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Report

Large scale Open Educational Resources (OER) initiative in mathematics

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Abstract

A team of LaGuardia Community College math faculty designed and launched the OER (Open Educational Resources) project in Spring 2017 to allow to take mathematics courses at zero or low textbook cost. Our first pilot phase started with 10 sections in Fall 2017 using three different OER platforms: Myopenmath, Webwork and Khanacademy.One out of the three platforms, Myopenmath used in phase 1 was selected to pilot 34 sections in Spring 2018. In Fall 2018, the OER team moved to a full-scale implementation on all remedial and gateway courses of 164 sections including Fundamentals of Algebra, Intro to Algebra, Elementary Algebra Co-req STEM, College Algebra and Elementary Statistics. From Fall 2017 to Spring 2018, a total of $477,182 was saved by 5,560 LaGuardia students. By Fall 2019, the project had saved a total of $1,184,329.25 on textbook costs. In addition, the pass rates for OER courses were either better or the same when compared to non-OER courses. Furthermore, the pass rate for OER Co-req STEMwas almost two times higher than the one for non-OER Co-req STEM sections.

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Introduction

In this paper, we describe how LaGuardia Community College's Mathematics, Engineering and Computer Sciences (MEC) designed and implemented large scale OER courses in mathematics. The goal of the project, which benefited more than 6,000 students annually, was to sustain and enhance student access to free educational resources using zero textbook cost materials as well as accessing to free learning management system platform.

This paper is intended to share our experiences, by first describing our OER project timeline from Spring 2017 to Fall 2019, then providing the concept and practical guidance on each process, followed by resulting outcomes on students pass rate and retention rate, licensing flexibility, educational equity, and the estimated amount of money saved for students.

Primary Audience

The primary audience for this publication is presidents, provosts, VPs, department chairs, and faculty.

Problem Statement

Most of LaGuardia's students come from families who live under the poverty line. According to LaGuardia's Fast Facts of 2019, about 71% of students come from families with a household income less than $25K. Of those students, many decided against buying a book required for their class due to the high cost of math textbooks. According to the U.S. Public Interest Research Group Education Fund and Student Public Interest Research Groups study, two-thirds of postsecondary students are reluctant to purchase commercial materials due to high cost (USPIRG, 2014). The price of commercials textbooks in higher education has risen substantially over the past few decades (US Bureau of Labor Statistics, 2016). In addition to the high cost is the restrictive license of commercials materials that prevent instructors to share, revise or adapt materials. The response to high cost and license inflexibility issues of commercial materials is

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Open Educational Resources (Butcher, 2015). Open Educational Resources (OER) are teaching and learning materials that are available to the public for free use with licensing that allows instructors to share, revise, adapt and align with learning objectives and inclusive of student needs (Clinton-Lisell, Legerski, Rhodes, & Gilpin, 2020). Most importantly, OER promotes social justice principles by supporting marginalized communities, who have less, more equitable access to higher education (Lambert, 2018). Therefore, the Mathematics Engineering and Computer Sciences (MEC) department launched the OER initiative to provide more opportunities to our students and increase the voices of community colleges and marginalized students across the United States.

Action

The Math, Engineering and Computer Sciences (MEC) department launched the OER (Open Educational Resources) initiative in Spring 2017, which allow students to take mathematics courses at zero or low textbook cost.

Context

Conditions which enabled the transition to OER included common understanding of the issue, faculty readiness to embrace the transition and the existence of CUNY-wide OER grant from the State of New York to facilitate the process. To succeed the OER initiative, instructors must have knowledge of open pedagogies to ease their transitions to OER implementation (Conole & Brown, 2018). The MEC department has a history of innovations with Co-requisite courses and experience with scalable projects (Belkharraz, Cuellar, & Funk, 2020). We achieved faculty buy-in to this project through multiple presentations at departmental meetings and faculty workshops before and during pilot phases.

Process

A team of LaGuardia Community College math faculty designed and launched the OER project in Spring 2017. Researchers suggest the use of pilots helps answer methodological questions and addressed few issues before full scale implementation (Prescott & Soeken, 1989; Doody & Doody, 2015). Our first pilot phase started in Fall 2017 using three different platforms:myopenmath , webwork and Khanacademy.Ten faculty members, each taught one section, participated in the first pilot. One out of the three platforms used in phase 1 was selected to pilot 34 sections in Spring 2018.There were 28 faculty members involved in pilot phase 2. In Fall 2018, the OER team moved to a full-scale implementation on all remedial and gateway courses of 164 sections including Fundamentals of Algebra, Intro to Algebra, Elementary Algebra Co-req STEM, College Algebra and Elementary Statistics. There were constant adjustments of the master templates after each pilot phases' assessments and during the full-scale implementation. These adjustments were due to course alignments, change of textbooks, and adding more supplemental materials to fulfill students and instructors' needs.

Outcomes

From Fall 2017 to Spring 2018, a total of $477,182 was saved by 5,560 Laguardia students. By Fall 2019, the total saving for students taking OER courses was $1,184,329.25. Beyond reducing financial barriers, there is evidence that OER increase retention and passing rate (Hall et al., 2003). For the first pilot phase, the pass rates for OER courses were either better or the same when compared to non-OER courses. These results were similar for the second pilot phase for all courses piloted except for Co-req STEM courses: the pass rate for OER co-req stem was almost two times higher than the one for non-OER co-req STEM sections. The 5R's activities of OER - retain, reuse, revise, remix, and redistribute – give instructors more flexibility to design their courses based on students' needs (Wiley & Hilton, 2018). We were able to customize our courses by aligning our courses curriculum to OER materials, adding more "home-made" video lessons, revising homeworks assignments and designing departmental exams as well as departmental exam practices. Furthermore, we could create folders, hidden from students, for important instructors' memos. This would not be possible without faculty collaboration working together: Inputs from each faculty member were considered and valued for the success of this project. We were not able to make these changes with previous commercial platforms due to license restrictions.

OER contribute to more equitable access to education (Clinton-Lisell, Legerski, Rhodes, & Gilpin, 2020). The flexibility, freedom and capabilities that results from OER initiatives define social justice in education (Sullivan, 2011). Our first step was to explore how our OER initiative centered on students learning and student's success. This major step in infusing justice alignment throughout the curriculum, addressed the educational equality gap between privileged and marginalized students (Polat ,2011).

Sources of Support

The CUNY OER initiative funded by the State of New York contributed to the success of this change, including grant funding of $970,000 from 2017 to 2021. The fund was used to redevelop courses, align homework and assignments, design videos, create materials more suitable to our students. The fund benefited more than 24,000 students enrolled in more than 800 sections.

The full scale OER implementation involved more than 30 full-time math and computer science faculty and more than 40 part-time faculty.

Context

Location & Student Population

LaGuardia Community College of the City University of New York (CUNY) is a gateway for thousands of ambitious college students – for the most part, immigrant, Hispanic, and low-income. Located in western Queens, NY, LaGuardia annually serves nearly 16,000 degree-seeking students and 80,000 continuing education students. Approximately 60% are foreign born, and half of those have lived in the U.S. fewer than five years.

Eighty-seven percent are minorities (Hispanic: 49%, Asian: 22%, Black: 16%, Other: 1%), and many are the first-generation college students. In terms of financial resources, 60% of degree-seeking students receive financial aid grants including Pell grants, 57% of students live with parents with a family income of less than $25,000, while 78% of students live away from parents and have income less than $25,000. There is a wide range of ages in the degree-student population, with 53% of students falling in the traditional college age range of 17 to 22. The median age has remained at 21 for the past 5 years (LaGuardia Community College Institutional Profile, 2019).

Most of LaGuardia's students enter the college academically underprepared as determined by a system-wide placement test. From Fall 2013 to Fall 2017, 71% of entering students were placed into a remedial math course by this test. Following a similar national trend (Bailey, Jeong, and Cho, 2010), Hispanic and Black students at LaGuardia are placed into developmental mathematics courses at higher rates than their peers.

Reasons for the Initiative

On average, the yearly cost of learning materials in postsecondary is $1200 (The College Board, 2019). This amount is high given that nearly 60% of our students come from family with household income less than $25,000. From Fall 2013 to Fall 2017 at LaGuardia Community College, students in remedial and gateway courses were required to either buy the book or purchase the access code in order to complete their class assignments which include homeworks, quizzes and exams. The platform used for remedial courses was ALEKS which cost on average $95 per student. Students in college algebra, statistics, precalculus and calculus used mymathlab (Pearson) which cost nearly $100 per student. The high textbook or access code cost had an impact on students' retention rates.According to a research study, the withdrawal rate for courses that used commercial textbooks was 29 % higher than the rate of OER courses (Clinton & Khan, 2019). Students who were unable to purchase the access codes in remedial mathematics courses were obliged to drop the class: all exams and homeworks were done in Aleks.

In addition to that, the MEC department had great innovative ideas on how to align adopted platforms to our students and faculty need. Commercial materials were not the answers due to licensing restriction. With OER licensing, we can finally revise and remix to better connects curriculum and pedagogy which improve student learning outcomes (Forbes, 2013; Remillard, 2005).

Our institution, as most community colleges, promote a culture that values and promotes diversity, equity and inclusion (Association of Community Colleges Trustees, 2015). OER initiative expand equitable access to quality education.

Enabling Conditions

Several factors made LaGuardia Community College a hospitable environment for a suitable, reliable, scalable and money saving OER project initiative. These include a common understanding of the problem, the readiness of faculty to change and a supportive administration.

A Common Understanding

There was a strong understanding within the mathematics department that the cost of textbook especially for remedial and gateway courses affected students' success. Students enrolled in remedial and gateway courses must purchase the textbook or access codes in order to remain in the classroom: most of the class works were assigned online including homeworks, quizzes and exams. Many LaGuardia students who come from low-income families elected not to purchase the book or access codes and therefore end up withdrawing from the class. Besides, we commonly agree for the need of less licensing restriction and more freedom when designing our courses' platforms.

Faculty Readiness

Faculty were ready to embrace the transition due to the department long history of successful innovations. Almost every faculty scheduled to teach an OER course, attended the OER training prior to the start of semester. By Fall 2019, all mathematics instructors in the department received a training on the nuts and bolts of myopenmath and /or Lumen platform.

A Supportive Administration

Since the Fall semester of 2018, the State of New York has granted $4,000,000 per year to the City University of New York to enhance and sustain free access to Open Educational resources throughout CUNY. The LaGuardia Community College's Mathematics department received a portion of that fund to help redesign courses and facilitate the transition.

The Transition Process

For our project to be successful, it was necessary to adopt effective innovation strategies which should include conceiving effective approaches for scaling (OECD, 2016). In Spring 2017, we designed our project timeline which included 2 pilot phases of elementary algebra, fundamental algebra, college algebra, co-requisite college algebra and elementary statistics, respectively in Fall 2017 and Spring 2018.The third phase of the pilots in Spring 2019 involved precalculus and calculus courses.

Project Timeline

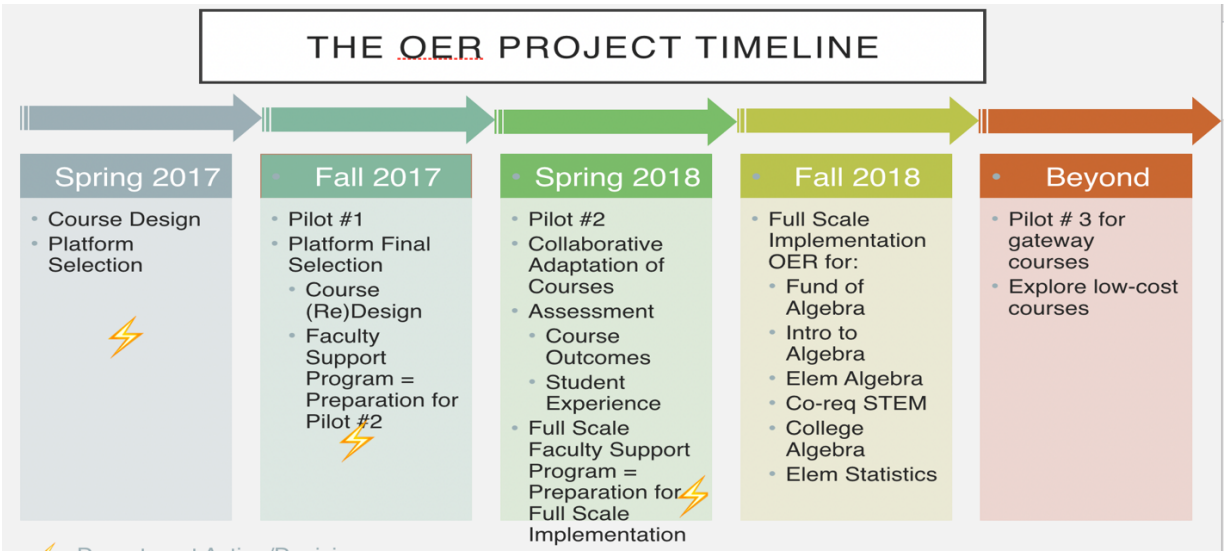

Figure 1.

Project Timeline

Design New Courses (Spring 2017)

A team of LaGuardia Community College math faculty was formed to designed new OER course templates in Spring 2017 using three different OER platforms- Myopenmath, KhanAcademy and Webwork- to pilot in Fall 2017. A course master template was created for each platform. The OER team hosted a training session in Spring 2017 for faculties who volunteer to participate in the pilot in Fall 2017.

Pilot # 1 (Fall 2017)

A total of 10 OER courses were piloted in Fall 2017. Two fundamental algebra, one Co-req non-STEM and two college algebra courses used Myopenmath. The courses piloted using Khan Academy included one co-req STEM, one co-req non STEM and one elementary statistics course. In addition, there was a college algebra course using Webwork platform.

At the end of Fall 2017 semester, students and faculty involved in this pilot took a survey to weigh their experiences using OER platform.

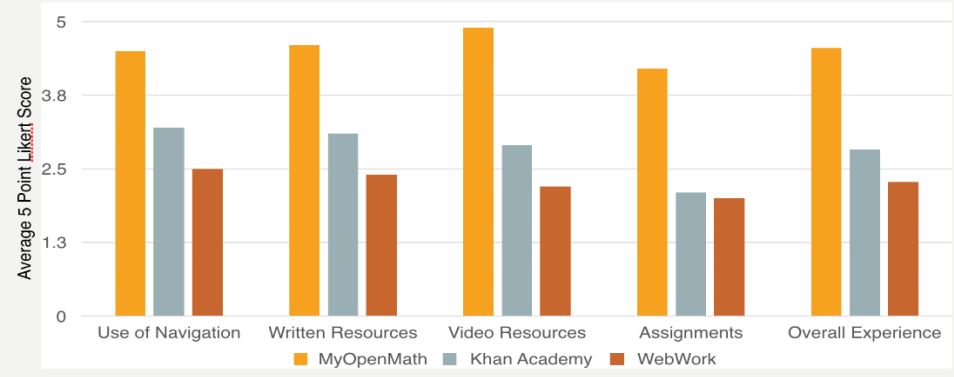

Figure 2.
Pilot Survey Data-Students

Based on the pilot survey data shown in Figure 2, students found myopenmath a better platform, compared to Khan Academy and webwork, in written resources, video resources and has a larger assignments library. According to students, myopenmath platform was easier to navigate.

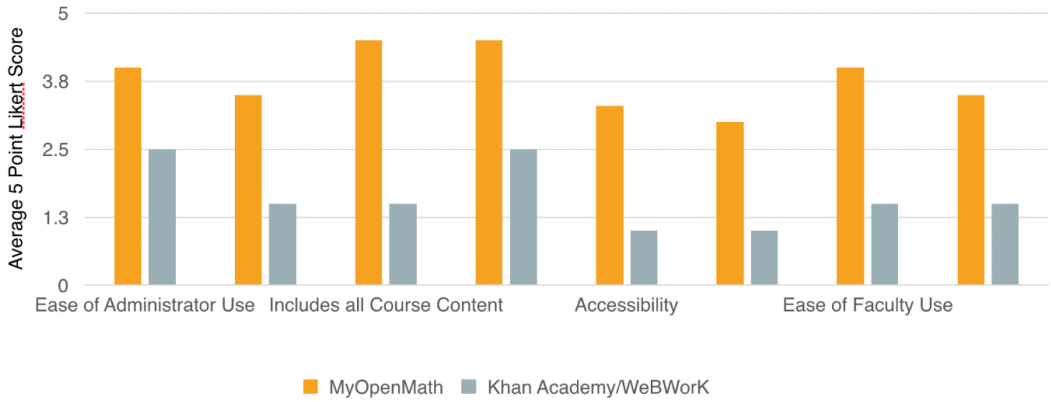

Figure 3.
Pilot Survey Data-Faculty

Faculty members had a similar experience with myopenmath. They found that myopenmath was a better user-friendly platform and accessible than khan Academy and Webwork (figure 3). Furthermore, the administrator use in myopenmath is easier.

Based on students and faculty experiences, the OER team selected to move on with myopenmath for the second phase of the pilot in Spring 2018 (figure 1). In addition to the extensive assignments' library, myopenmath was more reliable and suitable to our students and faculty needs. However, writing and adding additional questions were challenging in myopenmath.

Pilot # 2 (Spring 2018)

In Spring 2018, 34 sections including 7 sections of elementary algebra, 7 sections of fundamental algebra, 7 sections of college algebra, 6 sections of college algebra (co-requisite) and 7 sections of elementary statistics using MyOpenMath and OHM lumen (premium version of myopenmath) as the learning management platforms.

A larger number of faculty joined this phase, and leadership teams were implemented, consisting of faculty leading and teaching Elementary Statistics, Co-Requisite STEM, Fundamentals of Algebra, College Algebra, as well as a newly formed Copyright Team (figure 4).

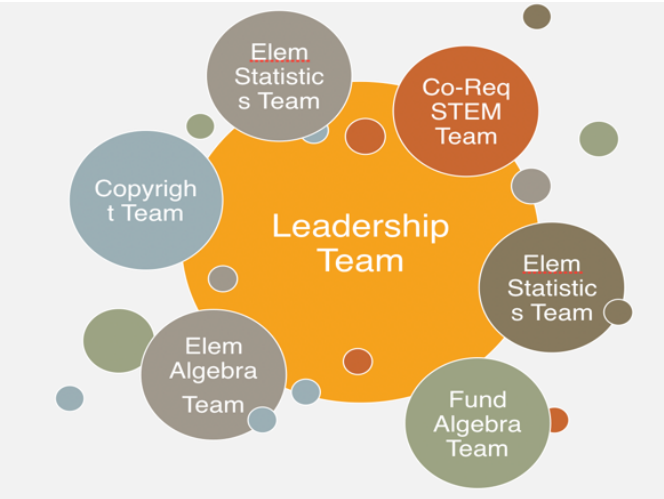

Figure 4.
OER Faculty Organization

Each team collaborated on the design of the course through meetings and constant communication. Each course customized assignments using the question bank in MyOpenMath and/or Lumen (a premium version of myopenmath).

Full Scale (Fall 2018)

Prior to Fall 2018, the newly formed Copyright Team launched with the goal of instituting training for the department, adapting the syllabus to OER, and overseeing OER Copyright compliances. The team consisted of faculty from the M.E.C. department as well as faculty from LaGuardia's Library.

In Fall 2018, the M.E.C. Department implemented full-scale OER for all sections of Fundamentals of Algebra, Introduction to Algebra, Elementary Algebra, Co-requisite STEM, College Algebra and Elementary Statistics. These courses used Lumen OHM which is premium version of Myopenmath. Furthermore, our Quantitative Reasoning, Elementary Statistics 2, Pre-calculus and Calculus series entered the OER course design phase. At the start of the semester, we trained faculty teaching OER courses and faculty mentors were assigned for each course. Faculty mentors were available to help faculty new to OER with any of their issues or concerns. The department also held an OER Forum in during the semester, where faculty shared their experiences teaching OER courses and provided recommendations for best pedagogical practices. Faculties also participated on a brief survey at the end of the forum. The results of the survey were mostly positive. About 40% stated they have used OER in the past, over 90% stated that the OER platform supports learning and over 70% stated that OER is better than commercial platforms (figure 5). On the other hand, only 25% said they were confident about copyright using OER. For the areas that needed improvement, 40% of the faculty mentioned assignments and 20% said gradebook.

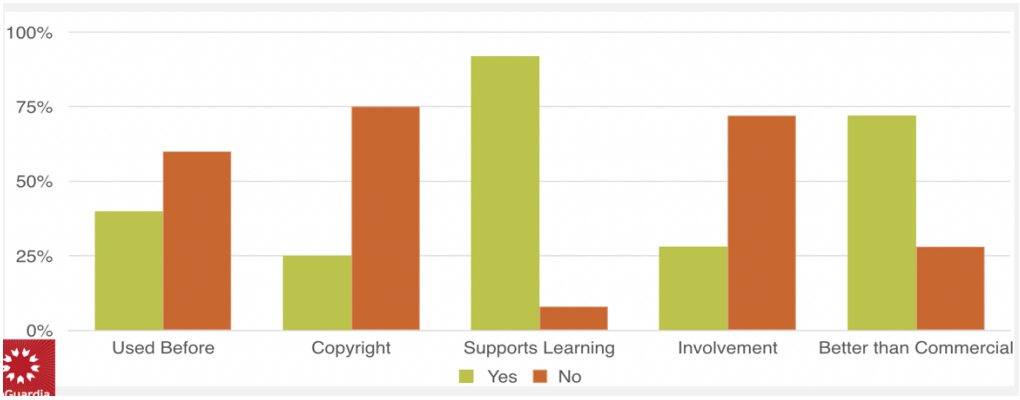

Figure 5.
Instructors' Attitude toward OER

Full Scale timeline (Winter 2019 to Summer 2019)

After the full scale OER implementation in the Fall semester of 2018 for remedial and gateway courses, the OER leadership team continued to make sure all our mathematics courses became fully OER.

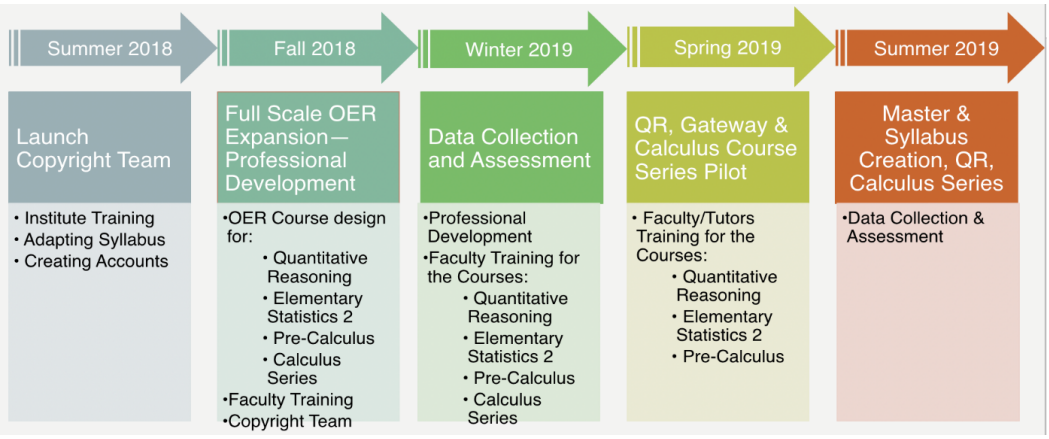

Figure 6.
Full Scale Timeline

In winter 2019, the OER faculty leadership team continue working on strategic plan to increases OER sections for Quantitative reasoning, Elementary statistics 2, Pre-calculus and calculus courses (figure 6).
The Copyright team revised all master templates in lumen to make sure the OER contents were Copyright compliant and that sources were properly cited. The team created a "best practice" guide for faculty and presented their work in Spring 2019 at the college-wide professional development.

In Spring 2019, faculty and tutors were trained on OHM lumen new assessment player. For over 200 sections offered in Spring 2019, the OER team found the need to assign course mentors who help orient and support instructors, new to OER,for this challenging phase of their careers.

During Summer 2019, the OER leadership team collected data and assessment from the 2018 – 2019 academic year (figure 6). The sub-teams modified the master courses and syllabi while the Quantitative Reasoning and Calculus Series continued to work on their OER courses.

Faculty Development

Well-established infrastructure, continuous and on-demand training opportunities, technical support and leadership support are among factors that positively affected teachers' transition to OER (Buabeng-Andoh ,2012). Faculty training was one of the main reasons why our OER project was a success. Every faculty member was trained and prepared before teaching an OER course. For the first pilot phase in Fall of 2017, all 10 sections piloted were taught by OER project leaders who were self-trained. However, during winter session, we offered a series of two workshops (cohort 1 and cohort 2) to all faculty members to help them prepare for the second phase of the pilot in Spring of 2018 semester. A mid-semester training was also offered in advance of full-scale adoption in Fall 2018.

OER Workshop Cohort 1

Cohort 1 workshop was offered on January 31, 2018, on the "nuts and bolts" of Myopenmath platform. This workshop focused on how to create a course, help students self- register, change assessment dates, assign late passes, set the gradebook, add offline grading, create new assessment and use the communication tools (messaging and forum).

OER Workshop Cohort 2

This workshop was hosted on March 7, 2018, to discuss the pedagogical tools available in Myopenmath. Participants focused on the content of the course which included adding/ deleting items, reordering topics and discussing course content. Two faculty members share their experiences about Myopenmath during the first pilot phase of Fall 2017.

Midsemester OER Workshop

On April 25, 2018, the OER team hosted a large-scale training workshop to prepare for the Fall 2018 in which fundamental algebra, Co-requisite STEM, College Algebra and Elementary Statistics would enter full scale implementation phase. This workshop focused on the practical aspects of technology adoption of Ohm-Lumen (premium version of Myopenmath) rather and the all-important pedagogical considerations. A total of 113 faculty members, including full-timers and adjuncts, attended the workshop.

In Fall 2018, we hosted a training for faculty members who missed the Midsemester OER training on Lumen. There was a series of small group training which included high school teachers who were part of the college now program and adjuncts professors.

In late Fall of 2018, the OER leaders decided to listen to the faculty members teaching OER courses to share their experiences using Lumen. Therefore, a forum was held on the 28th of November 2018 to address Lumen platform quality and issues, level of technological support, and topics alignment on platform as compared to the syllabus for Fundamentals of Algebra, Introduction to Algebra, Elementary Algebra, Co-requisite STEM, College Algebra and Elementary Statistics. About 102 faculty members attended the forum. There was an interactive dialogue between the mentors of each OER section and the attendees during the breakout session. Attendees of the forum suggested a review of the departmental exams for intro to algebra course, limit the number of questions in each homework to at most 15 and most importantly make sure the sequence of topics in Lumen for intro to algebra, elementary algebra and fundamental algebra aligns with their course syllabi.

During the OER forum, attendees suggested to host a workshop on "gradebook setting" in lumen. The main objective of this workshop which took place on February 19, 2019, was to clarify the Lumen gradebook functionality that most faculty had issues during Fall 2018 to make grading quicker and more useful for both instructors and students. These issues included adding /managing offline grades, setting the default attempts per problem, extending the time Limit for students with letter of accommodation, modifying individual score, drop lowest scores and adding a grade category.

Coding

The question bank in Lumen and MyOpenMath is limited, especially for certain courses, like Pre-Calculus. Many instructors expressed interest in learning to code questions for their classes and our department provided training for both faculty and students. A "coding questions on Lumen" workshop was held on January 29, 2020 and was attended by approximately 60 faculty and four students. Attendees also received a digital copy of the presentation.

In Spring I, 2020, with the transition to online-learning due to COVID, MEC decided that final departmental exams would be given on Lumen. Previously, final exams for statistics, college algebra and coreq stem were given in person on paper while the final for remedial courses were given online at the school testing center. The course coordinators worked out the new format of the exams,15 questions where 10 were auto graded and 5 were "show work" questions, to be coded in Lumen. We also created a "final exam answers entry practice" to familiarize students with the types of questions they would see on the final exam. Courses coordinators hosted workshops to faculty teaching these courses prior to the final. At the workshop, we shared the new format of the exam, and showed instructions on how students should upload their work and how uploaded work should be graded manually. The workshops were recorded and distributed to faculty who could not attend.

Being able to code custom questions in online platforms is extremely important for Instructors. It allows them to shape the content of their assessments to the needs of the department and the specifics of the individual courses they are teaching.

Copyright

You can use learning materials produced by others if they are made available under an open license (Wiley & Green, 2012). Copyrighted material allows one to freely copy problems and examples from such sources if they are properly attributed (Grodecka & Śliwowski 201). By design, the OER platforms allow and encourage users to retain, reuse, revise, remix, and redistribute (Wiley & Hilton, 201). In this context, the copyright status of content and its "fair use" gets tricky; it is easy to lose track of what the sources are as instructors freely copy and modify each other's work. With the rise of OER use, understanding copyright has become essential (Comforto, 2015).

The Copyright team was put together in the summer semester of 2018 with the mission to inspect the master section of each course and carefully examined the content to ensure compliance with existing copyright law. The team consisted of members of the MEC department as well as faculty from LaGuardia's Library. At first, the team learned about the different sorts of creative common licenses that are used, and about "fair use.".

The Copyright team first met in Fall 2018 and worked out long-term goals, which include:
Establishing easy-to-follow copyright compliance protocols for instructors to follow when creating content . Giving workshops for faculty to help them learn these protocols. The team created citations for material in the courses using an OER attribution creator, Open Washington Attribution Builder. They also created a standard "licenses and attributions" heading for the videos used in the courses. The team created original statistical tables for their statistic course because the tables in use were uncited and the original source could not be found. They also created a "copyright how-to" flowchart and presented their work at an MEC OER workshop on February 13, 2019. The workshop was attended by more than 50 faculty members from LaGuardia Community College.

Outcomes

Pilot # 1

In Fall 2017, the passing rates for courses using myopenmath were slightly lower, for fundamental algebra and college algebra, and slightly higher for the co-req Stem course when compared to non-OER courses (figure 7).

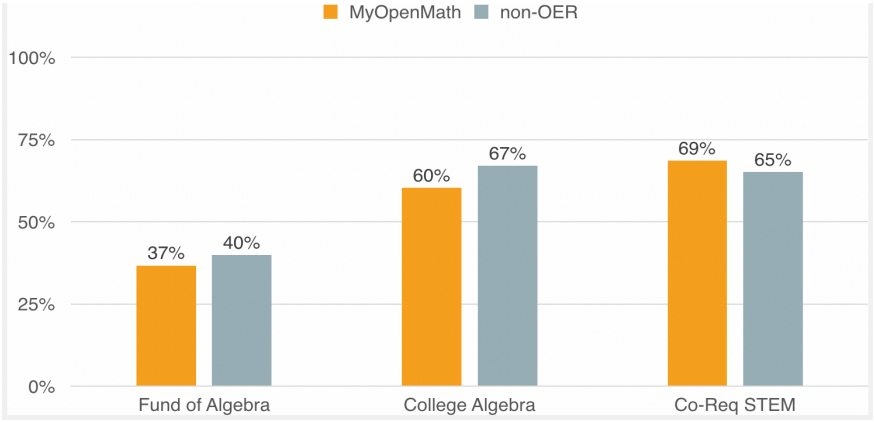

Figure 7.

Pass Rates Myopenmath (Fall 2017)

Pilot # 2

In Spring 2018 ,the pass rate outcomes of the OER sections for the four courses were comparable to the non-OER sections, except in the Co-requisite STEM course, where the OER sections performed much better (figure 8): in an incomplete analysis of the pass rates, the Fundamentals of Algebra course saw no difference in the pass rate (41%); College Algebra OER sections had 58% pass rate compared to 62% in the non-OER sections; the Co-Requisite STEM OER sections saw 55% pass rate compared to 28% in the non-OER sections, and the Elementary Statistics OER sections had 65% pass rate compared to 68% in the non-OER sections.

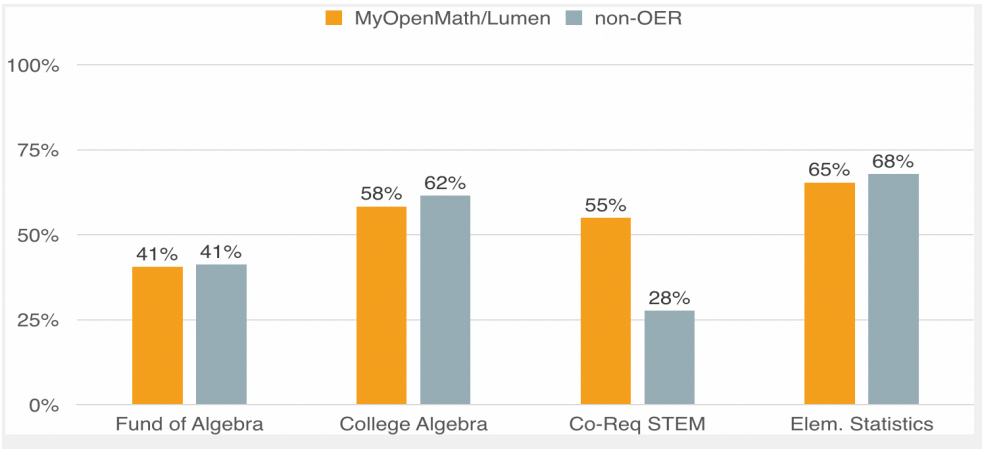

Figure 8.

Pass Rates Myopenmath / lumen (Spring 2018)

Full Scale (Fall 2018)

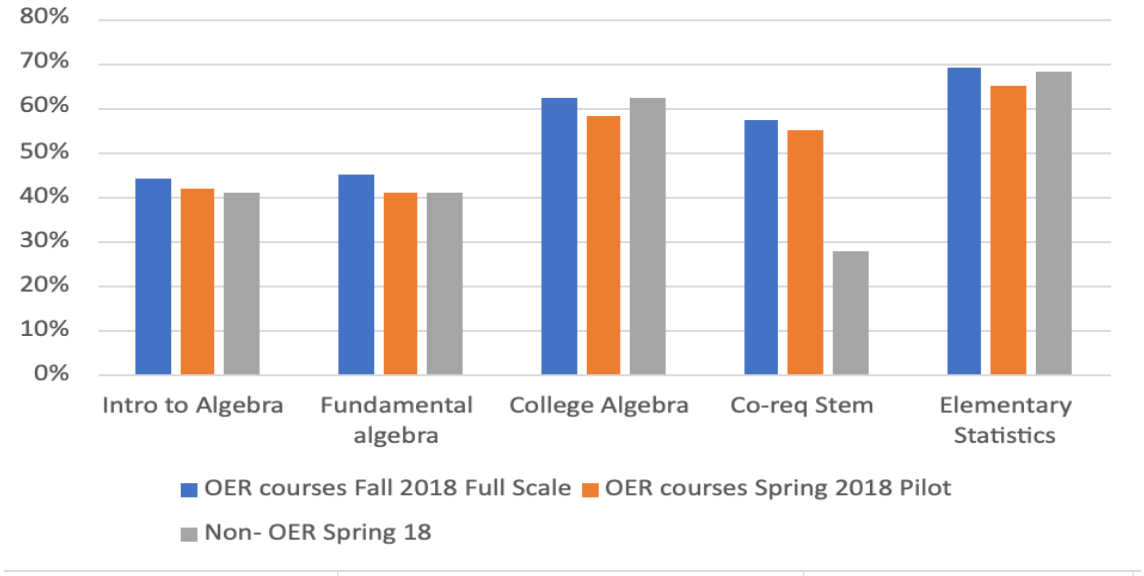

Figure 9.

Pass Rates Myopenmath / lumen (Fall 2018)

With a full-scale implementation of OER courses in Intro to Algebra, Fundamental Algebra, College Algebra, Co-req STEM and Elementary Algebra courses, we compared the pass rate of OER sections in Fall 2018 to Spring 2018 non-OER sections. As shown on figure 9, the pass rates for OER sections in Fall 2018 were either the same or better than the pass rates of non- OER courses in Spring 2018.Furthermore, the pass rates of Fall 2018 OER courses are higher than the pass rates of OER courses piloted in Spring 2018 (figure 9). The OER courses templates refinements and improvements in Fall 2018 might have had an impact on students' mathematics achievements.

Prior to the OER initiative, Aleks platform was used for Introduction to Algebra (MAT096), Fundamental Algebra (MAT099) and Co-req Stem course (MAT 117). The college algebra (MAT115) and elementary statistics courses (MAT120) used Educo and MyStatLab respectively. In Fall 2018, which is our full-scale OER phase, these courses including 164 sections saved our students a total of $382,609.50 (Table 1).

Table 1.

Textbook Cost Savings Summary (Fall 2018)

TEXTBOOK COST SAVINGS SUMMARY: FALL18

Courses	Previous Textbook / Platform Cost	Enrollment	Maximum Cost Savings
MAT096	Aleks: $88.00	13 Sections 364 students	$32,032.00
MAT099	Aleks: $91.75	29 Sections 725 students	$66,518.75
MAT115	Educo: $62.00	55 Sections 1540 students	$95,480.00
MAT117	Aleks: $91.75	13 Sections 325 students	$29,818.75
MAT120	MyStatLab: $105.00	54 Section 1512 students	$158,760.00
		Total Cost Savings	$382,609.50

From Fall 2017 to Fall 2018, 5560 students were enrolled in OER courses that included 208 sections. This led to a total of $477,182 total saving by LaGuardia students (Figure 9 and 10).

Figure 9.
Total Cost Saving from Fall 2017 to Fall 2018

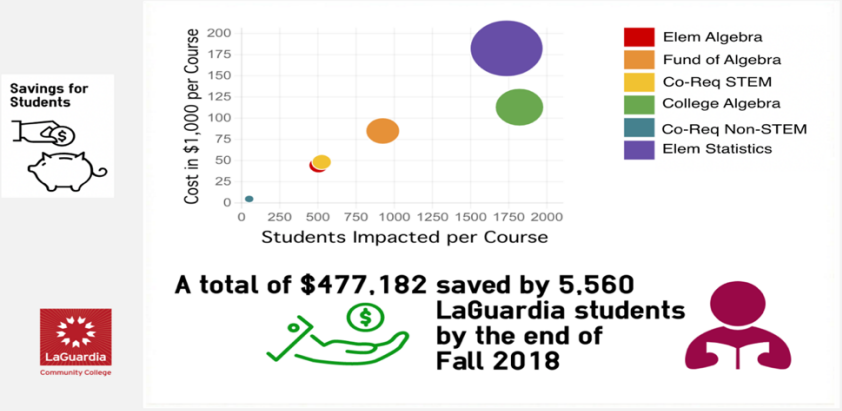

Figure 10.
Savings for Students (Fall 2017 to Fall 2018)

Full Scale timeline beyond Fall 2018

From Fall 2018, the pass rates in our fully implemented OER courses are either the same or slightly higher than the ones from previous semesters, before the OER courses adoption. Open educational resources had provided our students a way to receive high- quality learning materials at little or no cost to students. From Fall 2018 to Fall 2019, a total of 14191 students were enrolled in Intro to Algebra, Fundamental Algebra, College Algebra, Co-req STEM or Elementary Algebra OER courses. This saved students a total of $ 1,184,309.25 (Table 2).

Table 2.
Textbook Cost Savings Summary (Fall 2018 and beyond)

Semester	OER sections	Enrollment	Maximum cost Savings
FALL 2018	164	4466	$382,609.50
Winter 2019	43	1184	$97,614.50
Spring 2019	117	3200	$266,294.00
Summer 2019	42	1164	$100,389.25
Fall 2019	152	4177	$337,402.00
Total	**518**	**14191**	**$1,184,309.25**

Flexibility and Collegiality

The adoption of OER is more than just cost of textbook saving, it helps instructors pedagogy, knowing that all students have the class materials the first day of class (Watson et al., 2017). OER leaders worked with course coordinators to make sure all master templates are ready and uploaded into instructors accounts a week before class started. This allowed instructors to set their assignments due dates and made changes that tailored to their teaching style. We encouraged instructors to provide Lumen course identification and enrolment key for students to self-register before the first day of class. Prior to using OER materials, very few students came the first day of class with the class materials.

OER brings more freedom and flexibility in designing courses to make sure students have all the learning materials they need to succeed. Users can remove OER materials that are irrelevant to the course objectives as well as adding relevant contents from a different OER source (DeCarlo, 2019). When designing our course templates, course coordinators mixed multiple existed OER courses in Lumen to meet our course objectives. We embedded short videos lessons, most of them are from youtube, into the homeworks assignments. For our statistics course, few instructors volunteered to make short videos lessons for all lessons. These short videos were linked in chapter's readings and homework assignments. We added important instructor' memos as well as students' memos in all course templates. From our experience, making such changes were not possible using commercials platform.

Our OER initiative had fostered connections with colleagues within the department and around the colleges. The collaborations between faculty members became more frequent due to the OER mentorship that was put in place to facilitate the transition from commercials to OER materials. Based on the course, each faculty member was assigned to work with an OER mentor who was more familiar with the project and the platform used. In addition, faculty members teaching the same course met twice a semester to discuss about changes and recommendations on a particular course item. OER initiative brought the entire college together by having faculty members from different department working together to design new OER courses through OER seminars facilitated by the college center of teaching and learning. The first college OER seminar was launched in Spring 2020. Three OER leaders from three departments, including the MEC department, helped faculty members across the college in finding high-quality OER, selecting the right platform/LMS, understanding Copyright & licensing and doing the right assessment.

CUNY OER committee was founded in Fall of 2019 to allow faculty members across the City University of New York to gather each month and discuss the current and future stages of the OER initiative within the university.

Equity

As reported from a research paper, 80% of students in higher education don't have the textbook on the first day of class due to the cost (Jenkins et al., 2019). It may even be weeks before they buy the book or access code, if using learning platform. Some students even dropped the class just to avoid the costs (Jhangiani & Jhangiani, 2017; Moxley, 2013). These issues are the reasons why researchers encourage widespread use of OER and found it to solve social justice issues in education (Lambert, 2018; Hilton,2016; Jenkins et al,2020). OER provides all students same chances to access high quality education. Our OER courses were designed to make sure our students are trigger in learning valuable resources needed to succeed in mathematics with no cost. As a result, the report from our college's office of institutional research revealed that the retention rate from our fundamental algebra course went up from 66.7 percent in Fall 2017 to 77.6 percent in Fall 2018 when the course rolled out to full scale implementation. For the same course, the pass rate was also higher by 4 percent (figure 9).

Challenges

Course Refinement and Governance

The adoption of Open Educational resources textbooks and platforms is a change in the course curriculum. This required courses coordinators to update the course proposals, which must be approved by the college curriculum committee. This has been an issue for some courses that are still looking for better OER textbooks.

At the beginning, a handful of instructors believed that commercial textbooks were better simply because of the zero cost of OER materials. These instructors were reluctant to join the OER initiative and sometimes missed our trainings. OER leaders, led by the chairperson, patiently worked to have them experience the benefits of OER beyond cost savings.

In Fall 2019, the OER lab assignments were linked to specific websites. When the creator removed the contents from the server in which they were originally linked, this caused chaos because we needed to make up the lab assignments immediately. We consulted Lumen technical support for advice to avoid this happening again in the

future. Since the material had creative commons licenses, we could download the assignments from the websites instead of simply linking them.

In the beginning, it was a bit of a hassle adding new customs questions. Coding of new assignments was tedious and time consuming given that we had 2 faculty members who were experts in doing it. Some courses needed more time to finish the master templates because there were not enough OER materials available. We had to code 80% of the assignments to have the best course alignments with our curriculum.

Question Bank and Customization

Although MyOpenMath/Lumen have course templates and large question banks, a massive drawback is the OER team will need coding to customize departmental exams. It may not be easy for instructors who are used to customizing their own assignments using previous commercial platform.

Copyright Committee

Most resources we use are copyrighted. While "fair use" allows educators to use parts of copyrighted materials in the classroom, it can become complicated and confusing to know how much is okay. The copyright team was created to understand creative commons licenses and create a "best practice" for using and creating materials in our courses. This involves giving credit where credit is due, by citing sources. Initially, most of our courses did not provide citations for videos or texts used. The Copyright team went through the master sections and fixed these problems.

Communication

For the OER project to be a success, frequent communication with faculty is necessary. Email was one of the most used formats in our way of communication. However, communicating effectively by email is not as easy as "type and send." due to our large number of adjunct faculties who don't frequently check their emails. As a result, the MEC clerical staffs had to make individual phone call to every adjunct faculty member to communicate all OER related business.

Large Scale Faculty Development

Converting all our instructors to OER adoption may take a considerable amount of time for the transitional period. Training on the new OER system was required, along with the costs of instructors' stipend for attending the trainings.

Future Plan

Future for the OER project include continued faculty development and mentorship, expanded curricular offerings, continued copyright clearance and the emphasis on coding.

Continued Faculty Development and Mentorship

After the full-scale implementation of five major courses in Fall 2018, there has been frequent OER workshops for faculty teaching OER courses on changes in master course templates, new assessment player in Lumen and coding questions in Lumen. Faculty members can also seek help from OER course mentors whose role was to help creating assignments, setting due dates, gradebook setting and any other lumen related questions.

Expanded Curricular Offerings

Precalculus (MAT200)

In Spring 2019, an OER precalculus team was launched to develop OER materials using OHM Lumen. The pilot phase started since Fall 2019 and the team has been preparing for the full scale OER implementation of MAT 200 will start in Fall 2021.In the meantime, the OER precalculus team has been revising the Master course template each semester.

Calculus Series

In Fall 2020, the OER team started the first pilot phase of calculus 1 using myopenmath platform. The team created a master course including reading materials, video lessons, weekly homeworks/ quizzes, exams and reviews, and forum topics that foster critical thinking & active learning. The full-scale implementation of Calculus 1 will start in Fall 2021. The team plan to start the pilot phase of Calculus II and III in Fall 2021.

Continued Copyright Clearance

The Copyright team continue to oversee copyright compliance of new courses created in the platforms as well as updating current master course templates. They will continue to host workshops to educate faculty and students on copyright as well as answer questions about copyright.

Emphasis on coding

The goal of the OER team is to convert all mathematics courses into OER. Unfortunately, finding all the OER materials, including assignments, that suit our course curriculum can be a challenge. The OER team sees the need to train more faculty members to learn how to code customize questions. Our goal is to have at least one coder for each course by Fall 2022.

Creating our own server

Web servers are the mechanism for distributing Web-based content. Some of our contents were linked to specific website that can fail to download sometimes. In order to have the contents more accessible, we plan on creating our own to store OER materials use in our course templates. We will no longer dependent upon a server to see the content.

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