final exam scores for students using the non-OER materials. The final exam included 35 questions, and the mean score for the OER students was 24.5 out of 35, which was a 70%. The mean score for the non-OER students was 26.2 out of 35, or 75%. This

difference in mean final exam scores was not statistically significantly, as evidenced by a two-sample *t*-test. Table 2 provides a summary of the descriptive statistics for the final exam scores.

Table 2

Final Exam Scores: Descriptive Statistics

	OER			non-OER				
	n	*M*	*SD*	*n*	*M*	*SD*	Test Statistic	*p*
Exam Score	46	24.5	5.4	32	26.2	5.9	$t = -1.302$	0.197

Students were required to earn a grade of D or higher on the final exam to pass the class, which required correct responses to a minimum of 21 out of the 35 questions. To further examine differences in the final exam results, a frequency distribution by letter grade was created. Differences in the proportion of students earning each letter grade were examined via *z*-tests of proportions. No significant differences were indicated for letter grades of A, B, C, or F (see Table 3). Based on the z-test, there was a significant difference in the proportion of students earning a D on the final exam, with 33% of OER students earning a D and only 9% of non-OER students earning a D. However, this was based on only three students in the non-OER condition earning a grade of D. Thus, no conclusion about differences in final exam performance were made.

Table 3

Final Exam Letter Grade Distribution

Letter Grade	OER (n = 46)	non-OER (n = 32)	Test Statistic	*p*
Passing				
A (32 – 35)	5 (11%)	7 (22%)	z = -1.325	0.185
B (28 – 31)	8 (17%)	9 (28%)	z = -1.129	0.259
C (25 – 27)	11 (24%)	7 (22%)	z = 0.210	0.834
D (21 – 24)	15 (33%)	3 (9%)	z = 2.396	0.017
Passing Total	39 (85%)	26 (81%)	z = 0.412	0.680
F (0 – 20)	7 (15%)	6 (19%)	z = -0.412	0.680

Student Surveys

The overall response rates to the surveys were 13.1% for the initial survey in March and 9.9% for the follow-up survey in April. Since this study was investigating the use of OER, survey responses were segmented based on whether students used the OER materials or not. The bulk of the detailed analyses were conducted on the responses of students who used the OER materials to understand their perceptions of those materials. The process for segmenting the data is reported in this section, which is followed by a summary of the survey results.

OER classification. Given that the survey was sent to all students registered for Algebra 2, regardless of which materials they were using, students who used the OER materials needed to be identified. For the March survey, responses to several survey questions were used to classify students as OER or non-OER. All students who indicated that their materials were available for free or who spent less than $61 on course materials were initially classified as OER. This classification was validated by examining whether students specifically mentioned the OER

materials in their open-ended responses or indicated that they had used a workbook. All remaining students who stated that they did not use a workbook were categorized as traditional (non-OER). Once that initial classification was complete, 19 responses needed classification. Of those, if they spent more than 81 dollars on their materials or they specifically mentioned the traditional materials in their open-ended responses, they were categorized as non-OER. As a result of the classification process, 22 respondents to the March survey were classified as OER students. The second survey specifically asked students which materials they used, and 17 students were classified as OER based on their response to that question.

The OER students had significantly higher response rates to the surveys than the non-OER students. For the first survey, 22.2% of the OER students responded compared to only 10.9% of the non-OER students ($p = 0.003$). Similarly, for the second survey, 19.1% of the OER students respond compared to only 7.6% of the non-OER students ($p = 0.001$). Response rates and OER classifications are illustrated in Table 4.

Table 4

Survey Response Rates

	OER			non-OER				
	Sent	*Resp*	*R. Rate*	*Sent*	*Resp*	*R. Rate*	*Test Stat.*	*p*
Survey 1 (Mar)	99	22	22.2%	412	45	10.9%	$z = 2.991$	0.003
Survey 2 (Apr)	89	17	19.1%	357	27	7.6%	$z = 3.266$	0.001

Student characteristics. Student profile data were examined to provide context for the necessity of reducing the costs of course materials and to determine whether there were differences between students using OER materials and those using traditional materials. In both administrations of the survey, approximately 60% of non-OER students reported using loans,

Pell grants, or fee waivers to fund their education. For the OER students, the percentage dropped from 59.1% in the first survey to 52.9% in the second survey, but that difference was not statistically significant. There was also no difference between the OER and non-OER groups in either administration of the survey (see Table 5).

Table 5

Student Characteristics: Financial Support

	OER			non-OER				
	n	*Yes*	*%*	*n*	*Yes*	*%*	*Test Stat.*	*p-value*
Survey 1	22	13	59.1%	45	27	60.0%	z = -0.071	0.994
Survey 2	17	9	52.9%	27	16	59.3%	z = -0.412	0.682

Similarly, the number of semesters a student had been at County College was examined. It was expected that most students in a developmental class would be early in their tenure at County College. Given that it was the spring semester, and more students tend to start in the fall semester, it was expected that the majority of students would be in their first year. However, that was not the case for the OER students, with only 49.9% reporting being in their first year at County College. Table 6 illustrates student responses. Given the low response rates and small sample sizes, it is not clear if these data are representative of the non-OER and OER populations as a whole.

Table 6

Student Characteristics: Tenure at County College

	OER		non-OER			
	n	%	*n*	%	*Test Stat*	*p*
Survey 1	22		45			
1st semester	4	18.1%	4	8.9%	$z = 1.178$	0.238
Completed 1 – 2 sem.	7	31.8%	26	57.8%	$z = -1.849$	0.064
Completed 3 – 4 sem.	7	31.8%	13	28.9%	$z = 0.366$	0.711
Completed 5+ sem.	4	18.1%	2	4.4%	$z = 1.922$	0.055
Survey 2	17		27			
1st semester	1	5.9%	0	0.0%	$z = 1.275$	0.204
Completed 1 – 2 sem.	8	47.1%	13	48.2%	$z = -0.070$	0.944
Completed 3 – 4 sem.	3	17.7%	13	48.2%	$z = -2.048$	0.040
Completed 5+ sem.	5	29.4%	1	3.7%	$z = 2.420$	0.016

The remaining results focus on the students who used the OER materials. The OER materials were used in sections designated for students in non-STEM majors who were not planning to take Precalculus or College Algebra as their subsequent course. Despite programmatic and advising efforts to ensure adherence to the section designations, it was possible for students to enroll in a section of Algebra 2 that did not match their intended course of study. Students who indicated that their major was in a STEM field and that they were planning to take Precalculus as the subsequent course were considered STEM students. Table 7 illustrates the percentage of students who used the OER materials and may have been

mismatched in their Algebra 2 enrollment. Given the small number of STEM students, they were included in the data for the remaining analyses.

Table 7

OER Student Characteristics: Subsequent Course

	Survey 1 (n = 22)		Survey 2 (n = 17)	
STEM	2	9.1%	2	11.8%
non-STEM	20	90.9%	15	88.2%

Course material impact: OER. Students were asked to report what impact their course materials had on the learning experience. The specific survey question was, "In which of the following ways (if any), has your use of your Algebra 2 / MAT-014 course materials made an impact on your formal studies. Students were prompted to respond "Yes" or "No" to each option. The options ranged from "increased participation in class discussions" to "being more likely to complete my course of study." Table 8 includes all of responses along with the percentage of students who responded "Yes."

The results for this question were analyzed using a Cochran's Q-test and subsequently with a McNemar test. Both of these tests compared corresponding percentages within the same group of students. The Cochrans' Q-test was used to compare proportions of responses to three or more categories, and the McNemar test compared exactly two proportions. Based on the Cochran's Q-test ($Q(11) = 25.5$, $p = 0.008$, $n = 16$), significant differences were found in students' perceptions of the course materials in the first administration of the survey. In other words, there were differences in the "Yes" responses to various options on this particular question. Significant differences were not found in the responses to the second administration of the survey. Increased satisfaction with the learning experience received the greatest proportion

of "Yes" responses, with 88.9% on the first survey and 81.3% on the second survey. One of the limitations of the Cochran's *Q*-test is that only surveys with answers to each category can be included in the Cochran's *Q*-test, which is why the *n* varies in Table 8.

Table 8

Reported Benefits of Materials: OER

	Survey 1			Survey 2		
Use of the course materials has led to my ...	*n*	*Yes*	*%*	*n*	*Yes*	*%*
Increased participation in class discussions	17	11	64.7%	17	12	70.6%
Increased interest in Algebra 2	18	8	44.4%	17	11	64.7%
Increased satisfaction with the learning experience	18	16	88.9%	17	13	81.3%
Gaining confidence	18	13	72.2%	16	13	81.3%
Grades improving	18	13	72.2%	16	13	81.3%
Having increased independence and self-reliance	17	12	70.6%	16	12	75.0%
Increased engagement with lesson content	18	13	72.2%	16	11	64.7%
Increased experimentation with new ways of learning	18	11	61.1%	17	11	64.7%
Increased collaboration with my peers	18	9	50.0%	17	10	58.8%
Increased enthusiasm for future study	18	9	50.0%	16	9	56.3%
Becoming interested in a wider range of subjects than before I used the materials	17	9	50.0%	16	8	50.0%
Being more likely to complete my course of study	19	15	78.9%	16	13	81.3%

Since the Cochran's *Q*-test indicated significant differences in the responses on the first survey, pairwise McNemar tests were conducted to compare response proportions between the proportion of "Yes" responses on a pairwise basis. The pairwise McNemar tests were

performed on the truncated dataset used for the Cochran's Q-test, which included only observations with a response to each option, as well as on all complete pairs. Significant differences were found in five pairs. Four of the pairs were in comparison to "Use of the MAT-014 / Algebra 2 course materials has led to my increased satisfaction with the learning experience", and Table 9 illustrates the results based on all complete pairs. A pairwise McNemar test also indicated a significant difference ($p = 0.041$) between the responses "being more likely to complete my course of study" (78.9%) and "increased interest in Algebra 2" (44.4%). To confirm the Cochran's *Q*-test results for the April data, McNemar tests were also conducted, but no significant differences were found.

Table 9

Comparison to Increased Satisfaction with the Learning Experience

Comparison Response	n	Satisfaction	Comparison	*p*-value
Increased interest in Algebra 2	16	93.8%	43.8%	0.013
Increased collaboration with my peers	18	88.9%	50.0%	0.023
Increased enthusiasm for future study	18	88.9%	50.0%	0.023
Becoming interested in a wider range of subjects than before I used the materials	17	88.2%	52.9%	0.041

Course material impact: OER and non-OER. Comparisons were also made between the OER and non-OER responses. On the first survey, there were no significant differences in the benefits of the course materials between the OER and non-OER students, and there were similarities in the patterns of responses. However, at the end of the semester, a higher percentage of OER students reported that the OER materials led to positive outcomes in all categories, except one. The one exception was the response to "becoming interested in a broader

range of subjects than before using the materials" to which approximately 50% of students, regardless of material type, responded, "Yes." There was a significant difference in the response to "Use of the MAT-014 / Algebra 2 course materials has led to my gaining confidence" with 81.3% of OER students responding "Yes" and 48.1% of non-OER students responding "Yes" ($p = 0.032$). Table 10 illustrates the side-by-side comparisons for the OER and non-OER respondents for Survey 1, and Table 11 illustrates the same for Survey 2.

Table 10

Reported Benefits of Materials: Survey 1

	OER			non-OER		
Use of course materials has led to my ...	*n*	*Yes*	*%*	*n*	*Yes*	*%*
Increased participation in class discussions	17	11	64.7%	32	20	62.5%
Increased interest in Algebra 2	18	8	44.4%	32	19	59.4%
Increased satisfaction with the learning experience	18	16	88.9%	33	28	84.8%
Gaining confidence	18	13	72.2%	32	27	84.4%
Grades improving	18	13	72.2%	32	27	84.4%
Having increased independence and self-reliance	17	12	70.6%	32	25	78.1%
Increased engagement with lesson content	18	13	72.2%	32	26	81.3%
Increased experimentation with new ways of learning	18	11	61.1%	33	21	63.6%
Increased collaboration with my peers	18	9	50.0%	31	15	48.4%
Increased enthusiasm for future study	18	9	50.0%	33	21	63.6%
Becoming interested in a wider range of subjects than before I used the materials	17	9	50.0%	31	18	58.1%
Being more likely to complete my course of study	19	15	78.9%	32	27	84.4%

Table 11

Reported Benefits of Materials: Survey 2

	OER			non-OER		
	n	*Yes*	*%*	*n*	*Yes*	*%*
Increased participation in class discussions	17	12	70.6%	26	14	53.8%
Increased interest in Algebra 2	17	11	64.7%	26	11	42.3%
Increased satisfaction with the learning experience	17	13	81.3%	27	16	59.3%
Gaining confidence*	16	13	81.3%	27	13	48.1%
Grades improving	16	13	81.3%	27	19	70.4%
Having increased independence and self-reliance	16	12	75.0%	27	16	59.3%
Increased engagement with lesson content	16	11	64.7%	27	14	51.9%
Increased experimentation with new ways of learning	17	11	64.7%	26	14	53.8%
Increased collaboration with my peers	17	10	58.8%	27	12	44.4%
Increased enthusiasm for future study	16	9	56.3%	27	10	37.0%
Becoming interested in a wider range of subjects than before I used the materials	16	8	50.0%	27	14	51.9%
Being more likely to complete my course of study	16	13	81.3%	26	18	69.2%

* $p = 0.032$

Impressions of materials. Students were asked to evaluate the overall quality of the course materials used for Algebra 2. In both surveys, over 80% of OER students reported that the quality of the materials was of the same or better quality than the materials they have used in other courses (see Table 12). Survey 2 included additional specific questions about the quality of

the materials. As indicated in Table 13, students generally felt that the materials adequately supported their work both inside and outside of class.

Table 12

Overall Quality

	Survey 1 (n = 19)		Survey 2 (n = 17)	
Worse	2	10.5%	3	17.6%
Same	4	21.1%	6	35.3%
Better	13	68.4%	8	47.1%

Table 13

Additional Impressions

		Stg. Disag.				Stg. Agr.
Survey 2 responses (n = 17)	*Mean*	*1*	*2*	*3*	*4*	*5*
Supported work in class	4.24	1	0	2	5	9
Supported work outside of class	3.94	1	2	3	2	9
Thorough and complete	3.94	1	1	5	1	9
Relatively error-free	4.12	1	1	3	2	10
No trouble accessing materials	4.12	1	2	2	1	11
Would recommend to classmates	4.00	2	1	2	2	10

Two critical components of the materials were the workbook and the online homework application. Students rated elements of each of those tools on a scale of one to five, where one indicating that the component was not at all helpful and five that the element was very helpful (see Table 14). The online homework tool was perceived as being more helpful than the

workbook. In the second survey, half of the students rated the workbook as a one or a two on the five-point scale, although they had better impressions of specific elements of the workbook.

Table 14

Online Homework and Workbook Impressions

			Not Helpful				Very Helpful
	n	*Mean*	*1*	*2*	*3*	*4*	*5*
Survey 1							
Online HW tool overall	13	4.69	0	0	1	2	10
Online HW videos	13	4.38	0	1	2	1	9
Workbook overall	17	3.88	2	2	1	3	9
W.book worked examples	17	4.00	1	2	1	5	8
Workbook media examples	17	4.29	1	2	0	2	12
W.book you-try examples	17	4.06	1	2	2	2	10
Survey 2							
Online HW tool overall	13	4.38	1	1	0	1	10
Online HW videos	13	4.23	2	0	0	2	9
Workbook overall	10	2.80	1	4	2	2	1
W.book worked examples	10	3.30	1	2	1	5	1
Workbook media examples	10	3.90	2	0	0	3	5
W.book you-try examples	10	3.30	1	2	1	5	1

Material components. The usage of each component of the OER materials was also examined. Students reported which elements they used and for which academic purposes (see Table 15). Since the first survey did not explicitly instruct students to refer to the OER

workbook, student reported usage of the workbook from Survey 1 is not included in Table 15. The first and second surveys were consistent with respect to the tools used for homework. The worked example videos were the most-used component of the materials, and they were vital in supporting homework completion. It was less clear if students consistently used the videos to prepare for class. In Survey 1, 78.9% of the respondents reported using the videos to prepare for class. Video usage for class preparation dropped to 40.0% in Survey 2, which was a significant difference ($p = 0.02$). The use of the online homework tool was another inconsistency; the percentage of students who reported using the online homework tool to prepare for exams increased from 46.7% in Survey 1 to 84.6% in Survey 2 ($p = 0.04$).

Table 15

OER Component Usage

	n	*Class Prep*		*Do HW*		*Exam Prep*		*Other*	
Survey 1									
Online HW	15	8	53.3%	15	100%	7	46.7%	1	6.7%
Videos	17	9	52.9%	17	100%	10	58.8%	4	23.5%
Survey 2									
Workbook	9	3	33.3%	7	77.8%	5	55.6%	5	55.6%
Online HW	13	7	53.8%	13	100%	11	84.6%	4	30.8%
Videos	15	6	40.0%	15	100%	5	33.3%	2	13.3%

The non-OER materials were more reliant on a traditional textbook, and the online homework tool included written worked examples for each problem type. The OER online homework tool included videos as an accompaniment to a majority of the problems. No worked examples were available in the OER online homework tool. In the first administration of the

survey, no significant differences were reported in how students used the online homework tool or videos (see Table 16). However, the second survey indicated a difference in how students used their respective online homework tools. Specifically, the OER students used the online homework tool was used to prepare for class and exams more often than the non-OER students. Although the differences were not statistically significant, the videos also seemed more helpful for exam preparation than the worked examples in the non-OER online homework tool.

Table 16

Component Usage – OER and non-OER

	n		*Class Prep*		*Do HW*		*Exam Prep*	
	OER	non-OER	OER	non-OER	OER	non-OER	OER	non-OER
Survey 1								
Online HW	15	21	53.3%	38.1%	100%	95.2%	46.7%	66.7%
Videos	17	16	52.9%	50.0%	100%	87.5%	58.8%	68.8%
Survey 2								
Book[a]	9	12	33.3%	33.3%	77.8%	100%	55.6%	50.0%
Online HW	13	19	53.8%[b]	10.5%[b]	100%	94.7%	84.6%[b]	0.0%[b]
Videos	15	8	40.0%	12.5%	100%	100%	33.3%	0.0%
Worked Ex	*	18	*	11.1%	*	94.4%	*	0.0%

[a] For OER students, this is the workbook. For the non-OER students, this is the textbook.
[b] $p < 0.01$

To further understand how students perceived and used the OER materials, their responses to the open-ended questions were also examined. Student responses to the open-ended questions were coded using an evaluative coding scheme. Each comment was assigned a plus

(+) or minus (-) by code. Five codes were developed based on the open-ended responses; they can be found in Figure 7.

Code	Example Comment
Confidence	+: Made me more confidence in math
Engagement	+: Engage in the class, help class mates if and when needed
Online HW	-: the open math (OER HW tool) only made me wish I had aleks (non-OER HW tool)
Overall Evaluation	-: I learned nothing this semster. Class was a waste of money and time. I can see my entire class failing the final. +: I was able to participate more often. Also, I got good grades on my tests. Right now I have an A since the beginning of the semester and that has never happened before.
Videos	-: And the videos on the program weren't always that helpful . +: the media example videos has helped me a lot through the course

Figure 7. Student survey coding scheme

Few students commented on the OER materials. Table 17 displays the combined responses from both surveys. These comments expanded on the quantitative results from the surveys. Specifically, students reported finding the worked example videos to be instructive, and they stated that their confidence in math increased. Some students had prior experience with the non-OER online homework tool, and several commented that they preferred the commercial product.

Table 17

Open Ended Responses

Code	+ Responses	- Responses
Confidence	3	0
Engagement	1	0
Online HW	0	3
Overall Evaluation	5	3
Videos	3	1

Faculty Surveys

The faculty survey was sent to 18 faculty members teaching Algebra 2. There were 10 faculty members teaching STEM sections and eight teaching non-STEM sections, other than me. I did not participate in the survey. Responses were not differentiated between STEM and non-STEM instructors, but they were differentiated between those using OER and those not using OER. None of the STEM sections used OER materials. A small number of faculty participated in the survey; two OER faculty and five non-OER faculty participated (see Table 18).

Table 18

Faculty Response Rates

OER			non-OER		
Sent	*Resp*	*R. Rate*	*Sent*	*Resp*	*R. Rate*
3	2	66.7%	15	5	33.3%

All of the faculty who responded to the survey felt that the OER and non-OER materials were comparable in their support of student learning. Both of the OER instructors felt that the

materials were of better quality than materials used in other courses. The non-OER instructors were split on their reaction to their materials (see Table 19). Three of them felt that the materials were about the same, and the other two felt that they were better.

Table 19

Material Evaluation: Faculty

Ranking	OER (n = 2)	non-OER (n = 5)
Worse	0	0
About the same	0	3
Better	2	2

There were other differences in the faculty members' impressions of the materials. Both of the OER instructors agreed with the statement that the course materials increased learners' participation in class discussions. Of the non-OER instructors, two of the five (40%) did not agree with this statement. Similarly, both of the OER instructors agreed that the materials increased learners' interest in Algebra 2. Only one of the non-OER instructors agreed with that statement, and the others were neutral. Alternatively, all of the non-OER instructors felt that their materials increased learners' confidence, whereas only one of the OER instructors had that same perception.

One non-OER instructor noted that students needed to use the materials to benefit from them. The specific comment was, "If you can get them to actually purchase them, and sit down long enough to actually utilize them: frankly, they benefit[s] lots. Their comprehension is more significant than if they had not used the materials." The perception of how frequently students used the materials was similar between the two types of materials. As shown in Table 20, both OER instructors believed their students were using the materials multiple times per week,

whereas 2 (40%) of the non-OER instructors thought their students were using the materials less frequently.

Table 20

Student Usage: Faculty Perceptions

Usage	OER (n = 2)	non-OER (n = 5)
2 – 3 times per month	0	2
2 – 3 times per week	2	2
Most days	0	1

Four codes were used to analyze faculty perceptions of the materials: positive reactions, negative reactions, impact on student learning, and impact on teaching practice. A summary of the responses are illustrated in Figure 8. The OER students had positive reactions to both the workbook and online homework, but they also suggested some content-related improvements that could be made to the workbook. One positive comment of note about the OER materials was, "The materials had many real-world applications that the students could relate to. I think that helped to increase their interest in the course. Materials in other courses frequently have less applicability for students so it can be hard for students to relate or even care about an abstract topic." This comment was made by a faculty member who has taught at the college for over 18 years and taught this particular course 10 or more times. The non-OER instructors focused their comments on the online HW tool. The textbook was an eBook embedded within the online HW tool, and one instructor noted that students were less likely to access the textbook in this design.

Category	OER (n = 2)	non-OER (n = 5)
Positives	Facilitated different approaches to learning (1)	Online HW tool in general (4)
	Videos (1)	Online HW tool facilitated self-paced learning (1)
	Application problems (1)	Link between math and real life (1)
Negatives	Emphasis on graphing calculator (1)	Price (1)
	Lack of worked examples (1)	Lack of hard copy of textbook (1)
Student Impact	Increased confidence (1)	Online HW tool helps students learn (3)
	Low cost (1)	
Teaching Practice	Exploration of flipped classroom (1)	Increased questioning style (1)

Figure 8. *Faculty open-ended responses*

Student Interviews

The student interviews were intended to explore how students used the materials, and the data were used to further explain responses to the closed-ended survey questions. The interviews also elicited evaluative comments about the materials. The coding scheme for the student interviews began with the codes from the open-ended survey questions which were expanded based on the scope and focus of the interview. The final coding scheme of 19 codes is illustrated in Figure 9.

Four of the five students who were interviewed made at least one positive comment about the materials in general or about specific elements of the materials. As a general comment about the OER materials, one student noted, “It was all straight-forward stuff that was good.” Of particular note, three of the five students felt that the video worked examples were particularly helpful. One of the specific comments was that “the videos are so beneficial to me, because like

I said, I'm a visual learner. I need to see it, not just hear it, all the time, and that helped me so much. I watched it so many times."

Parent Code	Child Codes
Online HW	negative evaluation
	positive evaluation
	used for test preparation
Overall Evaluation	negative evaluation
	positive evaluation
Videos	negative evaluation
	positive evaluation
	used for homework
	used to prepare for class
Workbook	negative evaluation
	positive evaluation
	used for homework
	used to prepare for class
	referred to solutions
	used the assessment
	used in class
	used the practice problems
	used for test preparation
Missing Worked Examples	

Figure 9. *Student interview coding scheme*

Three students had constructive feedback about the materials, particularly about the online homework tool. Two of the three noted that the materials were lacking in written worked examples. Two students also did not like that you only had three attempts on a particular problem in the online HW. After three tries, students were required to attempt a new version of the problem, which was generated algorithmically. One of those students felt that she was penalized for having correct answers with incorrect formatting and that it could take more than three attempts to correct the matheamtical notation. While there were some specific areas noted for improvement, the overall sentiment was positive.

During the interviews, students reported how they used the materials. Each of the students reported on at least one particular way in which they used the materials, and a summary of those reported usages is outlined in Table 21. Of note was how the materials were not used. The online HW was not seen as a tool to prepare for class, and the videos were not used to study for tests. For example, when one student was asked how she used the workbook, she responded, "to study, to practice, to actually do the work."

Table 21

Student Interview: Materials Usage

Materials Usage	Number (n = 5)
Used online HW for test preparation	3
Used videos to help with the HW	3
Used videos to prepare for class	2
Used workbook to help with HW	3
Used workbook to prepare for class	3
Used workbook for test preparation	3

Summary of Findings

Even though there was not a significant difference between the final exam scores of the OER and non-OER students, the survey and interview data illustrated some benefits of the OER materials. With the small sample sizes, the results were only directional, but by all measures, the students were satisfied with the OER materials. Although students did not pinpoint one specific OER component, they felt that the materials were linked to an increased satisfaction with the overall learning experience. There was also some evidence, both quantitative and qualitative, that the OER materials were connected to a sense of confidence in their mathematical ability. While students utilized all components of the materials, the video worked examples were frequently cited as a favorite element. Faculty also had a positive reaction to the materials. These positive responses indicated that further investigation of OER materials is a worthwhile undertaking.

Chapter 5: Discussion

The primary purpose of this study was to understand how community college students interacted with OER materials designed for an Algebra 2 course. It built upon research on student satisfaction with OER course materials and on student usage of traditional course materials. An extensive search of the OER literature did not reveal other work involving how students specifically engage with their OER course materials. The findings of this study have been and will continue to be used to inform course material adoption decisions in the Mathematics Department at County College. The findings will also be shared with the larger County College community as it explores the use of OER across disciplines. This chapter includes a discussion and interpretation of the findings along with limitations and implications for practice.

Discussion of Findings

This section includes a summary of the findings organized by research question. Each research question is restated alongside a brief synopsis of the relevant findings.

Component use. The first research question was, "How do students use the components of the Algebra 2 OER learning materials?" The OER materials included an online OpenStax eBook, a workbook, which was available to view online, print, or to purchase from the bookstore, videos associated with the workbook, and a free online homework platform. The online homework platform included worked example videos for many of the homework problems. The OpenStax textbook was only used by one interviewee so an analysis of how it was used was not possible; the conclusion is that students were not interested in using a traditional textbook in eBook form. The videos were used the most often, with 17 (77.3%) of the respondents to the first survey and 15 (88.2%) respondents to the second survey indicating when

and how they used them. The online homework tool was also frequently used, with 15 (68.2%) and 13 (76.5%) of students responding to each survey, respectively, reporting using it. Usage of the workbook was only reported on by 52.9% of the survey respondents.

Of particular interest was how students used the online homework tool. Not surprisingly, it was used for completing the homework, but it was also used as a tool for class and test preparation. Specifically, on the second survey, 11 of the 13 OER respondents indicated that they had used the online homework tool to help prepare for exams and none of the non-OER respondents reported using their online homework tool in this way. Approximately half of the OER students also found the online homework tool and videos useful for class preparation, whereas only one third found the workbook useful for that purpose.

All five of the students who were interviewed discussed the videos. They all had used the videos, and three of them were particularly enthusiastic about them and their helpfulness in preparing for class. However, they did not refer to the videos as a tool for test preparation. One student summed it up this way, “So every night, if I'm doing OpenMath [the online homework], I'm looking at my workbook also. I love those videos. MyOpenMath [online homework] and those videos are like godsend. Literally. I love those videos.”

Benefits and disadvantages. The second research question asked, “What do students perceive to be the benefits and disadvantages of the components of the Algebra 2 OER learning materials?” Students felt strongly that the OER materials increased their overall satisfaction with the learning experience, with 88.9% responding affirmatively to this statement on the first survey and 81.3% responding affirmatively on the second survey. For example, one student noted on the second survey that, “all the videos and problems that walk through each step helped me with homework and studying.” This finding was supported by the level of helpfulness the students

reported for the online homework tool. On the first administration of the survey, 12 out of 13 (92.3%) students rated the online homework tool as a four or a five on a one-to-five scale of helpfulness, with a five indicating that the tool was very helpful. Similarly, 11 out of 13 (84.6%) rated the tool as a four or five one the survey at the end of the semester.

Although the results were not statistically different from some of the less noted attributes, students also reported that the using the OER materials increased their likelihood of completing their course of study, resulted in higher grades, and increased their confidence in learning mathematics. The videos may have contributed to these positive reactions to the course materials. The homework videos were rated as a four or five on the one-to-five scale of helpfulness by 10 out of 13 (76.9%) students on the first survey and 11 out of 13 (84.6%) students on the second survey. One student also noted in her interview that, "Yes. I liked the videos, it was like another way to interpret the lessons another way." More specifically, the increase in confidence was also supported by open-ended comments on the surveys, with one student stating, "I really enjoyed the course and the work book. It gave me the ability to feel confident with my math skills."

According to the students, the OER materials were not effective at increasing collaboration, increasing interest in the subject of Algebra 2, or increasing interest in future studies or studying a wider range of topics. The lack of affirmative responses to these potential benefits were statistically significantly lower than affirmative responses to the general satisfaction with the learning materials. Specifically on the first survey only 43.8% of students reported that the materials had led to an increased interest in Algebra 2, which was significantly lower than the 93.8% who reported that the materials contributed to their overall satisfaction (p =

0.013). Similarly, only 50% of students reported that the materials increased collaboration or enthusiasm for future study ($p = 0.023$).

Only two students (10.5%) who responded to the first survey and three students (17.6%) who responded to the second reported that the materials were categorically worse than other course materials, and the primary reason noted for their dissatisfaction was the lack of written worked examples. The workbook included few worked examples which meant that students had to develop the content either in class or by watching the associated videos. Some students found this to be a disadvantage to the materials, with one student stating on the survey:

> I felt like the text book that I bought wasn't really so helpful . It had a lot of problems to practice and all but I don't feel like there was a lot of information or explaining in it especially if there was a section you weren [sic] sure about . It had the table of contacts [sic] for the section which was helpful to find . But after the brief description of the topic that was gonna be in the section there was no more explaining . And the videos on the openmath weren't always helpful.

Similarly, the lack of written worked examples in the online homework tool was also noted as a disadvantage. On the second survey, five (50%) students ranking the workbook as a 1 or 2 on a scale of one to five, with one indicating "not helpful". However, on the first survey, nine of the 17 respondents rated the workbook as a five (very helpful); thus, the overall student perception of the workbook is not conclusive.

Faculty perceptions. The third research question was, "How do faculty perceive the effectiveness of the Algebra 2 OER learning materials as a support for student learning?" The two OER faculty members who participated in the faculty survey felt that the materials were better than the non-OER course materials, and I agreed with them. The OER instructors also

were more likely to think that the course materials were linked to greater class participation and an increased interest of their students in the course content. Given my experience with the course materials and based on personal conversations with one of the OER faculty members, I believe the perception of increased interest was due to the application problems in the OER materials. The application problems in the OER materials were often interspersed with the symbolic manipulation problems, rather than added to the end of the section or as their own section. The application problems were also linked with explanatory videos, which provided students with an opportunity to engage with those problems in a meaningful way outside of class. In contrast to this faculty perception, students did not report an increased interest in the course content based on the materials.

The non-OER instructors cited the online homework tool as a key element for student success in their courses, while none of the OER instructors specifically mentioned their online homework tool. Instead one of the OER instructors made a note that the videos were a key element to support student learning. The OER instructors also believed that their students were engaged with their materials more frequently than the non-OER students, with both reporting that they believed their students used the materials multiple times per week. In contrast, 60% of the non-OER faculty believed their students used the materials multiple times per week. Cost was also noted as a barrier to use of the non-OER materials and a benefit of the OER materials.

Researcher perceptions. I chose not to take the faculty survey to reduce the potential for bias in the results. I agreed with the OER survey respondents that the OER materials were better than the non-OER materials used for Algebra 2. However, based on my experiences in the classroom, I did not find that student interest in the course content was increased based on the OER material, with the possible exception of business students. Many of the applications were

business-related applications, such as cost, revenue, profit problems Business majors did express a greater interest in those applications. This led me to conclude that the materials could be improved by included a greater variety of application problems. I did agree with the OER respondents that OER students used the course materials more frequently than when I have taught with the non-OER materials. This was evidenced by how frequently students contacted me with questions about homework problems and by how frequently they referred to the OER videos.

Final exam grades. The final research question asked, "Do students' grades on the standard departmental final exam differ when faculty assigns the Algebra 2 OER learning materials in place of commercial textbooks and associated homework tools?" There was no statistical difference between the final exam grades of students using the OER materials and those using the non-OER materials. Given that the final exam was tailored to the non-OER materials, including using questions from the publisher's test bank, this result provides evidence that use of the OER materials did not have a negative effect on student outcomes.

A greater percentage of OER students did earn a D on the final exam, which along with an overall average of C, was a requirement for passing the class. While a higher percentage of Ds may indicate that the OER materials had some deficiencies, it may also have been due to unfamiliar wording of exam questions, given the different class materials, different types of application problems presented in the course materials, or different content emphases in the different materials.

Interpretation of Findings

The goal of this mixed methods study was to understand how students interacted with and perceived OER instructional materials. Students were generally satisfied with the OER

materials, for academic reasons, and they also appreciated the low or free price point. Students found that the materials supported their work, and their final exam results validated this conclusion. In contrast with the students using the non-OER course materials, the OER students found multiple uses for the online homework tool, including using it for test preparation. However, this tool could be strengthened by the inclusion of written worked examples in addition to the video worked examples.

While students found the video worked examples useful, they did not uniformly indicate that they used them to complete problems in the workbook. One factor contributing to this might be differences in how faculty implemented the materials. Although not a focus of this study, how faculty enact and discuss course materials influences how students interact with their course materials (Weinberg et al., 2012). Some students indicated that they used the workbook in class, which could have resulted in a set of worked examples developed by the students with their professor during class. Other students indicated that they did not use the workbook in class, which may mean that their workbook was a set of blank problems and linked videos. This difference could have been exacerbated by differences in whether faculty assigned workbook pages as homework or not.

While OER faculty felt that the application problems were an advantage to these materials, the students did not find the specific content of the material more compelling than the non-OER materials. In particular, OER students were unlikely to report that the materials increased their interest in the subject or their interest in further study in the discipline. This could be due to the fact that Algebra 2 is a required pre-requisite course for transfer-level math courses, and student may not perceive specific applicability to their chosen non-STEM disciplines.

Limitations

A primary limitation was the low response rate of participants. To minimize the potential for this limitation, I incentivized participation with Amazon.com gift cards, and I asked all faculty to remind their students to complete the survey. Despite those efforts, the response rates for the surveys were both under 15%. Those low response rates presented a particular challenge given that the OER materials were only used in five sections. Such a low response rate in a small population magnified the potential limitations of using email surveys. While it was possible to conduct statistical tests on the two samples, the statistical strength of the results was limited by the small sample sizes.

A secondary limitation was lack of broad consent to use final exam data. I visited each section of non-STEM Algebra 2 one time to request consent. I was only able to obtain permission from students who were present, which presented a challenge in several instances. For example, I visited one class at the end of class, and many students had left early. I visited other classes at the beginning of class and was unable to obtain consent from students who arrived late. Within my own classes, I was careful to emphasize that providing consent was optional and had no bearing on grades. It is possible that the resulting convenience sample of final exams was not representative of the population of students who took non-STEM Algebra 2 in the spring.

Implications for Practice

The use of OER materials saves students money, and students have consistent access to their course materials beginning on the first day of class. However, more important than a low cost, course materials also need to support student learning. The results of this study indicate that OER materials can do that in the context of a community college developmental

mathematics class. Importantly, the participants in this study included adjunct faculty who received minimal professional development and support on the use of these materials. Given the large percentage of developmental courses taught by adjunct faculty, the findings indicated that the use of OER should be scalable, even with a large part-time faculty population.

The design of the specific OER materials was of particular importance. While students were generally satisfied with the videos and online homework tool, they did note that written worked examples are also beneficial. Given the nature of OER, particularly the workbook-style of OER used in this study, student input can be incorporated into the materials either during the semester or between semesters. In fact, the County College Mathematics Department has voted to implement the workbook-style of OER in all developmental mathematics classes starting in the Fall Semester 2019. The two developmental coordinators will be cultivating the materials after the spring semester and feedback from this study will be used to inform that cultivation process. For example, written worked examples could be incorporated into the online homework tool.

One challenge with implementing OER is the development time required by faculty, and the resulting costs to the college. A recent study estimated the cost of developing OER materials for a single course is approximately $11,700 when developed by one faculty member and up to $18,200 if a team of faculty work on the project (Griffiths et al., 2018). These costs are incurred through providing faculty with release time, training, and general administrative support. Despite these costs, County College and colleges around the country are working to implement OER to support institutional goals such as increasing access and equity in their offerings.

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Appendix A: Sample of OER Workbook

Link to full workbook: https://drive.google.com/file/d/1Gz1G2auFC97Ei7eKWvPbb-77PpRJPyPD/view?usp=sharing

Link to Media Example Video for Problem 1 shown below:

https://www.youtube.com/watch?v=ufTjNFRJJRc&feature=youtu.be

Section 1.1 – Review of Solving Linear Equations

Definition
An **algebraic equation** is a mathematical sentence stating that an algebraic expression *is equal to* a specified value, variable, or another expression. The **solution** to an equation is the value, or set of values, that make the equation true.

Definition
Equivalent equations are two or more equations that have the same solution.

STEPS FOR SOLVING A LINEAR EQUATION
1. Simplify each side of the equation. Remove parenthesis if necessary. Combine like terms. 2. Add or subtract terms on each side of the equation so that all terms containing the variable are on one side and all constant terms are on the other side. 3. Simplify each side of the equation by combining like terms. 4. Apply the Multiplication/Division Property of Equality to isolate the variable. 5. Check by substituting the solution into the original equation.

Solve for the variable in each of the following equations. Check your answers.

Problem 1	**MEDIA EXAMPLE – Solving Multi-Step Equations**

Solve $x - 5 = 4x + 7$ Check:

Appendix B: Final Exam

County College
MAT 014 – Final Exam
For Students Preparing for 113/123
Spring 2018

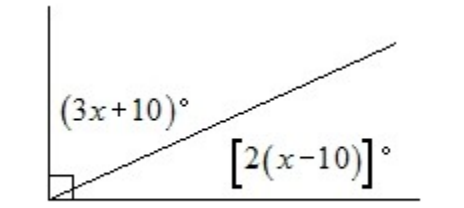
Fill in the circle on the Scantron form that corresponds to the correct answer.

1. In the mid-nineteenth century, explorers used the boiling point of water to estimate altitude. The boiling temperature of water T (in °F) can be approximated by the model $T = -1.83a + 212$ where a is the altitude ***in thousands of feet***. For example, if the altitude is 8,000 ft, the temperature would be calculated by $T = -1.83(8) + 212 = 197$.

Determine the temperature at which water boils at an altitude of 11,000 ft. Round to the nearest degree:

A) 210°F B) 214°F C) 232°F D) 192°F

2. Solve for x and find the measure of each angle.



(Figure is not necessarily drawn to scale.)

A) 70°, 20° B) 73°, 17° C) 71°, 19° D) 75°, 15°

3. Solve: $x - 8 > 11$

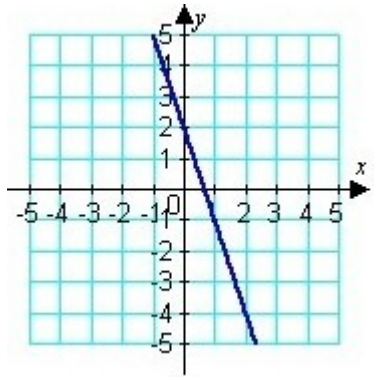
A) $x < 19$ B) $x > 3$ C) $x > -8$ D) $x > 19$

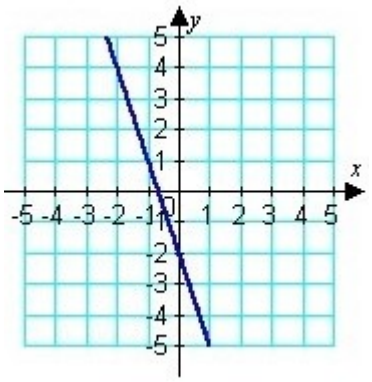
4. Solve: $-16 \leq 2x - 7 < 4$

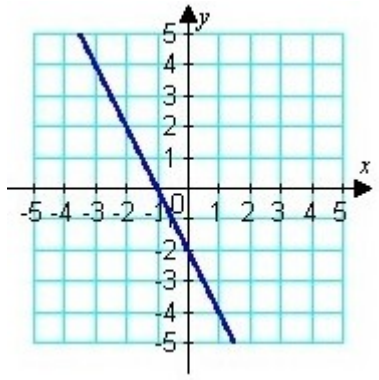
A) $-\frac{9}{2} \leq x < 4$ B) $-\frac{9}{2} \leq x < \frac{11}{2}$

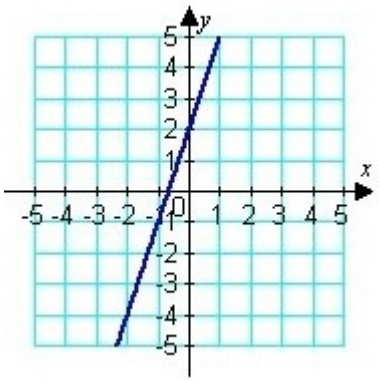
C) $-16 \leq x < \frac{11}{2}$ D) $-\frac{23}{2} \leq x < -\frac{11}{2}$

5. Graph the linear equation: $y = -3x + 2$

A) 

B) 

C) 

D) 

6. Find the x-intercept and the y-intercept: $5x - 2y = 10$

A) $(-5,0)$ and $(0,2)$

B) $\left(\frac{5}{2}, 0\right)$ and $\left(0, \frac{2}{5}\right)$

C) $(0,0)$ and $(0,0)$

D) $(2,0)$ and $(0,-5)$

7. The S-Cargo shipping company calculates shipping charges using the linear model $y = 2.13x$, where y is the cost in dollars and x is the weight of the package in pounds $(1 \leq x \leq 13)$. Use the linear model to compute the weight of a package with a shipping cost of \$25.56. Round to the nearest hundredth of a pound, if necessary.

A) 5.63 lb B) 12.00 lb C) 14.13 lb D) 25.56 lb

8. Suppose Uber's rates are \$0.55 per mile plus an additional \$3.10 for the ride. You have \$15 with you, and you want to make sure you have **\$3 to tip the driver**. What is the greatest number of miles can you travel with Uber and still stay within your budget?

A) 12 B) 22 C) 16 D) 21

9. List the domain and range.

x	y
9	5
-6	10
0	9
-10	4
-6	6
0	4

A) Domain: {–10,–6, 0, 9}; Range: {4, 5, 6, 9, 10}

B) Domain: {4, 5, 6, 9, 10}; Range: {–10,–6, 0, 9}

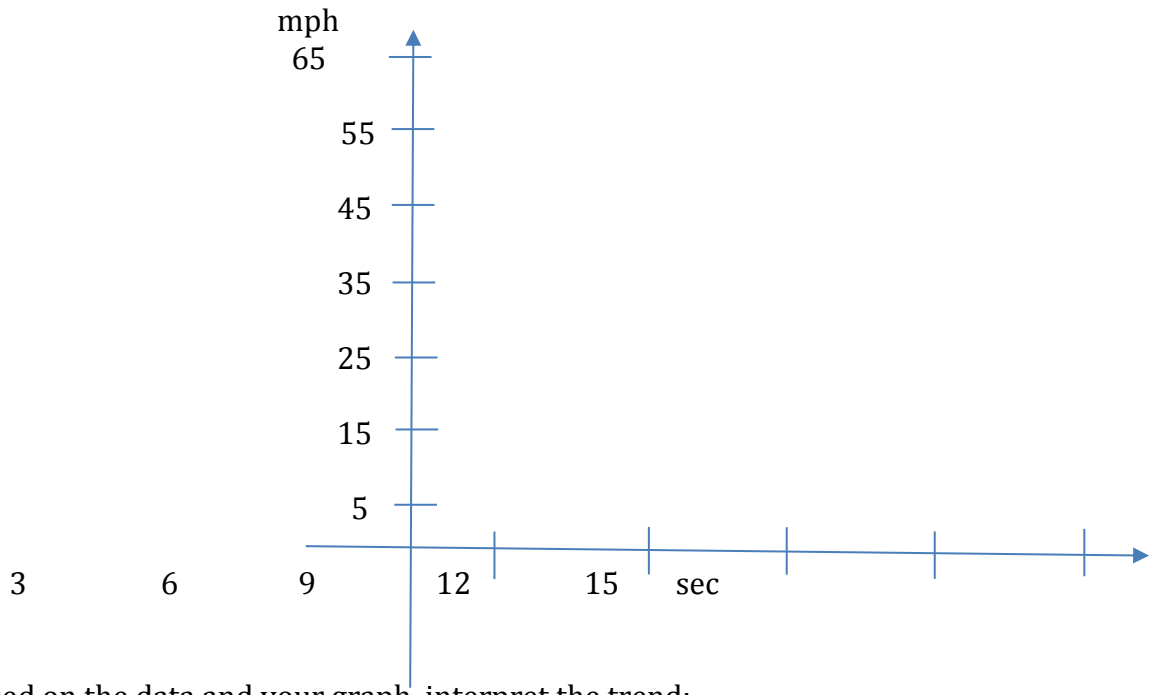
C) Domain: {-9, 0, 6, 10}; Range: {–4, –5, –6, –9, –10}

D) Domain: {–6, 0}; Range: {4}

10. Suppose that the speed of a car, measured in miles per hour (mph), is monitored for some short period of time after the driver applies the brakes. The following table relates the speed of the car to the amount of time, measured in seconds (sec), elapsed from the moment that the brakes are applied.

Elapsed time (sec)	3	6	9	12	15
Speed of car (mph)	62	48	33	19	3

To help you visualize the trend, represent the data in the table graphically with elapsed time on the horizontal axis and speed on the vertical axes.



Based on the data and your graph, interpret the trend:

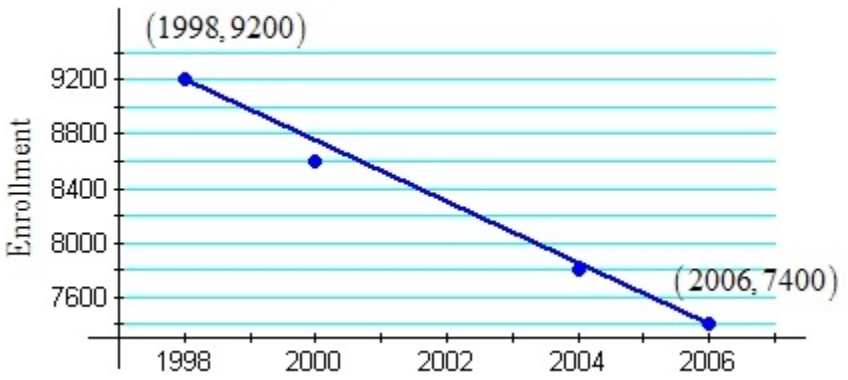
A) As time increases, speed decreases linearly.

B) As time increases, speed decreases, but in a non-linear fashion.

C) As time increases, speed increases linearly.

D) As time increases, speed increases, but in a non-linear fashion.

11. The graph below shows the enrollment at Riverside Community College for selected years. Use the coordinates of the given points to find the slope of the line. Interpret the meaning of the slope in the context of this problem.



A) $m = -450$
Enrollment decreases by approximately 450 students per year.

B) $m = -1800$
Enrollment decreases by approximately 1800 students per year.

C) $m = -225$
Enrollment decreases by approximately 225 students per year.

D) $m = 225$
Enrollment increases by approximately 225 students per year.

12. If $f(x) = 2x^2 + 7x - 4$, find $f(-3)$.

A) $f(-3) = -43$ B) $f(-3) = -7$ C) $f(-3) = 21$ D) $f(-3) = 11$

13. Write a function defined by $y = f(x)$ subject to the following conditions: The value of $f(x)$ is 6 more than nine times x.

A) $f(x) = 6x + 9$ B) $f(x) = 9x + 6$

C) $f(x) = 6x - 9$ D) $f(x) = 9x - 6$

14. Lorenzo invested $16,000 into two accounts; one pays 4% simple interest and the other pays 5% simple interest. At the end of the first year, Lorenzo's total return was $730. How much did he invest in each account?

A) $9000 at 5%; $7000 at 4%
B) $9000 at 4%; $7000 at 5%
C) $10,000 at 4%; $6000 at 5%
D) $10,000 at 5%; $6000 at 4%

15. The cost in dollars of producing *x* fruit baskets is represented by $C(x) = 12.3x$. The revenue received is represented by $R(x) = 23.95x + 13$. The profit is the revenue minus the cost (i.e., $R(x) - C(x)$). Write a function *P(x)* that represents the profit.

A) $P(x) = 36.25x + 13$
B) $P(x) = 11.65x + 13$
C) $P(x) = 11.65x - 13$
D) $P(x) = -11.65x - 13$

16. Perform the indicated operation and simplify: $3s^2t^4(s^3t^2 + 8st^2 - 6s^5)$

A) $3s^5t^6 + 24s^3t^6 - 18s^7$
B) $3s^5t^6 + st^2 - 6s^5$
C) $3s^5t^6 + 24s^3t^6 - 18s^7t^4$
D) $3s^5t^6 + 8s^3t^6 - 6s^5$

17. Perform the indicated operation and simplify: $(2v + 6w)^2$

A) $4v^2 + 12vw + 36w^2$
B) $4v^2 + 24vw + 36w^2$
C) $4v^2 - 24vw + 36w^2$
D) $4v^2 + 36w^2$

18. Which of the following is a factor of $x^2 + 10x - 11$?

A) $(x - 11)$ B) $(x - 2)$ C) $(x + 1)$ D) $(x + 11)$

19. Factor completely: $25r^2 - 36$

A) $(5r + 6)(5r - 6)$ B) $(6 - 5r)^2$

C) $(6 + 5r)(6 - 5r)$ D) $(5r - 6)^2$

20. Solve the equation: $x^2 + 11x = -24$

A) $x = 3,8$ B) $x = -8,3$ C) $x = -8, -3$ D) $x = -3,8$

21. If $m(y) = \frac{y-7}{y^2-4}$, find $m(7)$.

A) $m(7) = 2$ B) $m(7) = 0$ C) $m(7) = \frac{1}{45}$ D) $m(7)$ is undefined

22. Simplify: $\frac{y^2+5y-14}{y^2-4}$

A) $\frac{5y-14}{4}$, provided $y \neq -2$ B) $\frac{y+7}{y-2}$, provided $y \neq -2$

C) $\frac{y+7}{y+2}$, provided $y \neq 2$ D) cannot be simplified

23. Perform the indicated operation: $\frac{x}{x+3} + \frac{3}{x}$

A) $\frac{x + 3}{x^2 + 3x}$ B) $\frac{x^2 + 3x + 9}{x^2 + 3x}$

C) $\frac{2x^2 + 3x + 9}{x^2 + 3x}$ D) $\frac{x + 3}{2x + 3}$

24. Solve the equation: $\frac{7}{x+9} = \frac{-3}{5x}$

A) $x = -\frac{20}{3}$ B) $x = 0, -9$ C) $x = -\frac{27}{38}$ D) $x = -7,9$

25. The ratio of men to women at one college is 4 to 5. If there are 17,100 total students, how many men are there?

A) 9500 men B) 8550 men C) 7600 men D) 8440 men

26. Evaluate: $-\sqrt[4]{1296}$

A) -6 B) 6 C) 7 D) not a real number

27. Simplify: $16^{-3/2}$

A) $\frac{1}{64}$ B) -64 C) -4 D) $\frac{1}{4}$

28. Simplify $\sqrt{44x^{13}}$. Assume that all variables represent positive real numbers.

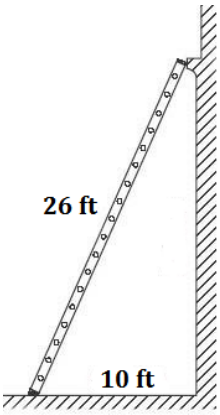
A) $2x^6\sqrt{11x}$ B) $11x^6\sqrt{2x}$ C) $4x^6\sqrt{11x}$ D) $2x^{11}\sqrt{11x}$

29. Determine the data value that is missing from the table.

x	y
0	0
1	1
4	2
16	?
25	5

A) 3 B) 4 C) 8 D) 16

30. How high up a vertical wall will a 26 foot extension ladder reach if the base is placed 10 feet away from the wall?



A) 16 ft B) 6 ft C) 27.9 ft D) 24 ft

31. Solve: $(t + 10)^2 = 4$

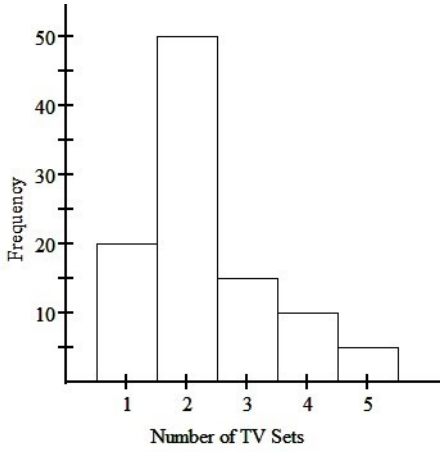
A) $t = -8, -12$ B) $t = 8,12$ C) $t = -6$ D) $t = 0$

32. Find the range of the data listed below.

27 24 31 27 41 2 25 47

A) 45 B) 20 C) 27 D) 39

33. The histogram below represents the number of television sets per household for a sample of U.S. households. How many households have exactly 1 television set?



A) 20 B) 50 C) 100 D) 15

34. Find the mean, median, and mode for the data provided. The data shows hours spent at work for a group of men.

Name	Hours
Alvin	62.5
Juan	59.5
Sean	56.7
Victor	48.7
Chan	43.5
Jacques	39.3
Philip	35.7
Roberto	31.3

A) mean: 46.1, median: 47.15, mode: 46.1

B) mean: 47.15, median: 46.1, mode: no mode

C) mean: 46.1, median: 47.15, mode: 46.9

D) mean: 47.15, median: 46.9, mode: no mode

35. A box contains five blue, eight green, and three yellow marbles. If a marble is selected at random, what is the probability that it is blue?

A) $\frac{1}{16}$ B) $\frac{1}{5}$ C) $\frac{5}{8}$ D) $\frac{5}{16}$

Appendix C: OER Perception, Student Survey

A sample student survey based on Bliss et al. (2013). Survey retrieved from a link at http://openedgroup.org/toolkit

Q1 – Consent Information (http://openedgroup.org/toolkit for a sample consent form)

Q2 What is your gender?
- ❍ Male (1)
- ❍ Female (2)
- ❍ Other/prefer not to say (3)

Q3 Have you received any LOANS to fund your education?
- ❍ Yes (1)
- ❍ No (2)

Q4 Have you received any PELL GRANTS or FEE WAIVERS to fund your education?
- ❍ Yes (1)
- ❍ No (2)

Q5 How many terms have you completed in college?
- ❍ Less than 1 (1)
- ❍ 1-2 (2)
- ❍ 3-4 (3)
- ❍ 5-6 (4)
- ❍ 7-8 (5)
- ❍ 9-10 (6)
- ❍ More than 10 (7)

Q6 What is your cumulative college Grade Point Average (GPA) on a 4.0 scale?
- ❍ 0.0 - 1.4 (1)
- ❍ 1.5 - 2.0 (2)
- ❍ 2.1 - 2.5 (3)
- ❍ 2.6 - 3.0 (4)
- ❍ 3.1 - 3.5 (5)
- ❍ 3.6 - 4.0 (6)
- ❍ This is my first term (7)

Q7 In general, how often do you purchase the required texts for the courses you take?
- ❍ Never (1)
- ❍ Rarely (2)
- ❍ About Half the Time (3)
- ❍ Often (4)
- ❍ Always (5)

Q8 How much do you typically spend on texts each semester?
- Less than $100 (1)
- $101 - $200 (2)
- $201 - $300 (3)
- $301 - $400 (4)
- $401 - $500 (5)
- More than $500 (6)

Q9 On average, how many courses do you take each semester?
- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 (7)
- 8 (8)
- More than 8 (9)

Q10 For a typical course, how often do you use the required texts?
- Never (1)
- 2-3 Times a Semester (2)
- 2-3 Times a Month (3)
- 2-3 Times a Week (4)
- Daily (5)

Some of the questions that follow refer to "this course." In these questions, we are referring to the course taught by the instructor who sent you the link to this survey.

Q11 Did you purchase any texts for this course?
- Yes (1)
- No (2)

Answer Q12 If Did you purchase any texts for this course? Yes Is Selected
Q12 How much did you spend on texts for this course?
- Less than $20 (1)
- $21 - $40 (2)
- $41 - $60 (3)
- $61 - $80 (4)
- $81 - $100 (5)
- $101 - $120 (6)
- $121 - $140 (7)
- More than $140 (8)

Answer Q13 Did you purchase any texts for this course? No Is Selected

Q13 Why did you not purchase the texts for this course? (select all that apply)
- ☐ The texts were not available for purchase (1)
- ☐ The texts were available free of charge online (2)
- ☐ I simply didn't want to purchase texts for this course (3)
- ☐ I borrowed someone else's texts (4)
- ☐ I used library copies (5)
- ☐ I heard the instructor doesn't use texts for this course (6)
- ☐ I couldn't afford to purchase the texts (7)
- ☐ The texts were sold out (8)
- ☐ I rented the texts (9)
- ☐ Other reasons (10) _____

Q14 Did you print text materials for this course?
- ○ Yes (1)
- ○ No (2)

Answer Q15 If Did you print text materials for this course? Yes Is Selected
Q15 How much did you spend on printing text materials for this course?
- ○ Less than $10 (1)
- ○ $11 - $20 (2)
- ○ $21- $30 (3)
- ○ $31 - $40 (4)
- ○ $41 - $50 (5)
- ○ $51 - $60 (6)
- ○ $61 - $70 (7)
- ○ More than $70 (8)

Q16 How often did you use the texts for this course during the semester?
- ○ Never (1)
- ○ 2-3 Times a Semester (2)
- ○ 2-3 Times a Month (3)
- ○ 2-3 Times a Week (4)
- ○ Daily (5)

Q17 How would you rate the quality of the texts used for this course?
- ○ WORSE than the quality of the texts in my other courses (1)
- ○ About the SAME AS the quality of the texts in my other courses (2)
- ○ BETTER than the quality of the texts in my other courses (3)

Answer Q18 If How would you rate the quality of the texts used for this... WORSE than the quality of the texts in my other courses Is Selected
Q18 Please briefly describe what made the quality of this course's texts WORSE than those in other courses.

Answer Q19 If How would you rate the quality of the texts used for this... BETTER than the quality of the texts in my other courses Is Selected

Q19 Please briefly describe what made the quality of this course's texts BETTER than those in other courses.

Q20 Were the texts used in this course available to you primarily online?
- ❍ Yes (1)
- ❍ No (2)

Answer Q21 If Were the texts used in this course available to you... Yes Is Selected

Q21 How do you feel about the online format of the texts used for this course?
- ❍ I like the online format MORE than traditional printed texts (10)
- ❍ I like the online format LESS than traditional printed texts (11)
- ❍ I have no preference (12)

Q22 Overall, what do you think of the texts used in this course?

Q23 How likely are you to register for a future course with online texts like those used in this course?
- ❍ Very Unlikely (1)
- ❍ Somewhat Unlikely (2)
- ❍ Somewhat Likely (3)
- ❍ Very Likely (4)

Q24 Imagine a future course you are required to take. If two different sections of this course were offered by the same instructor during equally desirable time slots, but one section used texts similar to those used in this course and the other used traditional published texts, which section would you prefer to enroll in?
- ❍ I would enroll in the section with TRADITIONAL PUBLISHED TEXTS (1)
- ❍ I would enroll in the section with TEXTS LIKE THOSE OFFERED IN THIS COURSE (2)
- ❍ I would have no preference (3)

Appendix D: OpenStax, Student Survey

Retrieved from http://openedgroup.org/wp-content/uploads/2016/08/OER_Hub_Student.pdf.
This questionnaire is being conducted as part of a project which is investigating how people think and use different types of online resources. You have been invited to take this survey because you use OpenStax College textbooks.

The research is being carried out by The Open University (UK) in collaboration with OpenStax College, and is funded by the Hewlett Foundation in order to support future excellence in open education. Your answers will help us build a picture of how people across the world use online resources for learning and teaching. Our research data will help people around the world make more informed decisions about online teaching and learning.

All the answers you provide to the following questions will be held securely and our data protection policy complies with the UK's Data Protection Act (1988) and the USA's Protection of Human Subjects (45 CFR 46).

The survey should take around 20 minutes to complete. All questions are optional and you can stop at any time by closing your browser. Completion of the questions in the survey that follows indicates that you have read and understood the above consent and consent to participate in this research. By answering the survey questions below, you are granting us use of your anonymized data for research and dissemination purposes. Anonymity is the default in this survey; upon completion you will be invited to provide contact details should you wish to participate in further research. This is entirely optional.

If you have questions regarding this study, you may contact OER Research Hub by email: oer-research-hub@open.ac.uk

Minors under the age of 18 should not proceed until their parents have given them permission to complete this survey. By clicking the "Next" button below I am affirming that I am either 18 years or older or that I have my parents permission.

1. What is your age?

2. What is your gender?

- ◯ Male
- ◯ Female
- ◯ Transgender

3. Where do you live?

4. In which State, Province or Territory do you live?

5. Is English your first spoken language?

- ◯ Yes
- ◯ No

If you answered "No", please specify your first language

6. Do you consider yourself to have a disability?

- ◯ Yes
- ◯ No

7. In which of these ways, if any, have you accessed the Internet during the past three months? (Check all that apply)

	Yes	No
Via an Internet-enabled mobile phone (smartphone)	◯	◯
Via a tablet computer or iPad	◯	◯
At home using a broadband connection	◯	◯
At home using a dial-up connection	◯	◯
Via a games console	◯	◯
At work	◯	◯
At an educational institution	◯	◯
Via a community facility (e.g. a library)	◯	◯
Via a commercial facility (e.g. cyber café)	◯	◯

In another way (please specify)

8. Which of these things have you done in the last year? (Check all that apply)

	Yes	No
Sent an email	○	○
Written a document using word processing software (e.g. Word)	○	○
Used presentation software (e.g. Powerpoint)	○	○
Performed calculations with spreadsheet software (e.g. Excel)	○	○
Contributed to a Wiki (e.g. Wikipedia)	○	○
Published a blog post (e.g. Wordpress, Blogger)	○	○
Shared an image online (e.g. Flickr, Instagram, Pinterest)	○	○
Posted on a microblogging platform (e.g. Twitter, Tumblr)	○	○
Took part in a videochat (e.g. Skype)	○	○
Contributed to an Internet forum	○	○
Contributed to a social network (e.g. Facebook, Google+, MySpace, Beebo)	○	○
Used cloud-based storage (e.g. Dropbox, Google Drive)	○	○
Shopped Online (e.g. eBay, Amazon)	○	○
Downloaded a Podcast (e.g. iTunes)	○	○
Downloaded a file using a torrent client (e.g. Bittorrent, UTorrent)	○	○

Filmed and uploaded video content	○	○
Used a virtual learning environment to study or teach (e.g. Moodle, Blackboard, LMS, CMS)	○	○
Recorded and uploaded a podcast	○	○

Open Educational Resources are teaching, learning or research materials that are in the public domain or released with an intellectual property license that allows for free use, adaptation, and distribution. Open educational resources can be in many formats, including open textbooks, complete courses and small assets such as videos.

Many free online resources are open educational resources.

9. Which, if any, of the following types of open educational resources have you used? (Check all that apply)

	Yes	No
Open textbooks	○	○
Whole course	○	○
Elements of a course (e.g. a module/unit)	○	○
Videos	○	○
Audio podcasts	○	○
Images	○	○
Infographics	○	○
Interactive games	○	○
Lectures	○	○
Lesson plans	○	○
Tutorials	○	○
Quizzes	○	○
E-books	○	○
Data sets	○	○
Learning tools, instruments and software plugins	○	○

Other (please specify)

10. Which challenges, if any, do you most often face in using open educational resources? (Check all that apply)

	Yes	No
Overcoming technology problems when downloading resources	○	○
Knowing where to find resources	○	○
Finding suitable resources in my subject area	○	○
Finding resources of sufficiently high quality	○	○
Finding resources that are up-to-date	○	○
Finding resources that are relevant to my local context	○	○
Getting work colleagues/managers to accept the use of open educational resources	○	○
Not being skilled enough to edit resources to suit my own context	○	○
Not knowing whether I have permission to use, change or modify resources	○	○
Not having enough time to look for suitable resources	○	○
Not having connections with open educational resource-using peers who could be a source of support	○	○
Missing/needing the support of a tutor or teacher to help me work through open course materials	○	○
Non-alignment of resources with professional standards or regulation	○	○

11. Which of the following factors would make you more likely to select a particular resource when searching for open educational content? (Check all that apply)

	Yes	No
Evidence of interest in that resource (e.g. lots of downloads)	○	○
The resource being recently created, uploaded or updated	○	○
The resource being easy to download	○	○
A description of learning objectives or outcomes being provided	○	○
The resource being created/uploaded by a reputable/trusted institution or person	○	○
The resource having a Creative Commons license	○	○
The resource having an open license allowing adaptation	○	○
The length/complexity of the resource	○	○
Use of interactive or multi-media content (e.g. video or quiz) in the resource	○	○
Positive user ratings or comments about the resource	○	○

	Yes	No
Personal recommendation	◯	◯
Having previously used this resource successfully	◯	◯
The resource being relevant to my particular interests/needs	◯	◯
The resource having a catchy title or attractive image(s)	◯	◯
Being required to use a resource for a project or study task	◯	◯
The resource having previously been used with students	◯	◯
A detailed description of the resource content being provided	◯	◯

Other (please specify)

12. How did you first become aware of OpenStax College textbooks?

13. Have you used, or are you using, OpenStax College textbooks?

◯ Yes

◯ No

14. Which of the following OpenStax College textbooks have you used, or are currently using, for your studies?

	Electronic format	Printed version
Anatomy and Physiology	☐	☐
Biology	☐	☐
College Physics	☐	☐
Concepts of Biology	☐	☐
Introduction to Sociology	☐	
Introductory Statistics	☐	☐
Precalculus	☐	☐
Principles of Economics	☐	☐
Principles of Macro-economics	☐	☐
Principles of Micro-economics	☐	☐

15. Please tell us more about how you used, or currently use, OpenStax College textbooks.

16. Within which educational context are you using OpenStax College textbooks? (Check one answer)

- ◯ School education
- ◯ Further education/college
- ◯ Higher education/University
- ◯ Work-based education
- ◯ Personal (one-to-one) tutoring
- ◯ Study without a teacher

Other (please specify)

17. What are your main reasons for study? (Check all that apply)

To gain a qualification/credits for further study	◯	◯
To improve my employment prospects	◯	◯
For professional development	◯	◯
For personal development	◯	◯
For leisure and enjoyment	◯	◯
To gain confidence or self-esteem	◯	◯

Other (please specify)

18. Do you receive any form of financial aid to help you study?

◯ Yes

◯ No

If you answered "Yes" to the above question, please tell us what kinds of financial support you receive:

19. Did you buy or borrow a textbook in addition to using OpenStax College textbook(s)? (Check all that apply)

- ☐ OpenStax College textbooks were required reading and I did not purchase any other textbooks for the course OpenStax
- ☐ College textbooks were recommended reading and I did not purchase any other textbooks for the course
- ☐ OpenStax College textbooks were neither recommended nor required reading and I did not purchase any other textbooks for the course
- ☐ I bought the latest edition of the required textbook(s) I
- ☐ bought an old edition of the required textbook(s)
- ☐ I rented the required textbook(s)
- ☐ I borrowed the required textbook(s) from a library I
- ☐ borrowed the required textbook(s) from a friend

20. What are your main reasons for using OpenStax College textbooks? (Check all that apply)

	Yes	No
Personal interest	○	○
Family interest	○	○
Professional development	○	○
Study related to my work or business	○	○
For use when training others at work	○	○
To improve my study skills	○	○
To improve my non-native language skills	○	○

Other (please specify)

21. In what ways, if any, has using OpenStax College textbooks impacted on your studies?

22. As a result of using OpenStax College textbooks, are you more or less likely to do any of the following?

	More likely	No change	Less likely	Don't Know
Study a free course / study a free open educational resource	○	○	○	○
Enrol on a paid-for course	○	○	○	○
Enrol on a paid-for course and work towards a qualification	○	○	○	○
Do further research in the subject you are interested in	○	○	○	○
Download more materials from OpenStax College	○	○	○	○
Make use of OpenStax College materials for teaching	○	○	○	○
Share OpenStax College materials with others	○	○	○	○
Recommend OpenStax free content to others	○	○	○	○
Use other Open Educational Resources for learning	○	○	○	○

Further comments

23. Do you think that your institution benefits financially by using OpenStax College textbooks?

○ Yes

○ No

○ Don't Know

Further Comments

24. In which of these ways (if any) has your use of Open Educational Resources made an impact on your formal studies? (Check all that apply)

"Using OpenStax College textbooks has led to my..."

	Yes	No
Increased participation in classroom discussions	○	○
Increased interest in the subjects taught	○	○
Increased satisfaction with the learning experience	○	○
Grades improving	○	○
Gaining confidence	○	○
Having increased independence and self-reliance	○	○
Increased engagement with lesson content	○	○
Increased experimentation with new ways of learning	○	○
Increased collaboration with my peers	○	○
Increased enthusiasm for future study	○	○
Becoming interested in a wider range of subjects than before I used these resources	○	○
Being more likely to complete my course of study	○	○

25. Please provide evidence, or tell us more about any experience, which supports your responses to the previous question's statements.

26. In what other ways, if any, has using OpenStax College textbooks impacted on your studies?

27. Do you think you have saved money by using OpenStax College textbooks?

- ◯ Yes
- ◯ No
- ◯ Don't Know

Further Comments

28. How much money have you saved by using OpenStax College textbooks?

29. Would you recommend OpenStax College textbooks to other students?

- ◯ Yes
- ◯ No
- ◯ Don't Know

Please tell us more about why you would or would not recommend OpenStax College textbooks to other students

30. What features, if any, of the OpenStax College textbook(s) you are using/have used did you like the most?

31. What features, if any, of the OpenStax College textbook(s) you are using/have used did you like the least?

32. What improvements, if any, do you think could be made to the OpenStax College textbook(s) you are using/have used?

We are grateful to you for taking the time to complete this survey. The anonymised results will be shared with OpenStax College and the OER community.

Researchers might wish to contact you with a view to collecting more detailed data through, for instance, focus group or interview. If you are happy to be contacted then please submit your details below.

33. Name

34. Email address

If you'd like to stay in touch with the project, you can do so via: http://oerresearchhub.org/

Appendix E: Textbook Usage Survey Instrument

(Weinberg et al., 2012)

1. Do you

- O Have your own copy of the textbook?
- O Share a textbook with a classmate?
- O Borrow a copy of the text from the library?
- O Use online notes posted by the professor?
- O Not use a textbook?

2. In most chapters of the book do you look at the **Introduction**?

Not Applicable O No O Yes O

If "Yes" please fill in each circle that describes **when** and **why** you read the **Introduction**:

Introduction	While Preparing for Class	While Doing Homework	While Studying for Exams	Other Times
Read for better understanding	O	O	O	O
Make sense of definitions or theorems	O	O	O	O
Rephrase/summarize text (for notes, homework, etc.)	O	O	O	O
Other Reasons	O	O	O	O

3. In most chapters of the book do you look at the **Chapter Text**?

Not Applicable O No O Yes O

If "Yes" please fill in each circle that describes **when** and **why** you read the **Chapter Text**:

Chapter Text	While Preparing for Class	While Doing Homework	While Studying for Exams	Other Times
Read for better understanding	O	O	O	O
Look up definitions or theorems	O	O	O	O
Make sense of definitions or theorems	O	O	O	O
Rephrase/summarize text (for notes, homework, etc.)	O	O	O	O
Other Reasons	O	O	O	O

4. In most chapters of the book do you look at the **Examples**?

Not Applicable O No O Yes O

If "Yes" please fill in each circle that describes **when** and **why** you read the **Examples**:

Examples	While Preparing for Class	While Doing Homework	While Studying for Exams	Other Times
Read for better understanding	O	O	O	O
Make sense of definitions or theorems	O	O	O	O
Rephrase/summarize text (for notes, homework, etc.)	O	O	O	O
Other Reasons	O	O	O	O

5. In most chapters of the book do you look at the **Chapter Summary**?

Not Applicable O No O Yes O

If "Yes" please fill in each circle that describes **when** and **why** you read the **Chapter Summary**:

Chapter Summary	While Preparing for Class	While Doing Homework	While Studying for Exams	Other Times
Read for better understanding	O	O	O	O
Look up definitions or theorems	O	O	O	O
Make sense of definitions or theorems	O	O	O	O
Rephrase/summarize text (for notes, homework, etc.)	O	O	O	O
Other Reasons	O	O	O	O

6.

In most chapters of the book do you look at the **Homework Problems**?	Not Applicable	No	Yes
	O	O	O

If "Yes" please fill in each circle that describes **when** and **why** you read the **Homework Problems**:

Homework Problems	While Preparing for Class	While Doing Homework	While Studying for Exams	Other Times
Read to see what ideas come up most frequently	O	O	O	O
Read/copy to complete homework	O	O	O	O
Other Reasons	O	O	O	O

7.

In most chapters of the book do you look at the **Answers to Exercises or Solutions Manual**?	Not Applicable	No	Yes
	O	O	O

If "Yes" please fill in each circle that describes **how often** and **why** you read the **Exercise Answers**:

Exercise Answers	Always	Often	Sometimes	Rarely	Never
Check my homework	O	O	O	O	O
Check my understanding of problems that weren't assigned	O	O	O	O	O
Look up answers without solving the problems	O	O	O	O	O
Other reasons	O	O	O	O	O

8. How well do the course material and the textbook match? (You may fill in more than one circle.)

O	The course material closely follows the textbook.
O	The course material generally follows the textbook, but the course sometimes covers material in a different order from the textbook.
O	The course material generally follows the textbook, but the course sometimes covers different material from the textbook
O	The course frequently covers material in a different order from the textbook.
O	The course frequently covers different material from the textbook.

9. Please rate the following qualities of a textbook for their importance, with 5 being very important and 1 being not important:

	Not Important = 1	2	3	4	5 = Very Important
Explains the big ideas of the course	O	O	O	O	O
Explains the underlying concepts of problems we're working on	O	O	O	O	O
Gives lots of examples to help you understand the material	O	O	O	O	O
Gives lots of examples that you can use on the homework	O	O	O	O	O
Highlights important equations (and definitions) by making them stand out from the rest of the text	O	O	O	O	O

10. Please indicate how frequently your professor asks you to do the following:

	Every Day	Every Week	Every Month	Never
Read the chapter	O	O	O	O
Do homework problems from the chapter	O	O	O	O
Look up definitions/theorems	O	O	O	O
Look at examples in the text	O	O	O	O
Other ways of using the textbook	O	O	O	O

Appendix F: MAT-014 Materials Survey 1 18SP

Q1 You are invited to participate in a research study that is being conducted by Jennifer Applebee, who is a graduate student in the Graduate School of Education at Rutgers University. The purpose of this research is to understand faculty and student perceptions of Open Educational Resource course material usage in Algebra 2 at County College.

This research is anonymous. Anonymous means that I will record no information about you that could identify you. There will be no linkage between your identity and your response in the research. This means that I will not record your name, address, phone number, date of birth, etc.

The research team, the Institutional Review Board at Rutgers University, and the Institution Research Board at County College are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated. All study data will be kept for three years per Federal Regulations.

There are no foreseeable risks to participation in this study. **At the conclusion of the survey, you will have the option of providing your email address to be entered in a drawing for a $25 Amazon.com gift card**. If you chose to provide your email address, it will not be connected to your responses to the survey.

Participation in this study is voluntary. You may choose not to participate, and you may withdraw at any time during the study procedures without any penalty to you. In addition, you may choose not to answer any questions with which you are not comfortable.

If you have any questions about the study or study procedures, you may contact myself at County College, ### XXX Avenue, Center 2 / Math Dept, XXX, XX #####, or japplebee@XXcc.edu, or ###-###-6000 x ####. You may also contact my faculty advisor Dr. Saundra Tomlinson-Clarke at Rutgers University, Graduate School of Education, 10 Seminary Place, New Brunswick, NJ 08901, or saundra.tomlinson-clarke@gse.rutgers.edu, or 848-932-0815.

If you have any questions about your rights as a research subject, please contact an IRB Administrator at the Rutgers University, Arts and Sciences IRB: Institutional Review Board, Rutgers University, the State University of New Jersey, Liberty Plaza / Suite 3200, 335 George Street, 3rd Floor, New Brunswick, NJ 08901, Phone: 732-235-2866, Email: humansubjects@orsp.rutgers.edu

Please retain a copy of this form for your records. By participating in the above stated procedures, then you agree to participation in this study.

If you are 18 years of age or older, understand the statements above, and will consent to participate in the study, click on the "I Agree" button to begin the survey/experiment. If not, please click on the “I Do Not Agree” button which you will exit this program.

- ❍ I Agree (1)
- ❍ I Do Not Agree (2)

❑ *Skip To: End of Survey If You are invited to participate in a research study that is being conducted by Jennifer Apple... = I Do Not Agree*

Q2 Have you received any LOANS to fund your education?

- ❍ Yes (1)
- ❍ No (2)

Q3 Have you received any PELL GRANTS or FEE WAIVERS to fund your education?

- ❍ Yes (1)
- ❍ No (2)

Q4 How many semesters have you completed in college?

- ❍ Less than 1 (1)
- ❍ 1 - 2 (2)
- ❍ 3 - 4 (3)
- ❍ 5 - 6 (4)
- ❍ 7 - 8 (5)
- ❍ 9 - 10 (6)
- ❍ More than 10 (7)

Q5 What course do you plan to take after Algebra 2 / MAT-014?

- ❍ Mathematical Structures / MAT-113 (for education majors) (1)
- ❍ College Algebra / MAT-116 (2)
- ❍ Statistics / MAT-123 (3)
- ❍ Pre-calculus / MAT-129 (4)
- ❍ Other: (5) _____

Q6 Is your major in one of the following fields: Biology, Chemistry, Computer Science, Earth Science, Engineering, Mathematics, or Physics?

- ❍ Yes (1)
- ❍ No (2)

❑ *Skip To: Q8 If Is your major in one of the following fields: Biology, Chemistry, Computer Science, Earth Science... = Yes*
❑ *Skip To: Q7 If Is your major in one of the following fields: Biology, Chemistry, Computer Science, Earth Science... = No*

Q7 Is your major Business Administration?

- ❍ Yes (1)
- ❍ No (2)

Q8 Did you purchase any materials for Algebra 2 / MAT-014? For the purposes of this survey, materials include textbooks, workbooks, and software access codes. Materials do not include school supplies or calculators.

- ❍ Yes (1)
- ❍ No (2)

❑ *Skip To: Q9 If Did you purchase any materials for Algebra 2 / MAT-014? For the purposes of this survey, material... = Yes*
❑ *Skip To: Q10 If Did you purchase any materials for Algebra 2 / MAT-014? For the purposes of this survey, material... = No*

Q9 How much did you spend on materials for Algebra 2 / MAT-014?

- ❍ Less than $20 (1)
- ❍ $21 - $40 (2)
- ❍ $41 - $60 (3)
- ❍ $61 - $80 (4)
- ❍ $81 - $100 (5)
- ❍ $101 - $120 (6)
- ❍ $121 - $140 (7)
- ❍ More than $140 (8)

❑ *Skip To: Q11*

Q10 Why did you not purchase materials for Algebra 2 / MAT-014? (select all that apply)

- ❑ The materials were not available for purchase (1)
- ❑ The materials were available free of charge online (2)
- ❑ I simply didn't want to purchase texts for this course (3)
- ❑ I borrowed someone else's texts (4)
- ❑ I used the library's copies (5)
- ❑ I heard the instructor doesn't use texts for this course (6)
- ❑ I couldn't afford to purchase the texts (7)
- ❑ The texts were sold out (8)
- ❑ I rented the texts (9)
- ❑ Other reasons (10) _____

Q11 Did you print materials for MAT-014 / Algebra 2?

- ❍ Yes (1)
- ❍ No (2)

- ❑ *Skip To: Q12 If Did you print materials for MAT-014 / Algebra 2? = Yes*
- ❑ *Skip To: Q13 If Did you print materials for MAT-014 / Algebra 2? = No*

Q12 How much did you spend on printing materials for MAT-014 / Algebra 2?

- ❍ Less than $10 (1)
- ❍ $11 - $20 (2)
- ❍ $21 - $30 (3)
- ❍ $31 - $40 (4)
- ❍ $41 - $50 (5)
- ❍ $51 - $60 (6)
- ❍ $61 - $70 (7)
- ❍ More than $70 (8)

Q13 How often did you use the course materials for MAT-014 / Algebra 2 during the semester?

- ❍ Never (1)
- ❍ 2 - 3 times a semester (2)
- ❍ 2 - 3 times a month (3)
- ❍ 2 - 3 times a week (4)
- ❍ Daily (5)

Q14 Were the materials you used for MAT-014 / Algebra 2 available to you primarily online?

- ❍ Yes (1)
- ❍ No (2)

Q15 For Algebra 2 / MAT-014 do you

- ❍ Have your own copy of the course materials? (1)
- ❍ Share course materials with a classmate? (2)
- ❍ Borrow a copy of the course materials from the library? (3)
- ❍ Not use the course materials? (4)

Q16 In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Introduction?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q18 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Introduction? = Yes*
❑ *Skip To: Q18 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Introduction? != Yes*

Q17 Please indicate when and why you read the Introduction.

	While preparing for class (1)	While doing homework (2)	While studying for exams (3)	Other times (4)
Read for better understanding (1)	❑	❑	❑	❑
Make sense of definitions and theorems (2)	❑	❑	❑	❑
Rephrase / summarize text (for notes, homework, etc.) (3)	❑	❑	❑	❑
Other reasons (4)	❑	❑	❑	❑

Q18 In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Chapter Text?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q19 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Chapter Text? = Yes*
❑ *Skip To: Q20 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Chapter Text? != Yes*

Q19 Please indicate when and why you read the Chapter Text.

	While preparing for class (1)	While doing homework (2)	While studying for exams (3)	Other times (4)
Read for better understanding (1)	❑	❑	❑	❑
Make sense of definitions and theorems (2)	❑	❑	❑	❑
Rephrase / summarize text (for notes, homework, etc.) (3)	❑	❑	❑	❑
Other reasons (4)	❑	❑	❑	❑

Q20 In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Examples?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q21 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Examples? = Yes*
❑ *Skip To: Q22 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Examples? != Yes*

Q21 Please indicate when and why you look at the Examples.

	While preparing for class (1)	While doing homework (2)	While studying for exams (3)	Other times (4)
Read for better understanding (1)	❑	❑	❑	❑
Make sense of definitions and theorems (2)	❑	❑	❑	❑
Rephrase / summarize text (for notes, homework, etc.) (3)	❑	❑	❑	❑
Other reasons (4)	❑	❑	❑	❑

Q22 In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Chapter Summary?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q23 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Chapter Summary? = Yes*
❑ *Skip To: Q24 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Chapter Summary? != Yes*

Q23 Please indicate when and why you read the Chapter Summary.

	While preparing for class (1)	While doing homework (2)	While studying for exams (3)	Other times (4)
Read for better understanding (1)	❑	❑	❑	❑
Make sense of definitions and theorems (2)	❑	❑	❑	❑
Rephrase / summarize text (for notes, homework, etc.) (3)	❑	❑	❑	❑
Other reasons (4)	❑	❑	❑	❑

Q24 In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Homework Problems?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q25 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Homework Problems? = Yes*
❑ *Skip To: Q26 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Homework Problems? != Yes*

Q25 Please indicate when and why you look at the Homework Problems.

	While preparing for class (1)	While doing homework (2)	While studying for exams (3)	Other times (4)
To see what ideas come up most frequently (1)	❑	❑	❑	❑
To complete homework (2)	❑	❑	❑	❑
Other reasons (3)	❑	❑	❑	❑

Q26 In most chapters of the Algebra 2 / MAT-014 course materials, do you use an Online Homework tool?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not applicable (3)

❑ *Skip To: Q27 If In most chapters of the Algebra 2 / MAT-014 course materials, do you use an Online Homework tool? = Yes*
❑ *Skip To: Q28 If In most chapters of the Algebra 2 / MAT-014 course materials, do you use an Online Homework tool? != Yes*

Q27 Please indicate when and why you use an Online Homework tool.

	While preparing for class (1)	While doing homework (2)	While studying for exams (3)	Other times (4)
To see what ideas come up most frequently (1)	❑	❑	❑	❑
To complete homework (2)	❑	❑	❑	❑
Other reasons (3)	❑	❑	❑	❑

Q28 In most chapters of the Algebra 2 / MAT-014 course materials, do you look at course videos?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q29 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at course videos? = Yes*
❑ *Skip To: Q30 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at course videos? != Yes*

Q29 Please indicate when and why you watch the videos.

	While preparing for class (1)	While doing homework (2)	While studying for exams (3)	Other times (4)
To see what ideas come up most frequently (1)	❑	❑	❑	❑
To complete homework (2)	❑	❑	❑	❑
Other reasons (3)	❑	❑	❑	❑

Q30 In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Media Examples?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q31 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Media Examples? = Yes*
❑ *Skip To: Q32 If In most chapters of the Algebra 2 / MAT-014 course materials, do you look at the Media Examples? != Yes*

Q31 Please indicate when and why you look at the Media Examples.

	While preparing for class (1)	While doing homework (2)	While studying for exams (3)	Other times (4)
To see what ideas come up most frequently (1)	❑	❑	❑	❑
To complete homework (2)	❑	❑	❑	❑
Other reasons (3)	❑	❑	❑	❑

Q32 In which of these ways (if any), has your use of your Algebra 2 / MAT-014 course materials made an impact on your formal studies?

"Use of the MAT-014 / Algebra 2 course materials has led to my ... "	Yes (1)	No (2)
Increased participation in class discussions (1)	❍	❍
Increased interest in Algebra 2 (2)	❍	❍
Increased satisfaction with the learning experience (3)	❍	❍
Gaining confidence (4)	❍	❍
Grades improving (5)	❍	❍
Having increased independence and self-reliance (6)	❍	❍
Increased engagement with lesson content (7)	❍	❍
Increased experimentation with new ways of learning (8)	❍	❍
Increased collaboration with my peers (9)	❍	❍
Increased enthusiasm for future study (10)	❍	❍
Becoming interested in a wider range of subjects than before I used the materials (11)	❍	❍
Being more likely tocomplete my course of study (12)	❍	❍

Q33 Please provide evidence, or tell us more about any experience, which supports your responses to the previous question's statements.

_____
_____
_____
_____
_____

Q34 How well does the in-class content of Algebra 2 / MAT-014 match the course materials? (select all that apply)

- ❑ The in-class content closely follows the materials. (1)
- ❑ The in-class content generally follows the materials, but the course sometimes covers topics in a different order from the materials. (2)
- ❑ The in-class content generally follows the materials, but the course sometimes covers different topics from the materials. (3)
- ❑ The in-class content frequently covers topics in a different order from the materials. (4)
- ❑ The in-class content frequently covers different topics from the materials. (5)

Q35 Please rate the following qualities of mathematics course materials for their importance, with 5 being very important and 1 being not important.

	Not Important = 1 (1)	2 (2)	3 (3)	4 (4)	Very Important = 5 (5)
Explains the big ideas (1)	❍	❍	❍	❍	❍
Explains the underlying concepts of problems we're working on (2)	❍	❍	❍	❍	❍
Gives lots of examples to help you understand the course content (3)	❍	❍	❍	❍	❍
Gives lots of examples that you can use on the homework (4)	❍	❍	❍	❍	❍
Highlights important equations (and definitions) by making them stand out from the rest of the text (5)	❍	❍	❍	❍	❍

Q36 Please rate your impressions of the MAT-014 / Algebra 2 course materials.

	Very negative = 1 (1)	2 (2)	3 (3)	4 (4)	Very positive = 5 (5)
What was your initial reaction to the course materials? (1)	❍	❍	❍	❍	❍
How was your overall experience with the course materials? (2)	❍	❍	❍	❍	❍
How was your overall experience specifically with the text-based materials? (3)	❍	❍	❍	❍	❍

Q37 Did you use an online homework tool?

- ❍ Yes (1)
- ❍ No (3)

❑ *Skip To: Q38 If Did you use an online homework tool? = Yes*
❑ *Skip To: Q39 If Did you use an online homework tool? != Yes*

Q38 Please rate your impressions of the online homework tool.

	Not helpful / did not use = 1 (1)	2 (2)	3 (3)	4 (4)	Very helpful = 5 (5)
Did you find the online homework tool helpful? (1)	❍	❍	❍	❍	❍
Did you find the videos in the online homework tool helpful? (2)	❍	❍	❍	❍	❍
Did you find similar problems in the online homework tool helpful? (3)	❍	❍	❍	❍	❍

Q39 Did you use a workbook?

- ❍ Yes (1)
- ❍ No (2)

- ❑ *Skip To: Q40 If Did you use a workbook? = Yes*
- ❑ *Skip To: Q41 If Did you use a workbook? = No*

Q40 Please rate your impressions of the workbook.

	Not helpful / did not use = 1 (1)	2 (2)	3 (3)	4 (4)	Very helpful = 5 (5)
Did you find the workbook helpful? (1)	❍	❍	❍	❍	❍
Did you find the worked examples in the workbook helpful? (2)	❍	❍	❍	❍	❍
Did you find the Media Examples in the workbook helpful? (3)	❍	❍	❍	❍	❍
Did you find the You Try Problems helpful? (4)	❍	❍	❍	❍	❍

Q41 Please indicate how frequently your professor asks you to do the following.

	Every Day (1)	Every Week (2)	Every Month (3)	Never (4)
Read the chapter (1)	❍	❍	❍	❍
Do homework problems from the chapter (2)	❍	❍	❍	❍
Do online homework problems (3)	❍	❍	❍	❍
Watch videos (4)	❍	❍	❍	❍
Look up definitions / theorems (5)	❍	❍	❍	❍
Look at examples in the course materials (6)	❍	❍	❍	❍
Other ways of using the course materials (7)	❍	❍	❍	❍

Q42 How would you rate the quality of the materials used for MAT-014 / Algebra 2?

- ❍ WORSE than the quality of materials in my other courses (1)
- ❍ About the SAME AS the quality of the materials in my other courses (2)
- ❍ BETTER than the quality of the materials in my other courses (3)

❑ *Skip To: Q43 If How would you rate the quality of the materials used for MAT-014 / Algebra 2? = WORSE than the quality of materials in my other courses*
❑ *Skip To: Q45 If How would you rate the quality of the materials used for MAT-014 / Algebra 2? = About the SAME AS the quality of the materials in my other courses*
❑ *Skip To: Q44 If How would you rate the quality of the materials used for MAT-014 / Algebra 2? = BETTER than the quality of the materials in my other courses*

Q43 Please briefly describe what made the quality of this course's materials WORSE than in other courses.

_____
_____
_____
_____
_____

❑ *Skip To: Q45 If Please briefly describe what made the quality of this course's materials WORSE than in other cour... Is Displayed*

Display This Question:
If How would you rate the quality of the materials used for MAT-014 / Algebra 2? = BETTER than the quality of the materials in my other courses

Q44 Please briefly describe what made the quality of this course's materials BETTER than in other courses.

_____
_____
_____
_____
_____

Q45 What features, if any, of the MAT-014 / Algebra 2 course materials did you like the most?

_____

Q46 What features, if any, of the MAT-014 / Algebra 2 course materials did you like the least?

_____

Appendix G: MAT-014 Materials Survey 2 18SP

Q1 You are invited to participate in a research study that is being conducted by Jennifer Applebee, who is a graduate student in the Graduate School of Education at Rutgers University. The purpose of this research is to understand faculty and student perceptions of Open Educational Resource course material usage in Algebra 2 at County College.

This research is anonymous. Anonymous means that I will record no information about you that could identify you. There will be no linkage between your identity and your response in the research. This means that I will not record your name, address, phone number, date of birth, etc.

The research team, the Institutional Review Board at Rutgers University, and the Institution Research Board at County College are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated. All study data will be kept for three years per Federal Regulations.

There are no foreseeable risks to participation in this study. At the conclusion of the survey, you will have the option of providing your email address to be entered in a drawing for a $25 Amazon.com gift card. If you chose to provide your email address, it will not be connected to your responses to the survey.

Participation in this study is voluntary. You may choose not to participate, and you may withdraw at any time during the study procedures without any penalty to you. In addition, you may choose not to answer any questions with which you are not comfortable.

If you have any questions about the study or study procedures, you may contact myself at County College, ### XXX Avenue, Center 2 / Math Dept, XXX, XX #####, or japplebee@XXcc.edu, or ###-###-6000 x ####. You may also contact my faculty advisor Dr. Saundra Tomlinson-Clarke at Rutgers University, Graduate School of Education, 10 Seminary Place, New Brunswick, NJ 08901, or saundra.tomlinson-clarke@gse.rutgers.edu, or 848-932-0815.

If you have any questions about your rights as a research subject, please contact an IRB Administrator at the Rutgers University, Arts and Sciences IRB: Institutional Review Board, Rutgers University, the State University of New Jersey, Liberty Plaza / Suite 3200, 335 George Street, 3rd Floor, New Brunswick, NJ 08901, Phone: 732-235-2866, Email: humansubjects@orsp.rutgers.edu

Please retain a copy of this form for your records. By participating in the above stated procedures, then you agree to participation in this study.

If you are 18 years of age or older, understand the statements above, and will consent to participate in the study, click on the "I Agree" button to begin the survey/experiment. If not, please click on the “I Do Not Agree” button which you will exit this program.

- ❍ I Agree (1)
- ❍ I Do Not Agree (2)

❑ *Skip To: End of Survey If You are invited to participate in a research study that is being conducted by Jennifer Apple... = I Do Not Agree*

Q2 Have you received any LOANS to fund your education?

- ❍ Yes (1)
- ❍ No (2)

Q3 Have you received any PELL GRANTS or FEE WAIVERS to fund your education?

- ❍ Yes (1)
- ❍ No (2)

Q4 How many semesters have you completed in college?

- ❍ Less than 1 (1)
- ❍ 1 - 2 (2)
- ❍ 3 - 4 (3)
- ❍ 5 - 6 (4)
- ❍ 7 - 8 (5)
- ❍ 9 - 10 (6)
- ❍ More than 10 (7)

Q5 What course do you plan to take after Algebra 2 / MAT-014?

- ❍ Mathematical Structures / MAT-113 (for education majors) (1)
- ❍ College Algebra / MAT-116 (2)
- ❍ Statistics / MAT-123 (3)
- ❍ Pre-calculus / MAT-129 (4)
- ❍ Other: (5) _____

Q6 Is your major in one of the following fields: Biology, Chemistry, Computer Science, Earth Science, Engineering, Mathematics, or Physics?

- ❍ Yes (1)
- ❍ No (2)

❑ *Skip To: Q8 If Is your major in one of the following fields: Biology, Chemistry, Computer Science, Earth Science... = Yes*

❑ *Skip To: Q7 If Is your major in one of the following fields: Biology, Chemistry, Computer Science, Earth Science... = No*

Q7 Is your major Business Administration?

- ❍ Yes (1)
- ❍ No (2)

Q8 Did you purchase any materials for Algebra 2 / MAT-014? For the purposes of this survey, materials include textbooks, workbooks, and software access codes. Materials do not include school supplies or calculators.

- ❍ Yes (1)
- ❍ No (2)

❑ *Skip To: Q9 If Did you purchase any materials for Algebra 2 / MAT-014? For the purposes of this survey, material... = Yes*

❑ *Skip To: Q10 If Did you purchase any materials for Algebra 2 / MAT-014? For the purposes of this survey, material... = No*

Q9 How much did you spend on materials for Algebra 2 / MAT-014?

- ❍ Less than $20 (1)
- ❍ $21 - $40 (2)
- ❍ $41 - $60 (3)
- ❍ $61 - $80 (4)
- ❍ $81 - $100 (5)
- ❍ $101 - $120 (6)
- ❍ $121 - $140 (7)
- ❍ More than $140 (8)

❑ *Skip To: Q11*

Q10 Why did you not purchase materials for Algebra 2 / MAT-014? (select all that apply)

- ❑ The materials were not available for purchase (1)
- ❑ The materials were available free of charge online (2)
- ❑ I simply didn't want to purchase texts for this course (3)
- ❑ I borrowed someone else's texts (4)
- ❑ I used the library's copies (5)
- ❑ I heard the instructor doesn't use texts for this course (6)
- ❑ I couldn't afford to purchase the texts (7)
- ❑ The texts were sold out (8)
- ❑ I rented the texts (9)
- ❑ Other reasons (10) _____

Q11 Did you print materials for MAT-014 / Algebra 2?

- ❍ Yes (1)
- ❍ No (2)

- ❑ *Skip To: Q12 If Did you print materials for MAT-014 / Algebra 2? = Yes*
- ❑ *Skip To: Q13 If Did you print materials for MAT-014 / Algebra 2? = No*

Q12 How much did you spend on printing materials for MAT-014 / Algebra 2?

- ❍ Less than $10 (1)
- ❍ $11 - $20 (2)
- ❍ $21 - $30 (3)
- ❍ $31 - $40 (4)
- ❍ $41 - $50 (5)
- ❍ $51 - $60 (6)
- ❍ $61 - $70 (7)
- ❍ More than $70 (8)

Q13 Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply)

- ❑ Intermediate Algebra, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS) (1)
- ❑ ALEKS (2)
- ❑ Algebra 2 Student Workbook, Version 1.1 (3)
- ❑ MyOpenMath (4)
- ❑ Intermediate Algebra free online textbook by Open Stax (5)
- ❑ Other: (6) _____

Q14 How often did you use the course materials for MAT-014 / Algebra 2 during the semester?

- ❍ Never (1)
- ❍ 2 - 3 times a semester (2)
- ❍ 2 - 3 times a month (3)
- ❍ 2 - 3 times a week (4)
- ❍ Daily (5)

Q15 Were the materials you used for MAT-014 / Algebra 2 available to you primarily online?

- ❍ Yes (1)
- ❍ No (2)

Q16 For Algebra 2 / MAT-014 do you

- ❍ Have your own copy of the course materials? (1)
- ❍ Share course materials with a classmate? (2)
- ❍ Borrow a copy of the course materials from the library? (3)
- ❍ Not use the course materials? (4)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q17 In most chapters of the textbook, did you read sections in the chapters?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q18 If In most chapters of the textbook, did you read sections in the chapters? != Yes*

❑ *Skip To: Q19 If In most chapters of the textbook, did you read sections in the chapters? = Yes*

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q18 Please indicate when you read the sections in the chapters. (select all that apply)

- ❑ While preparing for class (1)
- ❑ While doing homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5) _____

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q19 In most chapters of the textbook, did you look at the examples?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

- ❑ *Skip To: Q20 If In most chapters of the textbook, did you look at the examples? = Yes*
- ❑ *Skip To: Q21 If In most chapters of the textbook, did you look at the examples? != Yes*

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q20 Please indicate when you looked at the examples. (select all that apply)

- ❑ While preparing for class (1)
- ❑ While doing homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5) _____

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q21 In most chapters of the textbook, did you read the summary at the end of the chapter?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q22 If In most chapters of the textbook, did you read the summary at the end of the chapter? = Yes*

❑ *Skip To: Q23 If In most chapters of the textbook, did you read the summary at the end of the chapter? != Yes*

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q22 Please indicate when you read the summary at the end of the chapter. (select all that apply)

- ❑ While preparing for class (1)
- ❑ While doing homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5) _____

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q23 In most chapters of the textbook, did you do practice exercises?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

- ❑ *Skip To: Q24 If In most chapters of the textbook, did you do practice exercises? = Yes*
- ❑ *Skip To: Q25 If In most chapters of the textbook, did you do practice exercises? != Yes*

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q24 Please indicate when you did practice exercises. (select all that apply)

- ❑ While preparing for class (1)
- ❑ While doing homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u>, 4th or 5th edition, by Miller, O'Neil, Hyde (hard copy or accessed via ALEKS)

Or Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = <u>Intermediate Algebra</u> free online textbook by Open Stax

Q25 Please rate your impressions of the textbook.

	Not helpful / did not use = 1 (1)	2 (2)	3 (3)	4 (4)	Very helpful = 5 (5)
Did you find the textbook helpful? (1)	❍	❍	❍	❍	❍
Did you find the examples in the textbook helpful? (2)	❍	❍	❍	❍	❍
Did you find the homework problems in the textbook helpful? (3)	❍	❍	❍	❍	❍
Did you find the chapter summary in the textbook helpful? (4)	❍	❍	❍	❍	❍

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

Q26 In most chapters of the workbook, do you watch the Media Example videos?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

❑ *Skip To: Q27 If In most chapters of the workbook, do you watch the Media Example videos? = Yes*

❑ *Skip To: Q28 If In most chapters of the workbook, do you watch the Media Example videos? != Yes*

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

Q27 Please indicate when you watched the Media Example videos. (select all that apply)

- ❑ While preparing for class (1)
- ❑ While doing homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

Q28 In most chapters of the workbook, did you do the You Try problems?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not applicable (3)

- ❑ *Skip To: Q29 If In most chapters of the workbook, did you do the You Try problems? = Yes*
- ❑ *Skip To: Q30 If In most chapters of the workbook, did you do the You Try problems? != Yes*

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

Q29 Please indicate when you did the You Try problems. (select all that apply)

- ❑ While preparing for class (1)
- ❑ While doing homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

Q30 In most chapters of the workbook, did you do the Practice Problems at the end of the lesson?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

And In most chapters of the workbook, did you do the Practice Problems at the end of the lesson? = Yes

Q31 Please indicate when you did the Practice Problems at the end of the lesson. (select all that apply)

- ❑ While preparing for class (1)
- ❑ While doing homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5) _____

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

Q32 In most chapters of the workbook did you do the Assessment at the end of the lesson?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

And In most chapters of the workbook did you do the Assessment at the end of the lesson? = Yes

Q33 Please indicate when you did the Assessment at the end of the lesson. (select all that apply)

- ❑ While preparing for class (1)
- ❑ While doing homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5) _____

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = Algebra 2 Student Workbook, Version 1.1

Q34 Please rate your impressions of the workbook.

	Not helpful / did not use = 1 (1)	2 (2)	3 (3)	4 (4)	Very helpful = 5 (5)
Did you find the workbook helpful? (1)	❍	❍	❍	❍	❍
Did you find the examples in the workbook helpful? (2)	❍	❍	❍	❍	❍
Did you find videos associated with the workbook (Media Examples) helpful? (3)	❍	❍	❍	❍	❍
Did you find the practice problems helpful? (4)	❍	❍	❍	❍	❍

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = ALEKS

Q35 Did you use ALEKS?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = ALEKS

And Did you use ALEKS? = Yes

Q36 Please indicate when you used ALEKS. (select all that apply)

- ❑ While preparing for class (1)
- ❑ To do homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = ALEKS

And Did you use ALEKS? = Yes

Q37 Did you watch the videos in ALEKS?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = ALEKS

And Did you watch the videos in ALEKS? = Yes

Q38 Please indicate when you watched the videos in ALEKS. (select all that apply)

- ❑ While preparing for class (1)
- ❑ To do homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = ALEKS

And Did you use ALEKS? = Yes

Q39 Did you use the worked examples (similar problems) in ALEKS?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = ALEKS

And Did you use the worked examples (similar problems) in ALEKS? = Yes

Q40 Please indicate when you used the worked examples in ALEKS. (select all that apply)

- ❑ While preparing for class (1)
- ❑ To do homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = ALEKS

And Did you use ALEKS? = Yes

Q41 Please rate your impressions of ALEKS.

	Not helpful / did not use = 1 (1)	2 (2)	3 (3)	4 (4)	Very helpful = 5 (5)
Did you find ALEKS helpful? (1)	❍	❍	❍	❍	❍
Did you find the videos in ALEKS helpful? (2)	❍	❍	❍	❍	❍
Did you find the worked examples in ALEKS helpful? (3)	❍	❍	❍	❍	❍

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = MyOpenMath

Q42 Did you use MyOpenMath?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = MyOpenMath

And Did you use MyOpenMath? = Yes

Q43 Please indicate when you used MyOpenMath. (select all that apply)

- ❑ While preparing for class (1)
- ❑ To do homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = MyOpenMath

And Did you use MyOpenMath? = Yes

Q44 Did you watch the videos in MyOpenMath?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not Applicable (3)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = MyOpenMath

And Did you watch the videos in MyOpenMath? = Yes

Q45 Please indicate when you watched the videos in MyOpenMath. (select all that apply)

- ❑ While preparing for class (1)
- ❑ To do homework (2)
- ❑ While studying for exams (3)
- ❑ During class (4)
- ❑ Other: (5)

Display This Question:

If Which of the following did you use or purchase for Algebra 2 / MAT-014? (select all that apply) = MyOpenMath

And Did you use MyOpenMath? = Yes

Q46 Please rate your impressions of MyOpenMath.

	Not helpful / did not use = 1 (1)	2 (2)	3 (3)	4 (4)	Very helpful = 5 (5)
Did you find MyOpenMath helpful? (1)	❍	❍	❍	❍	❍
Did you find the videos in MyOpenMath helpful? (2)	❍	❍	❍	❍	❍

Q47 Please indicate how frequently your professor asks you to do the following.

	Every Day (1)	Every Week (2)	Every Month (3)	Never (4)
Read the chapter (1)	❍	❍	❍	❍
Do homework problems from the chapter (2)	❍	❍	❍	❍
Do online homework problems (3)	❍	❍	❍	❍
Watch videos (4)	❍	❍	❍	❍
Look up definitions / theorems (5)	❍	❍	❍	❍
Look at examples in the course materials (6)	❍	❍	❍	❍
Other ways of using the course materials (7)	❍	❍	❍	❍

Q48 In which of these ways (if any), has your use of your Algebra 2 / MAT-014 course materials made an impact on your formal studies?

"Use of the MAT-014 / Algebra 2 course materials has led to my ... "

	Yes (1)	No (2)
Increased participation in class discussions (1)	❍	❍
Increased interest in Algebra 2 (2)	❍	❍
Increased satisfaction with the learning experience (3)	❍	❍
Gaining confidence (4)	❍	❍
Grades improving (5)	❍	❍
Having increased independence and self-reliance (6)	❍	❍
Increased engagement with lesson content (7)	❍	❍
Increased experimentation with new ways of learning (8)	❍	❍
Increased collaboration with my peers (9)	❍	❍
Increased enthusiasm for future study (10)	❍	❍
Becoming interested in a wider range of subjects than before I used the materials (11)	❍	❍
Being more likely to complete my course of study (12)	❍	❍

Q49 Please provide evidence, or tell us more about any experience, which supports your responses to the previous question's statements.

_____

_____

_____

_____

_____

Q50 Please rate your impressions of the MAT-014 / Algebra 2 course materials.

	Very negative = 1 (1)	2 (2)	3 (3)	4 (4)	Very positive = 5 (5)
What was your initial reaction to the course materials? (1)	❍	❍	❍	❍	❍
How was your overall experience with the course materials? (2)	❍	❍	❍	❍	❍
How was your overall experience specifically with the text-based materials? (3)	❍	❍	❍	❍	❍

Q51 Please select the number that best applies regarding your impressions of the MAT-014 / Algebra 2 course materials.

	Strongly disagree = 1 (1)	2 (2)	3 (3)	4 (4)	Strongly agree = 5 (5)
The materials adequately supported the work I did in class. (1)	❍	❍	❍	❍	❍
The materials adequately supported the work I did outside of class. (2)	❍	❍	❍	❍	❍
The materials were thorough and complete in their presentation of the required topics and competencies. (3)	❍	❍	❍	❍	❍
The materials were relatively error-free. (4)	❍	❍	❍	❍	❍
I had no trouble accessing the materials. (5)	❍	❍	❍	❍	❍
I would recommend the use of these materials to my classmates.(6)	❍	❍	❍	❍	❍

Q52 How would you rate the quality of the materials used for MAT-014 / Algebra 2?

- ❍ WORSE than the quality of materials in my other courses (1)
- ❍ About the SAME AS the quality of the materials in my other courses (2)
- ❍ BETTER than the quality of the materials in my other courses (3)

❑ *Skip To: Q53 If How would you rate the quality of the materials used for MAT-014 / Algebra 2? = WORSE than the quality of materials in my other courses*

❑ *Skip To: Q55 If How would you rate the quality of the materials used for MAT-014 / Algebra 2? = About the SAME AS the quality of the materials in my other courses*

❑ *Skip To: Q54 If How would you rate the quality of the materials used for MAT-014 / Algebra 2? = BETTER than the quality of the materials in my other courses*

Q53 Please briefly describe what made the quality of this course's materials WORSE than in other courses.

_____

❑ *Skip To: Q55 If Please briefly describe what made the quality of this course's materials WORSE than in other cour... Is Displayed*

Display This Question:

If How would you rate the quality of the materials used for MAT-014 / Algebra 2? = BETTER than the quality of the materials in my other courses

Q54 Please briefly describe what made the quality of this course's materials BETTER than in other courses.

_____

Q55 What features, if any, of the MAT-014 / Algebra 2 course materials did you like the most?

_____

Q56 What features, if any, of the MAT-014 / Algebra 2 course materials did you like the least?

_____

Appendix H: OER Perception, Faculty Survey

A sample student survey based on Bliss et al. (2013). Survey retrieved from a link at http://openedgroup.org/toolkit

Q1 – Consent Information (http://openedgroup.org/toolkit for a sample consent form)

Q2 What is your gender?

- ❍ Male (1)
- ❍ Female (2)
- ❍ Other/prefer not to say (3)

Q3 How long have you been teaching at the college level?

- ❍ Less than 3 Years (1)
- ❍ 3 - 6 Years (2)
- ❍ 6 - 9 Years (3)
- ❍ 9 - 12 Years (4)
- ❍ 12 - 15 Years (5)
- ❍ 15 - 18 Years (6)
- ❍ More than 18 Years (7)

Q4 How many times have you taught this course?

- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 (7)
- ❍ 8 (8)
- ❍ 9 (9)
- ❍ 10 (10)
- ❍ More than 10 (11)

Q5 What is the highest degree you have obtained?

- ❍ High School Diploma (1)
- ❍ Associate's Degree (2)
- ❍ Bachelor's Degree (3)
- ❍ Master's Degree (4)
- ❍ Doctoral Degree (5)

Q6 What is your average teaching load during a regular length semester at your institution?
- ❍ 1 Course (1)
- ❍ 2 Courses (2)
- ❍ 3 Courses (3)
- ❍ 4 Courses (4)
- ❍ 5 Courses (5)
- ❍ More than 5 Courses (6)

Q7 How much did you communicate with your students about the experimental nature of the open textbook approach used in your course this semester?
- ❍ Never (1)
- ❍ Once (2)
- ❍ 2-4 Times (3)
- ❍ 5-7 Times (4)
- ❍ 8-10 Times (5)
- ❍ Every Class Meeting (6)

Q8 Have you taught this course in previous semesters?
- ❍ Yes (1)
- ❍ No (2)

Answer Q9 – Q12 If Have you taught this course in previous semesters? Yes Is Selected

Q9 When you have taught this course in the past, how much have students generally been asked to spend on required texts?
- ❍ Less than $20 (1)
- ❍ $21 - $40 (2)
- ❍ $41 - $60 (3)
- ❍ $61 - $80 (4)
- ❍ $81 - $100 (5)
- ❍ $101 - $120 (6)
- ❍ $121 - $140 (7)
- ❍ More than $140 (8)

Q10 When you have taught this course in the past, what percent of students do you think purchased the required texts?
- ❍ Less than 10% (1)
- ❍ 10 - 30% (2)
- ❍ 30 - 50% (3)
- ❍ 50 - 70% (4)
- ❍ 70 - 90% (5)
- ❍ More than 90% (6)

Q11 How much time did you spend preparing to teach this course each week this semester compared to previous semesters (not counting time spent developing the text, if applicable)?
- ❍ Much Less Time (1)
- ❍ Somewhat Less Time (2)
- ❍ About the Same Amount of Time (3)
- ❍ Somewhat More Time (4)
- ❍ Much More Time (5)

Q12 How did your students' preparedness in the course compare to previous semesters?
- ❍ Students were Less Prepared (1)
- ❍ Students were Equally Prepared (2)
- ❍ Students were More Prepared (3)

Q13 How often do you think students used the texts for this course throughout the semester?
- ❍ Never (1)
- ❍ 2-3 Times a Semester (2)
- ❍ 2-3 Times a Month (3)
- ❍ 2-3 Times a Week (4)
- ❍ Daily (5)

Q14 What feedback, if any, did you receive from students about the texts used in this course?

Q15 In future courses, how likely are you to use open texts like those used in this course this semester?
- ❍ Very Unlikely (1)
- ❍ Somewhat Unlikely (2)
- ❍ Somewhat Likely (3)
- ❍ Very Likely (4)

Q16 Did you work on the development of the open texts for this course?
- ❍ Yes (1)
- ❍ No (2)

Answer Q17 If Did you work on the development of the open texts for this course No Is Selected

Q17 On average, how would you rate the quality of the texts used for this course?
- ❍ WORSE than the quality of texts in my other courses (1)
- ❍ About the SAME AS the quality of texts in my other courses (2)
- ❍ BETTER than the quality of texts in my other courses (3)

Answer Q18 If On average, how would you rate the quality of the texts used for this course WORSE than the quality of texts in my other courses Is Selected

Q18 Please briefly describe what made the quality of this course's texts WORSE than those in other courses.

Answer Q19 If On average, how would you rate the quality of the texts used for this course BETTER than the quality of texts in my other courses Is Selected

Q19 Please briefly describe what made the quality of this course's texts BETTER than those in other courses.

Appendix I: OpenStax, Faculty Survey

Retrieved from http://openedgroup.org/wp-content/uploads/2016/08/OER_Hub_Student.pdf.
This questionnaire is being conducted as part of a project which is investigating how people think and use different types of online resources. You have been invited to take this survey because you use OpenStax College textbooks.

The research is being carried out by The Open University (UK) in collaboration with OpenStax College, and is funded by the Hewlett Foundation in order to support future excellence in open education. Your answers will help us build a picture of how people across the world use online resources, such as OpenStax College textbooks, for learning and teaching. Our research data will help people around the world make more informed decisions about online teaching and learning.

All the answers you provide to the following questions will be held securely and our data protection policy complies with the UK's Data Protection Act (1988) and the USA's Protection of Human Subjects (45 CFR 46).

The survey should take around 15-20 minutes to complete. All questions are optional and you can stop at any time by closing your browser. Completion of the questions in the survey that follows indicates that you have read and understood the above consent and consent to participate in this research. By answering the survey questions below, you are granting us use of your anonymized data for research and dissemination purposes. Anonymity is the default in this survey; upon completion you will be invited to provide contact details should you wish to participate in further research. This is entirely optional.

If you have questions regarding this study, you may contact OER Research Hub by email: oer-research-hub@open.ac.uk.

1. What is your gender?

- ○ Male
- ○ Female
- ○ Transgender

2. Where do you live?

3. In which State, Province or Territory do you live?

4. Is English your first spoken language?

◯ Yes

◯ No

If you answered "No", please specify your first language.

5. What is your highest educational qualification?

- ○ High School Diploma
- ○ Attended College
- ○ Associates Degree (Two Year)
- ○ Bachelors Degree
- ○ Masters Degree
- ○ PhD or Professional Doctorate
- ○ No Formal Qualification

Other (please specify)

6. In which of these ways, if any, have you accessed the Internet during the past three months? (Check all that apply)

	Yes	No
Via an Internet-enabled mobile phone (smartphone)	○	○
Via a tablet computer or iPad	○	○
At home using a broadband connection	○	○
At home using a dial-up connection	○	○
Via a games console	○	○
At work	○	○
At an educational institution	○	○
Via a community facility (e.g. a library)	○	○
Via a commercial facility (e.g. cyber café)	○	○

In another way (please specify)

7. Which of these things have you done in the last year? (Check all that apply)

	Yes	No
Sent an email	○	○
Written a document using word processing software (e.g. Word)	○	○
Used presentation software (e.g. Powerpoint)	○	○
Performed calculations with spreadsheet software (e.g. Excel)	○	○
Contributed to a Wiki (e.g. Wikipedia)	○	○
Published a blog post (e.g. Wordpress, Blogger)	○	○
Shared an image online (e.g. Flickr, Instagram, Pinterest)	○	○
Posted on a microblogging platform (e.g. Twitter, Tumblr)	○	○
Took part in a videochat (e.g. Skype)	○	○
Contributed to an Internet forum	○	○
Contributed to a social network (e.g. Facebook, Google+, MySpace, Beebo)	○	○
Used cloud-based storage (e.g. Dropbox, Google Drive)	○	○
Shopped Online (e.g. eBay, Amazon)	○	○
Downloaded a Podcast (e.g. iTunes)	○	○
Downloaded a file using a torrent client (e.g. Bittorrent, UTorrent)	○	○

Filmed and uploaded video content	○	○
Used a virtual learning environment to study or teach (e.g. Moodle, Blackboard, LMS, CMS)	○	○
Recorded and uploaded a podcast	○	○

8. What does "openness" in education mean to you?

Open Educational Resources are teaching, learning or research materials that are in the public domain or released with an intellectual property license that allows for free use, adaptation, and distribution. Open educational resources can be in many formats, including open textbooks, complete courses and small assets such as videos.

Many free online resources are open educational resources.

9. In which of these ways, if any, have you used or created Open Educational Resources? (Check all that apply)

	Yes	No
I have used open educational resources	○	○
I have adapted open educational resources to fit my needs	○	○
I have created open educational resources for study or teaching	○	○
I have created resources myself and published them on an open licence	○	○
I have added a resource to a repository	○	○
I have added comments to a repository regarding the quality of a resource	○	○
I have added comments to a repository suggesting ways of using a resource	○	○
I have not used or created open educational resources	○	○

Other (please specify)

10. Which, if any, of the following types of open educational resources have you used for teaching/training? (Check all that apply)

	Yes	No
Open textbooks	○	○
Whole course	○	○
Elements of a course (e.g. a module/unit)	○	○
Videos	○	○
Audio podcasts	○	○
Images	○	○
Infographics	○	○
Interactive games	○	○
Lectures	○	○
Lesson plans	○	○
Tutorials	○	○
Quizzes	○	○
E-books	○	○
Data sets	○	○
Learning tools, instruments and plug-ins	○	○

Other (please specify)

11. For which of the following purposes have you used open educational resources in the context of your teaching/training? (Check all that apply)

	Yes	No
To prepare for my teaching/training	○	○
To get new ideas and inspiration	○	○

	Yes	No
To supplement my existing lessons or coursework	○	○
As "assets" (e.g. images or text extracts) within a classroom lesson	○	○
To give to learners as compulsory self-study materials	○	○
To give to learners as optional self-study materials	○	○
To provide e-learning materials to online learners	○	○
To compare them with my own teaching/training materials in order to assess the quality of my materials	○	○
To broaden the range of my teaching methods	○	○
To broaden the range of resources available to my learners	○	○
To make my teaching more culturally diverse [or responsive]	○	○
To enhance my professional development	○	○
To stay up-to-date in a subject or topic area	○	○
To learn about a new topic	○	○
To engage my students more fully in a topic area	○	○
To connect with teachers or learners who have similar interests (e.g. by reading comments they have posted about resources)	○	○
To interest hard-to-engage learners	○	○

12. Which challenges, if any, do you most often face in using open educational resources? (Check all that apply)

	Yes	No
Overcoming technology problems when downloading resources	○	○
Knowing where to find resources	○	○
Finding suitable resources in my subject area	○	○
Finding resources of sufficiently high quality	○	○
Finding resources that are up-to-date	○	○
Finding resources that are relevant to my local context	○	○
Getting work colleagues/managers to accept the use of open educational resources	○	○
Not being skilled enough to edit resources to suit my own context	○	○
Not knowing whether I have permission to use, change or modify resources	○	○
Not having enough time to look for suitable resources	○	○

	Yes	No
Not having connections with open educational resource-using peers who could be a source of support	○	○
Missing/needing the support of a tutor or teacher to help me work through open course materials	○	○
Not knowing how to use the resources in the classroom	○	○
Not having enough time/opportunities to experiment with using open educational resources in the classroom	○	○
Lacking institutional support for my use of open educational resources	○	○
Resources not being aligned with professional standards or regulation	○	○

Other (please specify)

13. Which of the following factors would make you more likely to select a particular resource when searching for open educational content? (Check all that apply)

	Yes	No
Evidence of interest in that resource (e.g. lots of downloads)	○	○
The resource being recently created, uploaded or updated	○	○

	Yes	No
The resource being easy to download	○	○
A description of learning objectives or outcomes being provided	○	○
The resource being created/uploaded by a reputable/trusted institution or person	○	○
The resource having a Creative Commons license	○	○
The resource having an open license allowing adaptation	○	○
The length/complexity of the resource	○	○
Use of interactive or multi-media content (e.g. video or quiz) in the resource	○	○
Positive user ratings or comments about the resource	○	○
Personal recommendation	○	○
Having previously used this resource successfully	○	○
The resource being relevant to my particular interests/needs	○	○
The resource having a catchy title or attractive image(s)	○	○
Being required to use a resource for a project or study task	○	○
The resource having previously been used with students	○	○
A detailed description of the resource content being provided	○	○

Other (please specify)

14. What kind of teaching do you do? (Check any that apply)

- ☐ Full-time face-to-face teaching
- ☐ Part-time face-to-face teaching
- ☐ Full-time distance/online teaching
- ☐ Part-time distance/online teaching
- ☐ Full-time blended (face-to-face and distance/online) teaching
- ☐ Part-time blended (face-to-face and distance/online) teaching
- ☐ Work-based training

Other (please specify)

15. Within which educational context(s) do you work? (Check any that apply)

- ☐ School education (K12)
- ☐ Further Education/College
- ☐ Higher Education/University
- ☐ Work-based training
- ☐ Personal (one-to-one) tutoring

Other (please specify)

16. Which of the following apply to you? (Check all that apply)

- ☐ Classroom Teacher
- ☐ Department Chair
- ☐ Technology Integration Specialist
- ☐ Technology Director
- ☐ Curriculum Director
- ☐ Administrator

Other (please specify)

17. For how many years have you been teaching?

18. In which subject area(s) do you teach and in which subject area(s) do you usually use and/or create open educational resources? (Check all that apply)19. Did you buy or borrow a textbook in addition to using OpenStax College textbook(s)? (Check all that apply)

	I teach in this subject area	I use open educational resources in this subject area	I create open educational resources in this subject area
Computing and information science	☐	☐	☐
Psychology and Philosophy	☐	☐	☐
Religious Studies	☐	☐	☐
Social Science	☐	☐	☐
Languages and Linguistics	☐	☐	☐
Science	☐	☐	☐
Mathematics	☐	☐	☐
Arts	☐	☐	☐
Literature	☐	☐	☐
History & Geography	☐	☐	☐
Economics, Business & Management	☐	☐	☐
Applied science, technology, engineering	☐	☐	☐
Medicine	☐	☐	☐
Health & Social Care	☐	☐	☐
Education Studies	☐	☐	☐
Physical Education	☐	☐	☐
Special Education	☐	☐	☐

Other (please specify)

19. Do you believe that your students have saved money by using open educational resources?

- ○ Yes
- ○ No
- ○ Don't Know

Further comments

20. Do you think that your institution benefits financially by using open educational resources?

- ○ Yes
- ○ No
- ○ Don't Know

Further Comments

21. How did you first become aware of OpenStax College textbooks?

22.Have you used, or are you using, OpenStax College textbooks?

- ○ Yes
- ○ No

23. Which of the following OpenStax College textbooks have you used, or are currently using, with your students?

	Electronic format	Printed version
Anatomy and Physiology	☐	☐
Biology	☐	☐
College Physics	☐	☐
Concepts of Biology	☐	☐
Introduction to Sociology	☐	
Introductory Statistics	☐	☐
Precalculus	☐	☐
Principles of Economics	☐	☐
Principles of Macroeconomics	☐	☐
Principles of Microeconomics	☐	☐

24. Please tell us more about how you used, or currently use, OpenStax College textbooks.

25. Based on your experiences as an educator, to what extent do you agree with the following statements?
"Use of OpenStax College textbooks in the classroom..."

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Increases learners' participation in class discussions	○	○	○	○	○
Increases learners' interest in the subjects taught	○	○	○	○	○
Increases learners' satisfaction with the learning experience	○	○	○	○	○
Leads to improved students' grades	○	○	○	○	○
Builds learners' confidence	○	○	○	○	○
Develops learners' increased independence and self-reliance	○	○	○	○	○
Allows me to better accommodate diverse learners' needs	○	○	○	○	○
Increases learners' engagement with lesson content	○	○	○	○	○
Increases learners' experimentation with new ways of learning	○	○	○	○	○
Increases collaboration and/or peer-support among learners	○	○	○	○	○
Increases learners' enthusiasm for future study	○	○	○	○	○
Leads to learners becoming interested in a wider range of subjects than before they used OER	○	○	○	○	○

26. Please provide evidence, or tell us more about any experience, which supports your responses to the previous question's statements.

27. Based on your experiences as an educator, how would you rate the quality of OER when compared with traditional, proprietary materials?

"The quality of OER when compared with traditional, proprietary materials is usually..."

- ○ Significantly worse
- ○ Slightly worse
- ○ Comparable
- ○ Slightly better
- ○ Significantly better

Further comments

28. In what ways, if any, has using OpenStax College textbooks impacted on your students?

29. In what ways, if any, has using OpenStax College textbooks impacted on your own teaching practice?

30. What features, if any, of the OpenStax College textbook(s) you are using/have used did you like the most?

31. What features, if any, of the OpenStax College textbook(s) you are using/have used did you like the least?

32. What improvements, if any, do you think could be made to the OpenStax College textbook(s) you are using/have used?

33. As a result of using OpenStax College textbooks, are you more or less likely to do any of the following?

	More likely	No change	Less likely	Don't Know
Make use of other OpenStax College textbooks for teaching	○	○	○	○
Remix OpenStax College textbooks using the Connexions|platform	○	○	○	○
Submit details of any errata/corrections to OpenStax College	○	○	○	○
Recommend OpenStax College textbooks to fellow educators/teachers	○	○	○	○
Recommend OpenStax College textbooks to students as an additional/optional study aid	○	○	○	○
Make an OpenStax College textbook the required text for students	○	○	○	○
Discuss using OpenStax College materials with my institution's administrators	○	○	○	○
Contribute content to the Connexions repository	○	○	○	○
Use other Open Educational Resources for teaching	○	○	○	○

Further comments

We are grateful to you for taking the time to complete this survey. The anonymised results will be shared widely with OpenStax College and the OER community.

Researchers might wish to contact you with a view to collecting more detailed data through, for instance, focus group or interview. If you are happy to be contacted then please submit your details below.

33. Name

34. Email address

If you'd like to stay in touch with the project, you can do so via: http://oerresearchhub.org

Appendix J: MAT-014 Faculty Materials Survey

1. You are invited to participate in a research study that is being conducted by Jennifer Applebee, who is a graduate student in the Graduate School of Education at Rutgers University. The purpose of this research is to understand faculty and student perceptions of Open Educational Resource course material usage in Algebra 2 at County College.

This research is anonymous. Anonymous means that I will record no information about you that could identify you. There will be no linkage between your identity and your response in the research. This means that I will not record your name, address, phone number, date of birth, etc.

The research team, the Institutional Review Board at Rutgers University, and the Institution Research Board at County College are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated. All study data will be kept for three years per Federal Regulations.

There are no foreseeable risks to participation in this study. Participation in this study is voluntary. You may choose not to participate, and you may withdraw at any time during the study procedures without any penalty to you. In addition, you may choose not to answer any questions with which you are not comfortable.

If you have any questions about the study or study procedures, you may contact myself at County College, ### XXX Avenue, Center 2 / Math Dept, XXX, XX #####, or japplebee@XXcc.edu, or ###-###-6000 x ####. You may also contact my faculty advisor Dr. Saundra Tomlinson-Clarke at Rutgers University, Graduate School of Education, 10 Seminary Place, New Brunswick, NJ 08901, or saundra.tomlinson-clarke@gse.rutgers.edu, or 848-932-0815.

If you have any questions about your rights as a research subject, please contact an IRB Administrator at the Rutgers University, Arts and Sciences IRB: Institutional Review Board, Rutgers University, the State University of New Jersey, Liberty Plaza / Suite 3200, 335 George Street, 3rd Floor, New Brunswick, NJ 08901, Phone: 732-235-2866, Email: humansubjects@orsp.rutgers.edu

Please retain a copy of this form for your records. By participating in the above stated procedures, then you agree to participation in this study.

If you are 18 years of age or older, understand the statements above, and will consent to participate in the study, click on the "I Agree" button to begin the survey/experiment. If not, please click on the “I Do Not Agree” button which you will exit this program.

- ❍ I Agree (1)
- ❍ I Do Not Agree (2)

2. How long have you been teaching at the college level?

- ❍ Less than 3 years (1)
- ❍ 3 - 6 years (2)
- ❍ 6 - 9 years (3)
- ❍ 9 - 12 years (4)
- ❍ 12 - 15 years (5)
- ❍ 15 - 18 years (6)
- ❍ More than 18 years (7)

3. How many times have you taught MAT-014 / Algebra 2 (including this semester)?

- ❍ 1 (1)
- ❍ 2-3 (2)
- ❍ 4-6 (3)
- ❍ 7-9 (4)
- ❍ 10 or more (5)

4. What is the highest degree you have obtained?

- ❍ High School Diploma (1)
- ❍ Associate's Degree (2)
- ❍ Bachelor's Degree (3)
- ❍ Master's Degree (4)
- ❍ Doctoral Degree (5)

5. What is your average teaching load during a regular length semester?

- ❍ 1 course (1)
- ❍ 2 courses (2)
- ❍ 3 courses (3)
- ❍ 4 courses (4)
- ❍ 5 courses (5)
- ❍ More than 5 courses (6)

6. Did you use an OER workbook this semester in your section(s) of MAT-014/Algebra 2?

- ❍ Yes (1)
- ❍ No (2)

Display This Question:

If Did you use an OER workbook this semester in your section(s) of MAT-014/Algebra 2? = Yes

7. How much did you communicate with your students about the experimental nature of the OER approach used in your section(s) of MAT-014 / Algebra 2 this semester?

- ❍ Never (1)
- ❍ Once (2)
- ❍ 2-4 times (3)
- ❍ 5-7 times (4)
- ❍ 8-10 times (5)
- ❍ Most class meetings (6)
- ❍ Every class meeting (7)

8. Have you taught this course in previous semesters?

- ❍ Yes (1)
- ❍ No (2)

❑ *Skip To: Q12 If Have you taught this course in previous semesters? = No*

Display This Question:

If Have you taught this course in previous semesters? = Yes

9. When you have taught MAT-014 / Algebra 2 in the past, what percent of students do you think purchased the required materials?

- ❍ Less than 10% (1)
- ❍ 10 - 30% (2)
- ❍ 30 - 50% (3)
- ❍ 50 - 70% (4)
- ❍ 70 - 90% (5)
- ❍ More than 90% (6)

Display This Question:

If Have you taught this course in previous semesters? = Yes

10. How much time did you spend preparing to teach MAT-014 / Algebra 2 each week this semester compared to previous semesters?

- ❍ Much less time (1)
- ❍ Somewhat less time (2)
- ❍ About the same amount of time (3)
- ❍ Somewhat more time (4)
- ❍ Much more time (5)

Display This Question:

If Have you taught this course in previous semesters? = Yes

11. How did your students' preparedness in MAT-014 / Algebra 2 compare to previous semesters?

- ❍ Students were less prepared (1)
- ❍ Students were equally prepared (2)
- ❍ Students were more prepared (3)

12. How often do you think most students used the materials for MAT-014 / Algebra 2 throughout the semester?

- ❍ Never (1)
- ❍ 2 - 3 times in the semester (2)
- ❍ 2 - 3 times per month (3)
- ❍ 2 - 3 times per week (4)
- ❍ Most days (5)
- ❍ Daily (6)

13.Based on your experiences as an educator, to what extent do you agree with the following statements?

"Use of the MAT-014 / Algebra 2 course materials ... "

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Increased learners' participation in class discussions (1)	❍	❍	❍	❍	❍
Increased learners' interest in Algebra 2 (2)	❍	❍	❍	❍	❍
Increased learner's satisfaction with the learning experience (3)	❍	❍	❍	❍	❍
Led to improved students' grades (4)	❍	❍	❍	❍	❍
Built learners' confidence (5)	❍	❍	❍	❍	❍
Developed learners' increased independence and self-reliance (6)	❍	❍	❍	❍	❍
Allowed me to better accommodate diverse learners' needs (7)	❍	❍	❍	❍	❍

Increased learners' engagement with lesson content (8)	❍	❍	❍	❍	❍
Increased learners' experimentation with new ways of learning (9)	❍	❍	❍	❍	❍
Increased collaboration and/or peer-support among learners (10)	❍	❍	❍	❍	❍
Increased learners' enthusiasm for future study (11)	❍	❍	❍	❍	❍
Led to learners becoming interested in a wider range of subjects (12)	❍	❍	❍	❍	❍

14. On average, how would you rate the quality of the materials used for MAT-014 / Algebra 2?

- ❍ WORSE than the quality of materials in my other courses (1)
- ❍ About the SAME AS the quality of the materials in my other courses (2)
- ❍ BETTER than the quality of the materials in my other courses (3)

Display This Question:

If On average, how would you rate the quality of the materials used for MAT-014 / Algebra 2? = WORSE than the quality of materials in my other courses

15. Please briefly describe what made the quality of this course's materials WORSE than in other courses.

Display This Question:

If On average, how would you rate the quality of the materials used for MAT-014 / Algebra 2? = BETTER than the quality of the materials in my other courses

16. Please briefly describe what made the quality of this course's materials BETTER than in other courses.

17. What features, if any, of the MAT-014 / Algebra 2 course materials did you like the most?

18. What features, if any, of the MAT-014 / Algebra 2 course materials did you like the least?

19. What improvements, if any, do you think could be made to the MAT-014 / Algebra 2 course materials?

20. In what ways, if any, has using the MAT-014 / Algebra 2 course materials impacted on your students?

21.In what ways, if any, has using MAT-014 / Algebra 2 course materials impacted on your own teaching practice?

22. What feedback, if any, did you receive from students about the materials used in MAT-014 / Algebra 2?

Appendix K: Weinburg Interview Protocol

(Weinburg et al., 2012, p. 170)

1. Did your instructor ask you to use your book in specific ways?
    a. If so, what did they ask you to do?
    b. Do you think they wanted you to use the book in other ways, but didn't explicitly require it?
2. When did you use your textbook most frequently?
3. What parts of your textbook did you use?
4. If you read the chapter text, how do you read it? Do you browse, do you read multiple times, etc.?
5. What were your reasons to use your textbook?
6. Did you ever use the answers to odd-numbered problems or a solutions manual? What did you use it for, and how frequently did you use it?
7. What do you look for in a textbook?
8. Do you think a professor being a good lecturer or not would affect how you use your textbook?
9. Are there specific ways the class is set up or run that would affect the way you use your textbook?
    a. If the course content is very different from what is in the book
    b. If the course covers content in a different order than is in the book
10. Do you have any other comments about how you have used your math textbook that we haven't already covered?

Appendix L: MAT-014 Student Interview Protocol

1. Did your instructor ask you to use your workbook in specific ways?
    a. If so, what did they ask you to do?
    b. Do you think they wanted you to use the workbook in other ways, but didn't explicitly require it?

2. Did your instructor ask you to use MyOpenMath in specific ways?
    a. If so, what did they ask you to do?
    b. Do you think they wanted you to use the workbook in other ways, but didn't explicitly require it?

3. When did you use your workbook most frequently?

4. When did you use MyOpenMath most frequently?

5. What parts of your workbook did you use? (Prompt: Media Examples, Media Example Videos, Worked Examples, Practice Problems, End of Chapter Assessment)

6. What parts of MyOpenMath did you use? (HW assignments, reviewing HW assignments, videos in HW assignments)

7. Did your instructor provide the answers to the workbook problems?
    a. If so, did you use them?

8. What do you look for in course materials?
    a. Did you find those things in the course materials you used in this class?

9. Do you think your professor being a good lecturer or not would affect how you use your course materials?

10. Are there specific ways the class was set up or run that would affect the way you use your course materials?

11. Do you have any other comments about how you have used your math course materials that we have not already covered?