

**A RESOURCE FOR ACADEMIC SUCCESS:
AN OPEN EDUCATIONAL RESOURCE TO IMPROVE DEVELOPMENTAL
MATH COMPREHENSION**

by

Christopher M. Moody

An executive position paper submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Education in Educational Leadership

Spring 2015

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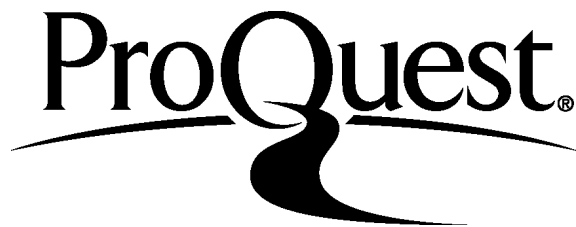
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by

Christopher M. Moody

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ABSTRACT

This study sought to justify the need of an Open Educational Resource (OER) at Delaware Technical Community College for students and members of the community. Specifically, I wanted to determine what mathematical content would be beneficial and what delivery methods would be most utilized. Students and teachers were given open-ended questionnaires. Questions regarding content, motivation to learn, and learning methods were explored in the questionnaires. Local manufacturers were also surveyed, answering questions regarding basic math skills needed for employment, math concepts that employees find challenging, and whether an OER would be beneficial to employees. I predicted there would be a need for a math OER, and it should be engaging. Results showed that the majority of participants would take advantage of such a resource and suggested basic math, geometry, fractions and measurement tutorials be included. The OER will include tutorial videos, games, and online support. My prediction was fulfilled as the majority of students said they would utilize an OER. In addition, interactive delivery methods were suggested, which was also supported by research.

Chapter 1

INTRODUCTION

The transition from high school to college or obtaining employment can often be difficult because of challenges with learning mathematics. Nationally, student success in developmental math is minimal and it is evident at many higher educational institutions. At Delaware Technical Community College, there is an open-admissions policy limited only by the following criteria: a student must be a high school graduate or the equivalent, or at least eighteen years of age and able to benefit from instruction. This open-admission policy provides a great opportunity to all potential students (DTCC Catalog, 2007). Delaware Tech is one of the cornerstones of educating students in Delaware. Those not obtaining a degree, may choose to complete a workforce development certification to better prepare themselves when entering the workforce. However, a majority of both degree and certification seeking individuals often need to take developmental math.

In 2009, the American Recovery and Reinvestment Act amended the Trade Act of 1974 to authorize the Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant Program. Then, on March 30, 2010, President Barack Obama signed the Health Care and Education Reconciliation Act, which included \$2 billion over four years to fund the TAACCCT program (USDOL, 2012). The objective

of this program was to provide community colleges with a grant funding opportunity to offer education and workforce training in a shorter timeframe than traditional programs. The maximum amount an institution could be awarded was five million dollars. There were several initiatives that Delaware Tech submitted and was awarded in their grant application. One of the initiatives was to create a mathematical Open Education Resource (OER) which could be used by everyone to improve math skills.

Math was a primary focus because of the continued demand for first year students enrolling in developmental math courses and growing concerns from the local employers. Over the years, Delaware Tech's developmental math program has been a lecture based curriculum. There are three available formats students can use to take developmental math. These formats consist of online, on-ground, and hybrid. More often than not, these formats have very similar success outcomes and neither one of them has been more successful than the other. These formats have kept students in a "one size fits all" box. Instructional Delivery, a report produced by Getting Past Go found that "a one size fits all approach to remedial instruction where students must enroll in one, two or more semesters of remedial instruction has not proven to be effective" (n.d.). In fact, "Research from the Community College Research Center (CCRC) has found that most students who require remedial education do not complete their remedial education sequence within one year. Many do not even enroll in a single remedial course" (Instructional Delivery, n.d.). Unfortunately, this trend is a pattern that is seen throughout many colleges. This research has, over the last couple of years, changed how developmental math is being taught and perceived.

One way to enhance and support developmental mathematics instruction methods would be to utilize an Open Educational Resource. The OER would need to meet the needs of its intended audience by improving the conceptual understanding. The implementation of the Common Core Standards in Mathematics, has resulted in more of an emphasis on students not only knowing the process and skills of solving a problem, but why these processes work. However, the OER would not be intended to enable every person that utilizes the OER to have a complete conceptual understanding of mathematics, but to provide basic instruction on the processes of solving equations. The OER would potentially benefit students by providing clear processes and skills when solving problems. A person who may benefit from this OER would be someone who needs a review, needs basic computation for a specific task at work, or is trying to become more fluent. In a conversation, Jansen shared “some people believe that the learners need a totally different approach - build in experiences to now deeply understand the mathematics, a different approach to the content, so that they understand why the procedures make sense” (A. Jansen, personal communication, March 29, 2015). The purpose of this study is to gather data to determine what mathematical content would be beneficial and what delivery methods would be most utilized. I intend to use the guiding questions below to guide the research of a mathematical OER at Delaware Tech.

- What math content for an OER would be most beneficial to potential users and why?

- What delivery methods/instructional strategies would be best when designing an OER utilizing Blackboard as the course management system?

Problem Statement

As a college administrator and past department chair of the Developmental Studies Department, I understand the importance and need of developmental coursework. English, math, and reading are the three courses that are required to enter any scholarly program and the workforce. The National Center of Developmental Education addresses the importance of developmental education stating,

The field of developmental education supports the academic and personal growth of under prepared college students through instruction, counseling, advising, and tutoring. The students of developmental education programs are traditional and nontraditional students who have been assessed as needing to develop their skills in order to be successful in college (NCDE, 2008).

Developmental education is needed to provide underprepared students with additional support to be successful in college. By a number of indicators, hundreds of thousands of high school students are graduating unprepared for the rigors of college. Spak (2011) conducted research which showed, “Nationally, in 2010, only 24 percent of ACT-tested high school graduates were deemed college ready in all four subjects tested — English, math, reading and science” (p. 1). These statistics are not surprising because there seems

to be a disconnect between the two major educational sectors. The nation's two main educational sectors are the K-12 and the higher education sector. Historically, these two sectors have been guided by policies pertinent to each sector which encourage each sector to operate in its own professional world, resulting in public policy that influences one sector and not the other; therefore, separate boards of education and legislative committees coordinate policies for one sector without input from the other (Kirst & Venezia, no date, p. 2). As a previous educator in the K-12 sector and currently being in the higher education sector, the disconnect is evident. When meetings occur between the local K-12 superintendents and Delaware Tech, it is evident that both sectors are striving to meet the specific goals they have been held accountable for. Since these goals are not aligned, therein lies the disconnect and one of the factors why students are not prepared for higher education or the workforce. According to Kirst and Venezia (no date), "The current fractured systems send students, their parents, and K-12 educators conflicting and vague messages about what students need to know and be able to do to enter and succeed in college" (p. 1). Tests for high school success often involve a different skill set than college entrance exams, and there is a disconnect between coursework standards from high school and college (Kirst & Venezia, no date, p.1). This disconnect seems to be evident across the United States because there was an initiative started several years ago called the P-20 Council. Many states adopted this initiative by establishing their own P-20 Council to assessing the educational system.

The P-20 Council shall make recommendations designed to ensure a more integrated, seamless education system that enables children to enter school

ready to learn, receive challenging instruction throughout their school careers, graduate from high school ready for college or work, and continue their education in a way that makes them productive and successful citizens (State of Delaware Code).

The P-20 Council has a difficult task to achieve. The mission of the Council is very clear, however, making strategic recommendations will be critical to their success.

When I advised students at Delaware Tech and a student took the placement test, he or she was usually surprised by the results. A majority of the students needed to take at least one developmental course (Delaware Tech Records). The students usually were upset about being required to take one developmental class, because more often than not, they said they just had a similar class in high school. According to Bailey and Cho (2010),

About 60 percent of incoming students are referred to at least one developmental course. Being required to take at least one developmental class is often surprising to them since the large majority of community college entrants are high school graduates. And for many, remediation is not just a course, but rather, for those referred to multiple levels, a whole curriculum (p. 1).

60% of students being required to take at least one developmental class is extremely high. However, this percentage is the national trend and this number has remained constant.

There are two areas of focus when educating high school students, college prep and workforce prep. Determining the path a student takes often leads to a question that I

have heard asked many times. Is “John” taking the college prep track or does he plan to graduate high school and start working? The previous question regarding whether someone will further their education or get a job after receiving their high school diploma, associate or bachelor’s degree, is completely irrelevant when preparing students for their future endeavors. There are nationally recognized tests evaluating basic math skills that are similar to the college placement tests. Studies show that the ACT placement test, used when entering college, is identical to WorkKeys, which is a job skills assessment system that measures real world skills.

Because WorkKeys and the ACT® test are measures of workforce and college readiness, respectively, we based our analysis on WorkKeys and ACT scores from a statewide sample of high school eleventh-grade students over a four-year period. We conducted a statistical concordance between the respective college and workforce training readiness levels in reading and mathematics from both programs. The concordance between the ACT College Readiness Benchmarks and WorkKeys Level 5 shows that the levels of readiness in reading and mathematics are comparable. Therefore, it is reasonable to conclude that the expectations of students who choose to enter workforce training programs for jobs that are likely to offer both a wage sufficient to support a small family and potential career advancement should be no different from the expectations of students who choose to enter college after high school graduation (ACT, 2006, p. 3).

Students graduating high school and entering college are not the only individuals that are underprepared. There are many occasions when someone prefers not to enroll in a degree awarding program, so a non-credit course is preferred.

There is a general consensus by local business owners that many of their job applicants do not have the basic math, reading, and English skills required for employment. The Departments of Labor, both nationally and on the state level, have recognized this concern and have been proactive in trying to support local businesses. The State Division of Employment Training has continued to support individuals in basic education to help them find employment and also to stay employed once hired. Employment Training also provides funding to businesses for both incumbent workers and potential employees.

In addition, Delaware Tech is committed to training and educating the state and local workforce and to being a solution for workforce training needs (Delaware Tech Mission Goals). For example, the Department of Labor reported that sustainable landscaping is an emerging trend and has potential for increased employment. Since there are few training programs locally that focus on sustainable landscaping, Delaware Tech has created a new Sustainable Landscaping Program. This training program is short-term and provides students with basic knowledge in sustainable design. This program is endorsed by many of the local landscaping companies, and they will hopefully hire the completers. One of the barriers students are having is their limited math skills. Students who test low on a placement test when registering for the sustainable landscape program, are required to take developmental math. Whether students are enrolled in a

credit or non-credit program, having a proficient math skillset is required. When I was an advisor of students taking developmental classes, they would need an entire year to finish all of the requirements. Often, developmental classes would result in a delayed start in their technology track. Students became frustrated because completing the degree would take an extra year and increased expenses.

In Workforce Development and Community Education we offer workforce training programs (Workforce Development Brochure). Receiving requests to train incumbent workers to increase their math competency is common. The requests often require basic measurement, addition, subtraction, multiplication, division, and using percentages. Current workers do not typically register for a basic non-credit math class to improve their skill level, so employers must hire instructors to train a group of employees at the same time. These types of requests and ongoing comments about job applicants and incumbent workers' skill level is a growing concern.

Although technology is often thought to help people with their job/career endeavors, there is still the need for basic math, reading and English skills to engage in most technology use. The advancement of technology continues to change the role employees have in the workforce. Computers serve several purposes in the workforce. Workers performing routine operations can be replaced by a computer whereas workers who perform problem solving tasks, seen as non-routine, can use a computer to complement their work (Partnership for 21st Century Skills, 2008). For example, at a local manufacturer, they use a computer to complete a simply assembly process, but the worker needs to continually check measurements and quantity. Math skills are critical to

the success of the requirements of this job. According the figure below, postsecondary education is becoming more common.

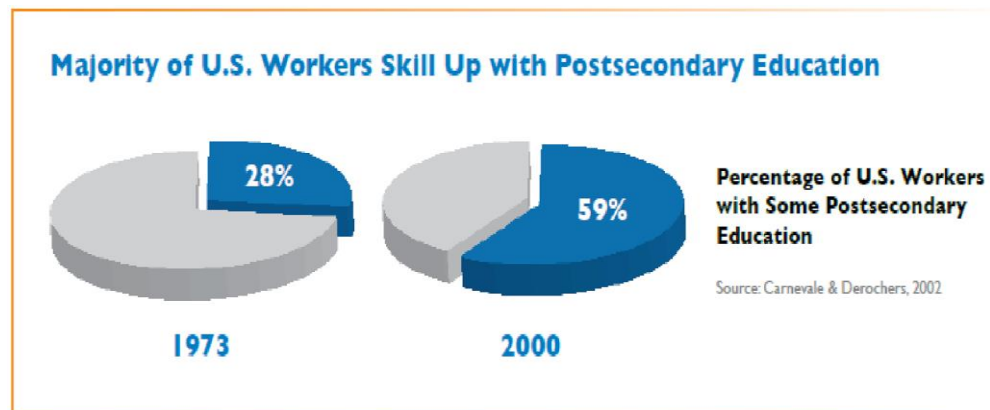


Figure 1 Percentage of U.S. Workers with Some Postsecondary Education (Partnership for 21st Century Skills, p 6, 2008)

According to Adams (2013), the ACT composite score dropped to 20.9 among high school students in 2013, the lowest in eight years. A report released by the Iowa City, Iowa-based organization found just 39 percent of test-takers in the class of 2013 met three or more of the ACT college-readiness benchmarks in English, reading, science, and math. Nearly one-third did not meet any (Adams, 2013). These reports are becoming more common across the United States and are not specific to one geographical area. Nearly 1.7 million high school graduates took the ACT college entrance exam in 2012, testing their knowledge of four core subjects: English, math, science, and reading. But most of those students are not prepped for success in college or the workforce, according to a report released by ACT, Inc. (Sheehy, 2012). Since 60% to

75% of students entering college need to take at least one developmental, the data from ACT supports this trend. Unfortunately, the trend has either remained unchanged or risen slightly in recent years.

The National Center on Education and the Economy (NCEE) published an executive summary on student preparedness and their focus was on community colleges since nearly half of students entering higher education attend community colleges. It is evident that academic preparedness is directly correlated to one's job and the financial stability someone will have. Norman Augustine, retired chairman and CEO of Lockheed Martin Corporation said,

With all the attention being devoted to America's educational system underperformance in K-12, obsolescent financial models in our state universities – we have overlooked one of the system's most important elements: our community colleges. These institutions enroll nearly half of our college students, teach much needed skills in the trades, and prepare students for four-year degrees (NCEE, 2013).

The trend for community colleges continues to have increased enrollments. However, regardless if a student chooses a two or four year school, there is a good possibility the student will need a developmental course.

Much of the research cited above, as well as countless other researchers, have sought to solve the dilemma of better preparing students and job applicants for successful job placement. Success in the job market is an ongoing concern among community members. A solution to better prepare students, as well as those seeking employment

would be advantageous. At Delaware Tech, we have actively assessed how we can make the necessary changes to support our mission of providing students and community members with an education and to prepare them for the workforce. As reported by Noy, et al. (2008), “Noncredit workforce education can play an important role in responding to local labor market demands by addressing employers’ workforce needs and students’ needs for immediate skills” (p. 5). This statement is accurate because Delaware Tech receives many requests statewide to train and educate Delaware’s workforce.

The lack of basic math skills is apparent in today’s society. The National Center for Public Policy and Higher Education states, “in two-year colleges, eligibility for enrollment typically requires only a high school diploma or equivalency. About one-quarter of incoming students to these institutions are fully prepared for college-level studies. The remaining 75% need remedial work in English, mathematics, or both” (2010). It seems that any path an individual decides to follow will require some basic math skills. Whether it is balancing a checkbook, reading informational content, or filling out an application, these skills are needed. Once one finishes high school, what opportunities are available to learn these basic skills? The obvious choice is higher education. However, not everyone can afford higher education, has the skill set to be accepted, or can devote the time to be successful. There are self-help books that focus on many of the basic skill areas. Self-help books can be difficult because of the reading required and the costs. If an accredited higher education institution offered free online resources that focused on the basic skills, opportunities would be instantly available to all, regardless of demographics.

Purpose of Study

Three years ago I envisioned creating a math OER that would replicate the same concepts taught in our Basic Math course. I had a few meetings with the math department chair and some of the instructors to determine what resources should be made available. This information was shared with one of our instructional designers and the development of the OER began. During this time, I was the Assistant Dean of Instruction. Shortly thereafter, I transitioned to the position of Director of Workforce Development, so I was no longer involved with this initiative. As the Workforce Development Director, I realized there were more people who needed a math resource than just our Delaware Tech math students. We needed to offer an OER that not only met the needs of the students enrolled at Delaware Tech, but high school students and the workforce.

The purpose of this study is to inform the need for Delaware Tech's Open Education Resource (OER) based on the research compiled during the literature review and data collection. The data collected from the surveys and interviews will guide the content in the OER to best assist anyone who is trying to increase their mathematical knowledge. Once the OER is revised, the expectation will be that the OER will be a utilized resource, which will be free and provide educational content to improve self-advancement.

Around the world, there has been an educational trend to offer courses and content for free to community members. Brown (2008) argues, "The most visible impact of the Internet on education to date has been the Open Educational Resources (OER) movement, which has provided free access to a wide range of courses and other

educational materials to anyone who wants to use them” (p. 18). With this trend continuing to gain support from higher education institutions and the need to better prepare students and potential job applicants for their studies, I realize the importance of this initiative. The open educational resources movement is growing in the higher education environment. According to Opensource.com (2013), nearly every week, if not every day, there are more open educational resources available to us. The availability of high speed Internet and instant access to information has dramatically changed education. The four walls where learning has traditionally taken place have been removed. Interactions among teacher and learner and learner with their peers are now enhanced by educational content (e.g. textbooks, course notes, assignments) and learning resources (e.g. whiteboards, laboratory equipment, virtual learning environments) (Lane, 2009, p. 9). Advancements in technology have enabled us to take the structure of formal education and create a new learning opportunity. With all of the information available on the Internet, it only makes sense to provide accurate and credible content to community members. Caswell, et al. (2008) contends, “New distance education technologies, such as OpenCourseWares, act as enablers to achieving the universal right to education. These technologies and the associated changes in the cost of providing access to education, change distance education's role from one of classroom alternative to one of social transformer” (p. 2). The trend of free access to education is continuing to increase and is supported by many colleges.

People are more often than not, willing to learn something new on their own. Self-learners are people that may benefit from an OER because it is often a self-learning

process. Figure 2, below, is a graph of data supporting the research that a large majority of people are self-learners. The graph comes from an MIT research project conducted in 2008 (MIT). As you will see, 49% of those polled were self-learners. A self-learner is different from a student because they are not learning from an instructor or in a classroom environment.

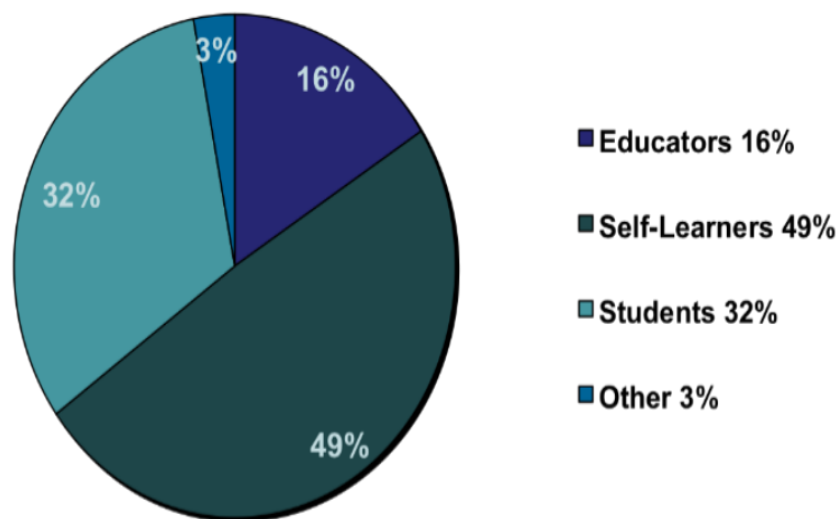


Figure 2 Percentage of Self Learners (MIT, 2008)

A lifelong learner may be presented with learning opportunities every day. These opportunities could consist of learning a new route to work or learning about something new on the Internet. However, when an individual wants to learn more or continue their academic growth, opportunities can sometimes be limited.

More often than not, there are many obstacles for people to overcome in life. One of these obstacles is lack of educational skills needed to be a successful member in society. While younger cohorts in other countries are consistently better educated than older ones, in the United States that is not always the case: 30-year-olds in 2012 scored lower, on average, in literacy tests than 30-year-olds in 1994 (Porter, 2013). Another barrier for learners is the financial cost of higher education. According to the College Board, during the 2009-10 school year, the average full-time tuition at community colleges was \$2,544, which is significant relative to the resources of a low-income family (Long, 2010). An OER is a free resource, so there would be no financial hardships.

However, there is an increase in opportunities for people to acquire these skills after high school. The technological advancements in educational technology and free resources are giving people a chance to learn these skills that were not acquired in school. An open educational resource with a focus on basic skills would be beneficial to the community. A resource that does not cost money and can be accessed from any device that is Internet-capable would change lives.

Being a self-learner takes a lot of motivation and discipline. However, with limited academic education content, the learning process can be frustrating for some. While no single idea can solve all of the world's problems, creating this online resource will aid in increasing options so that people can help themselves (Johnstone, S. 2005 p. 18). Offering a free online resource for all will instantly provide many with a catalyst for academic improvement.

In 2011, a coalition of colleges developed a partnership to develop and implement a project called the Bridge to Success (B2S). The B2S program has created open educational courses to assist students in assessing how they learn and in developing strategies of how to learn. The program also presents mathematics with real-world applications to strengthen students' math skills and understanding of math. The goal is to close students' developmental gaps so that they can move into college-level courses and complete a certificate or degree (Lascu, 2011). Over the last several years, the development of technology has provided many people with online learning opportunities that are very similar to the traditional classroom. With these advancements, many students are now choosing to learn online and they are taking advantage of the free open educational resources. During Open Education Week 2014, they shared that open education is thriving. According to Mary Lou Forward (2014), Executive Director for the OpenCourseWare Consortium, "Open education has opened amazing new learning opportunities for learners of all ages around the world. We are constantly gratified by the variety of impacts these resources are having on people's lives."

In response to DOL's priority for online access to workforce training and to improve student access to our programs, we will develop an open educational resource portal for developmental courses. Delaware Tech's online offerings and technology resources placed the college on the Center for Digital Education's Top Ten Digital Community Colleges list in 2009. We will build on this success to create a new open educational resource portal to include materials for math, reading, and English. The ability to review materials prior to enrollment will help

students and advisors select courses appropriate for the student's level and career goals, and the ability to access material online during and after courses may improve student outcomes in the target courses and subsequent courses (CCCTP, 2011, p. 1).

Offering a free math resource to the members in society that may be under a hardship, would be a tremendous opportunity for someone to upskill their academic level.

A federal grant that involves the Departments of Labor and Education (DOL) has granted the Owens Campus a major educational opportunity. The Community College and Career Training Program (CCCTP) grant will disperse \$500 million dollars to community colleges and other entities. Delaware Tech has received funding to support an open educational resource. An OER is a content specific resource all should be able to access. Everyone learns at a different pace, has different levels of technological skills, availability to technology varies, and may have financial barriers. Lane (2010) states, “nevertheless there appears to be a paradox in that learning design assumes a reasonably well-known and well-defined student audience with presumed learning needs and mediating technologies while OER are exposed to a multitude of potential learners, both formal and informal, with unknown learning needs and using diverse technologies” (p. 1). Providing a resource to someone that can only access it specific times of the day or needs to review a process over and over, may provide ample opportunity to someone.

OER Design

The design of an open education resource portal has no boundaries except it should represent the college's standards and be beneficial to the community. There are several institutions that have created free educational portals, and most are unique to their institution. Delaware Tech's vision for a math OER is that it must be free and content-based. The portal should be designed for an independent learner to navigate his or her way through the course and be able to learn the provided content. Like most other institutions, there will be no type of credit or certification associated with these courses. There is the hope that the OER would be beneficial to DTCC students, but it would be accessible to the general public, anyone who has internet access, not just students.

This design is similar to MIT's OpenCourseWare, which is considered to be the leader in this world-wide trend. MIT was the first to offer free courses in this format. This format was MIT's vision in 2001 when they announced their plan to create their OER. As reported by Goldberg (2001), "MIT plans on Wednesday to announce a 10-year initiative, apparently the biggest of its kind, that intends to create public Web sites for almost all of its 2,000 courses and to post materials like lecture notes, problem sets, syllabuses, exams, simulations, even video lectures. Professors' participation will be voluntary, but the university is committing itself to post sites for all its courses, at a cost of up to \$100 million." MIT has been successful, and they now have over 2,000 courses. The continued addition of courses demonstrates the need for these courses.

Accredited educational institutions are not the only organizations to be part of the open education resource movement. The Saylor Foundation (www.saylor.org) is a non-

profit organization founded in 1999 by Michael Saylor. The mission of the Saylor Foundation is to promote and offer free education to everyone. They have nearly 300 courses that focus on basic academics to professionalism in the workplace. Saylor believes that technology has eliminated many of the barriers in education, so they continue to implement new technology. By using technology as a means to deliver content, the need for people to visit physical buildings to learn is not necessary at times. By creating open courses and allowing anyone to take a free course or create a free course, Saylor's goal of eliminating the cost to be educated is becoming a reality.

Since most projects evolve over time, there have been a few refinements to the OER initiative. One of the changes is in the way an OER is referenced. Originally referred to as "OpenCourseWare," a more common name now is "Open Educational Resource," which is what I have followed. MIT is making a few changes to their OCW by adding "Scholar" to the name. The OCW Scholar courses are defined by the no-cost content-based resources, which offer no certification or communication with MIT faculty or students, but use materials drawn from a number of MIT courses; additional resources created especially for OCW Scholar publication are incorporated into the courses ("MIT OpenCourseWare," 2011).

The structure of the OER will have the following categories:

1. Overview

The overview will provide the user with an overview of the structure of the OER and what contents are available. The overview will provide enough information

to the user, so an informed decision can be made as whether to utilize the OER or not.

2. Self-assessment

A self-assessment will be available, so the user can self-assess what content areas are low and subsequently focus on related content. For the OER to be effective and meaningful, the assessment will need to be taken, so the user will not be completing content modules that efficiency has already been achieved.

3. Content by module

Content modules will create a simple structure to the OER, so the user can easily navigate the content modules that will be most beneficial. Modules will also provide opportunity to master each module by content before proceeding to more advanced modules.

4. Guided resources (media, PowerPoint (s)s, sample problems) related to the subject content

The guided resources will be very interactive, informative, and provide current problems, so the users will have the opportunity to choose what resource is best. These resources will provide the user with the multiple learning strategies to be successful.

5. Post self-assessment

Once the user has completed the content modules and feels mastery has been achieved, the post self-assessment will be available to confirm mastery.

6. External links

The external links will be a variety of additional resources available, so the user will have the opportunity to utilize additional resources if needed.

Chapter 2

METHODS AND PROCEDURES

Qualitative measures were used to answer the guiding questions in this study. Open-ended questionnaires were given to students and faculty. Local employers were interviewed over the phone. Scholarly data about existing OERs were collected and reviewed. All information gathered was used to justify the need and decide what content would be most beneficial for Delaware Technical Community College's OER.

Participants

The participants in this study were students, instructors, and employers. The students surveyed were Delaware Tech students who were enrolled in Basic and Pre-Tech Mathematics courses. These two courses are taken by students who take the Accuplacer test and score below the required score for a credit level course. The courses are zero credit but prepare students for the credit level math courses. Once a student successfully completes the basic levels, he or she then registers for the math course required by a specific technology. The basic level math courses are an academic level between sixth and twelfth grade math competencies. Anecdotal data suggest that these students are often frustrated that they need to take the basic level courses, and there is a concern among the faculty that these students do not appear to be as motivated as students taking courses for credit. With the requirement of these basic level courses, we need to make every effort to give students opportunities which ensure their success.

The instructors surveyed were from Delaware Tech and local school districts. These instructors are very familiar with the course content since they either teach the basic level courses at Delaware Tech or similar courses at the high school level. They have extensive knowledge in teaching and developing the competencies with this level of content, so they are considered experts in this field of study.

The employers who completed the survey are from a variety of manufacturing companies in Sussex County. The College is often contacted by manufacturers to request training. More often than not, the request pertains to the need to increase their staff's basic math skills. The knowledge of basic math is critical to many of the employees' daily job responsibilities, and a higher level of math is required in order to advance into a different role. When mistakes are made because of a computation or measurement error, it can be very costly and may delay the manufacturing line's daily output. Having their line workers take math "refresher" courses to keep their academic levels high is critical to ensure the success of the company.

Table 1 Questionnaire Percentage Completion

Questionnaire Response Rate	
Student Questionnaires	64%
Faculty Questionnaires	50%
Employers Interviewed	71%

Questionnaires

The guiding questions used to develop this EPP helped to determine the questions that were asked in the questionnaires (see Appendix A). Specifically, question two, “What delivery methods/instructional strategies would be best when designing an OER utilizing Blackboard as the course management system”, was used to develop questions for both student and teacher questionnaires. Question one, “what math content for an OER would be most beneficial to potential users and why”, was used to steer the interview questions for the manufacturing employers.

The student questionnaires were printed on paper and distributed to developmental math instructors at DTCC Owens campus (see Appendix B). Student questionnaires were handed out between week two and week six of the spring semester. Two hundred four questionnaires were distributed and 131 were collected. Students were given time during class to complete the survey. Privacy was ensured by asking the students to put their completed questionnaire in a folder and at the front of the classroom.

The instructor questionnaires for the Delaware Tech faculty and local school district teachers were also printed on paper and distributed (see Appendix C). They were asked to complete the anonymous questionnaire and return to their department chair; the surveys were placed in a folder. The questionnaires for the teachers in the local school districts were created in Survey Monkey (www.surveymonkey.com), so they could be distributed more easily. I contacted the superintendents of each school that I designated to participate and asked their permissions to distribute the survey. Once I received all approvals, I emailed a district contact and asked him or her to email the survey link, or I

emailed the link directly to the teachers. I believe asking a representative from the district to email the survey link to the teachers directly resulted in a higher response rate. A majority of the teachers I contacted directly were intrigued by this design and asked to be informed when completed so they could utilize the OER.

There were many contributing factors to the design of the questionnaires for all three groups. When developing the student questionnaire, I first analyzed several math assessments that all Pre-Tech MAT 012 students must take. I reviewed for any common trends where errors were made consistently. Once I found some common trends, I researched best practices for those specific mathematical topics. I also wrote down my personal experiences from having taught math classes for over ten years. Once I had a premise of areas in which students seemed to have the most common problems, I researched the available resources. These resources included instructional online videos, PowerPoint(s), narrative explanations, and recorded lectures. Once I reviewed the available resources, I created questions that aligned with these resources to see if they were relevant to my intended audience.

The instructor questionnaire was aligned with the student questionnaire to ensure consistency in what was being taught, what were identified as student weaknesses, and what resources would be beneficial to students. I talked with a few math instructors prior to developing the questionnaire to see if there was a common trend that would be beneficial to have in the OER. By asking these questions, I was able to provide the best supplemental resource available to students based on the experts in the classroom.

Whenever a questionnaire was administered to the students or faculty, they were told that their responses would be confidential. This statement was also written on the questionnaire in the instructions. Some of the faculty thought the confidentiality expectation was important because they did not want their opinions be perceived as negativity. I found it interesting that when I discussed the confidentiality aspect of the questionnaire to the manufacturers, they did not seem to care and thought most manufacturers agreed that math skills were low for everyone.

The data gathered from the questionnaires was compiled into one document by recording all answers given to every single question. If an answer was given by more than one participant, tally marks were recorded. The most common answers are shared in the results section, while all possible answers are shared in Appendix E.

Interviews

Manufacturing employers were contacted via the telephone or in person to discuss what weaknesses are commonly evident. The questions for the manufacturer interviews were created from informal discussions, and plant tours with plant supervisors (See Appendix D). All manufacturers were asked the same questions and answers were compiled in one document by recording all answers given to every question, which can be found in Appendix E. Based on these informal discussions, more often than not, there was a common concern among the supervisors that many of their entry level workers did not have a strong knowledge of basic mathematics. In many cases basic math is critical because whenever there is a mathematical error on a manufacturing line, the product has

to be recycled because it does not pass quality control. Another focus of the survey was job advancement. Everyone with whom I spoke during these informal discussions said that a higher level of math was required in order for someone to advance in the company. A higher level of math was very important because he or she would prefer to promote from within and allow their workers to grow with the company. Many of the companies said their workers lack the financial capacity or time to enroll in educational classes. However, if there was a free resource available that they could access when it was convenient for them, the companies thought it would be utilized often.

Chapter 3

RESULTS

Student Survey Results

The focus of the student survey was to determine what type of learner they were and to see what type of content would be most beneficial to them. Responses to all open-ended survey questions have been compiled into one document (see Appendix E). All answers to each question were documented word for word as written by the student. When more than one student gave the same answer, these answers were considered notable findings. Many notable and important findings are reported here. Below you will find a bar graph detailing the challenging math concepts for students. While there are many challenging concepts, there were several trends, including fractions, geometry, and algebra. The other category included answers such as remembering formulas, working with extremely large numbers (trying to simplify them), plotting numbers on a number line, order of operations, rounding, PEMDAS, and statistics.

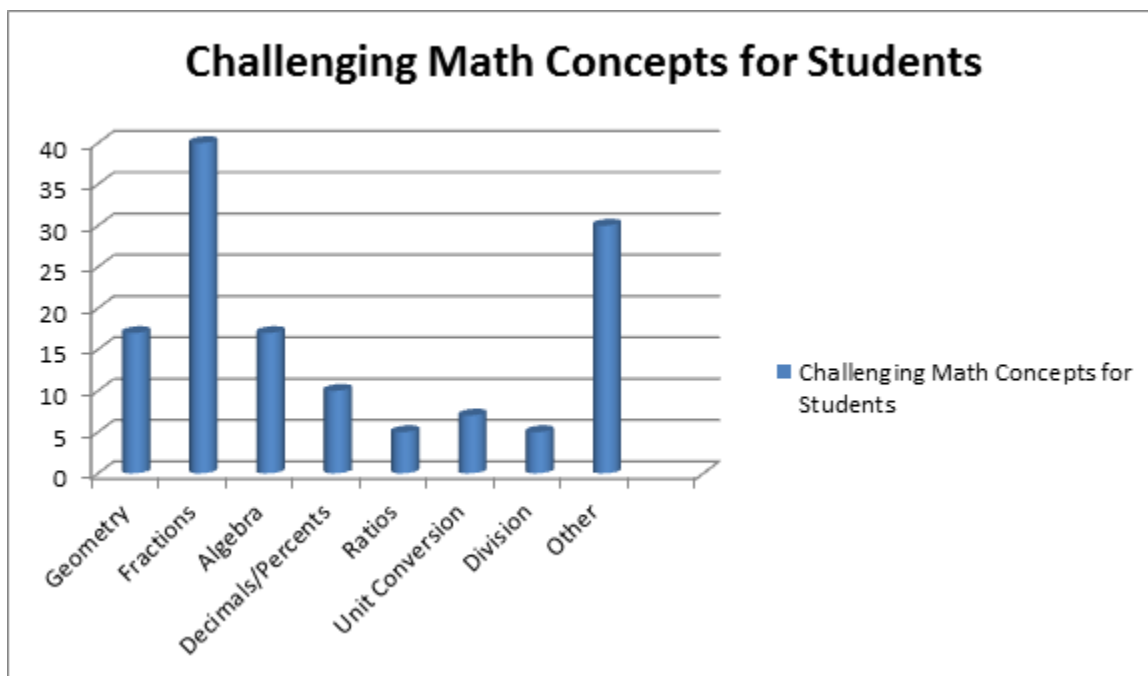


Figure 3 Challenging Math Concepts for Students

A majority of the responses (92) feel that real life examples are more engaging when trying to understand math concepts, which aligns with the feeling that many of them consider themselves to be visual learners. One student wrote, “It makes it easier for me to understand it if I see it.” Another states, “If someone is reading to me, I tend not to focus. If someone is showing me, I can figure it out.” One hundred two (102) students reported that they were visual learners; eight reported they were auditory learners; and 17 reported they learned both visually and aurally. One student wrote, “Real life examples are helpful to me because it’s like going into the store and adding everything up or going out to eat and trying to figure out how much of an tip to leave.” Another student wrote, “Knowing that what you learn in school will be used in the outside world makes you more eager to learn.” Other real life examples that students find to be helpful in learning

math include shopping (taxes and sales) to understand percentages; building things (to understand height, width, and area; and cooking or baking.

Students were questioned about whether they would utilize an OER if one was available to them. While 25 students reported they would not or were not sure if they would use one, 80 students said they would utilize such a resource. Below are the resources that students would like to see in an OER. Several students stated that a “ask the tutor option with a live chat” would be invaluable. It may seem odd that fractions and algebra, which are content areas, are in the same chart as resources, but the students interpreted the question in such a way that they gave both resources and content areas. The other category includes these resources: help with understanding complex problems, basic business, decimals, multiplication, basics, order of operations, percents and ratios, division, clinical math, walk through reviews/step by step, quizzes, practice (if you get the answer wrong, an explanation pops up), and translation with visual.

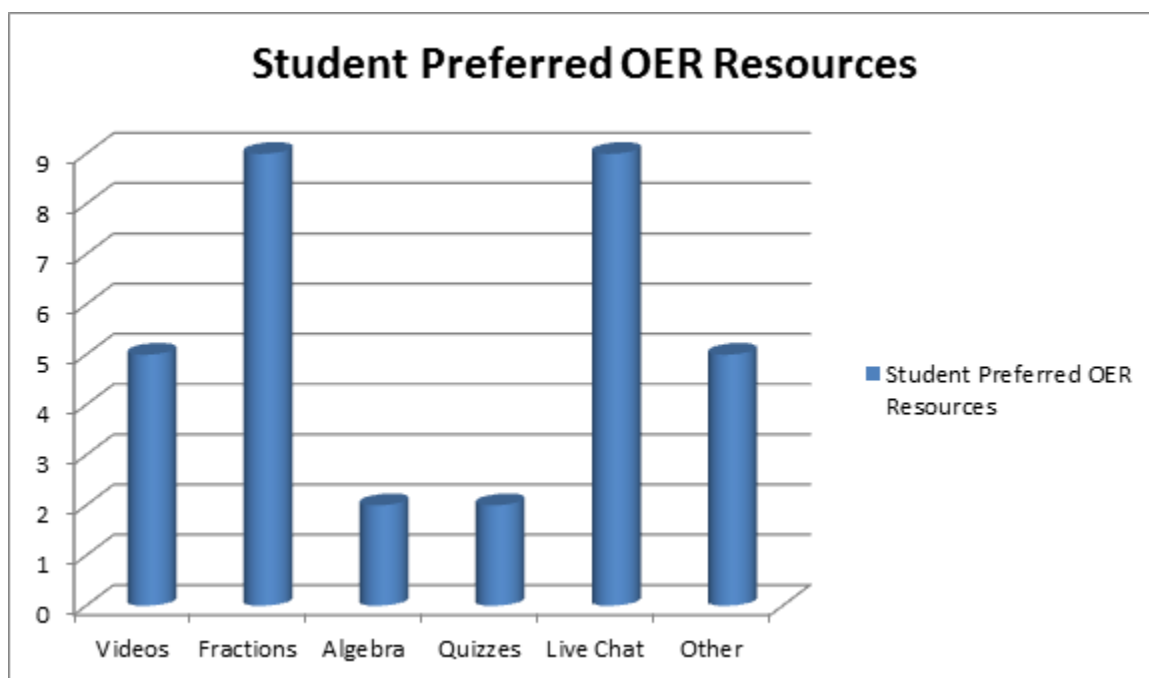


Figure 4 Student Preferred OER Resources

The majority of students (81) reported that they were self-motivated learners, while 22 students did not consider themselves self-motivated, and eight students considered themselves sometimes self-motivated. One student shared, “I am self-motivated by my sons, who motivate me to go back to school and better myself in the work force. My job motivates me to have better math skills.” Other students reported being motivated to give themselves a better life, earning money, understanding the value of education, and reaching educational goals. The other category included answers such as “failing”, “explainable math equations”, “passing quizzes”, “math is fun”, “nothing”, “my dad”, “the right teacher”, and “listening to music.”

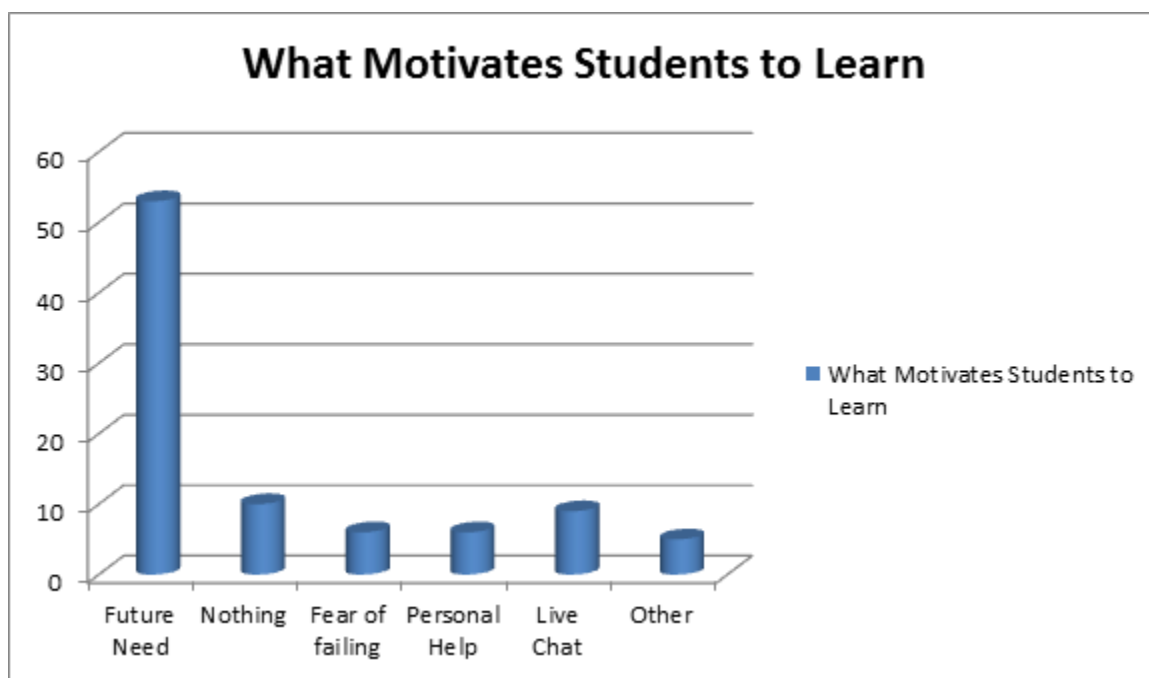


Figure 5 What Motivates Students to Learn

Students were asked about whether games help them to be more engaged when learning math. Sixty students reported that games help them to be more engaged, while 47 students said games do not help them to engage in math lessons, and 16 said they might be more engaged with a game. Students stated things like “games are always fun” and “who doesn’t like games?” Some games that were suggested as more engaging by students included a Jeopardy game, Minecraft, math bingo, and online math games.

Eighty one students reported that understanding how and why a particular math concept was needed prior to the lesson would support their learning of mathematics. One student reported, “Math is a subject that many people struggle with but it is something we use every day and need it.” Twenty five students said understanding the importance of

math concepts would not support their learning of mathematics. Several students reported that they already understand why concepts are being taught.

What's most notable is that the majority of students feel they are self-motivated, visual learners and would take advantage of an OER if one were available to them. Three main topics which should be included in the OER are fractions, geometry, and algebra. The OER should be engaging for students to best learn math concepts.

Faculty Survey Results

Faculty had similar responses to the students and manufacturers in regards to what topics seemed to create the most concern. Basic computations, number sense, and not enough repetition was commonly stated by all 10 instructors. However, when asked if the faculty used supplemental resources other than traditional lecture, only one instructor stated that web-based resources were utilized as supplemental material. Based on the results from the student survey that there is a need for supplemental support and it seems to be limited. When asked what additional resources would be beneficial, three instructors stated guided practice, group work, and making sure students were more engaged. Seven of the instructors did not answer this question. The additional resources stated by the three instructors supported the student data since the students often stated they needed one-on-one help, and they wanted to be more engaged in the learning process. One instructor thought, "hands-on materials are helpful to students learning math because they help the students see mathematical relationships and get students involved". When asked specifically about using videos to supplement instruction, four of

the instructors agreed that videos would be beneficial. One instructor believes that videos are beneficial “For self-motivated students, yes... for struggling students, there needs to be immediate feedback and interaction.” Another instructor stated that “tutorial videos could be effective if they are dynamic and show relationships to everyday life.” However, it was noted that the videos would need to be very specific to the problems and not a recorded lecture of a daily lesson. This question only had four responses, so they were all in agreement.

When asked about why they think students nationally test below a twelfth grade level when applying to college, there were five responses. One instructor shared, “Students don’t seem motivated to learn math. They need to be more engaged”. The instructors stated other reasons were the students do not have number awareness, students are assessed differently in high school than in college, and they do not know basic computations because they are not motivated.

When people discuss the topic of OERs, I often hear responses that they are not familiar with OERs or they are not sure how they can benefit students. The benefits of an OER were evident when I asked the instructors what they know about OERs. Out of the 10 surveys returned, only two said an OER is a free educational resource. Two of the responses said they were not sure what an OER was, and six did not answer.

Teachers agree that students need additional, engaging resources and videos seem to be an ideal resource. Though many teachers were not sure what an OER was, the majority feel that students need some supplemental resources. One interesting result was

the reporting that several teachers felt students were not self-motivated, while the majority of students felt they were self-motivated learners.

Manufacturing Survey Results

Through informal conversations with local manufacturers, all of them have stated that the level of academic proficiency of prospective employees, specifically math, was not high enough. Academic proficiency continues to be a barrier when hiring or promoting manufacturing employees. In an effort to gather more information, I surveyed seven local manufacturers. Of the five responses, all participating manufacturers stated that basic math is a hiring requirement.

Since almost all job responsibilities require some math, employees need a way to provide academic support. One method to increase the employee's mathematical proficiency is to hire someone to come in and teach a class. However, hiring someone is time consuming and may cause a disruption in production since they have to take employees off the lines. After reviewing the data received from the surveys, a majority of the manufacturers identified basic math, interpreting data from a chart, and fractions as a need in their occupation.

One solution to providing academic support would be to grant their employees access to an open education resource. The employees could access the online resource at their convenience and for those who do not have the capability to do so, computers are available to them at work. One of the survey questions explained what an OER is and asked if an OER would be beneficial to their employees. One individual said, "Definitely;

online tutorial program that could be utilized when shortcomings are identified as discussed.” Of the five responses, all five stated that having a resource available for their employees would be beneficial.

Manufacturing employees need, but lack basic math skills, especially interpreting data and fractions. Overall, manufacturers felt that an OER would be beneficial to employees and would encourage their employees to use one.

Results Summary

While the majority of students feel that they are self-motivated learners, teachers felt students were not self-motivated learners. Though not entirely sure what an OER is, teachers feel that students need supplemental resources and that students would take advantage of an OER if one were available to them. Manufacturers also agree that there is a lack of basic math skills and an OER could be beneficial to their employees. Teachers and students agree that additional, engaging resources, including videos, would be beneficial in an OER. Three main topics which should be included in the OER are fractions, geometry, and algebra.

Chapter 4

DISCUSSION AND CONCLUSION

Several students were not sure they would use an OER, but 76 percent of students thought they would use one if it was available to them. OERs are becoming increasingly popular. Plotkin and Chien (2014), from the U.S. Department of Education, reports that OER enables educators and students to access, customize, and remix high-quality course materials reflecting the latest understanding of the world, as well as materials that incorporate state of the art teaching methods. Other research suggests the positive value of open education materials. Pitt et al. (2013) shared that 95% of students gained mastery of a subject matter utilizing open materials. In addition, in its Adult College Completion Tool Kit, the US Department of Education suggests OER as a useful technology that saves time and resources by allowing programs to build on each other's work instead of starting from scratch (Tolbert, 2012). OERs are increasingly being used to improve learning outcomes and create scalable platforms for sharing educational resources that reach millions of students worldwide.

Ideally, proven success rates would be helpful in determining the usefulness of an OER. However, researching success rates has proven difficult. There are no reported success rates that can be found. Limited reporting may be because OER courses are not credit-based and final grades are not issued once the class is completed. However, some OERs are now issuing digital badges to demonstrate proficiency once a student successfully completes the course. While OERs are increasingly popular, we need to

discuss what would make a Math OER useful so that it meets the needs of the population who would utilize it.

The majority of students reported that fractions were hardest to understand, with geometry and algebra following closely behind. According to research reported in an article by Shellenbarger (2013), many students hit a wall when it comes to fractions, and research has found that a child's knowledge of fractions in fifth grade predicts performance in high-school math classes. Children in the USA receive substantial fraction instruction at an early age, but a recent national assessment found that 50% of eighth graders could not correctly order the magnitudes of three fractions (Siegler et al., 2013). Without an understanding of fractions, it is difficult to understand algebra, geometry, physics, statistics, and chemistry (Shellenbarger, 2013). In light of this research, it makes sense that the top three hardest math concepts to understand are fractions, geometry, and algebra. It would make sense to focus on fractions in an OER, along with geometry and algebra. The instructors would benefit from this information and the data obtained from the questionnaires, since they are the ones teaching this content. The information may also validate their perceptions of what students seem to have the most difficulty with.

Part of the problem in understanding fractions could be a lack of understanding in mathematical terms such as "divisor," "factor," "multiple," and "denominator." Without understanding these terms, students lose ability to focus on and understand terms and operations for algorithms and problem solving (Sherman, Richardson, & Yard, 2014). I do not believe it is enough to simply make students memorize these terms. Looking

further into how students learn best can aid us in how to better teach students these tough math subjects.

In this study, approximately 80 percent of students reported being visual learners, which was a large majority. In the general population, 65 percent of the population consider themselves to be visual learners, according to Mind Tools (2014). It would make sense to include visual learning tools in the design of the OER, such as pictures, images, and other visual media to make the learning process meet the individuals' needs. Sometimes, our life experiences can aid or hinder our understanding of math. Many students reported preferring real life examples when trying to understand math concepts. Sherman et al. (2014) observes, "Too few life experiences, such as trips to neighborhood stores or opportunities to communicate with others about numbers through practical life examples, can make math irrelevant for students. Gaps exist, therefore, not only in the curriculum but between the learner and perceived usefulness of the subject matter" (p.1). The OER will need to provide users with the opportunity to make sure they understand the usefulness of the subject matter. In his study, Hassen (2013) reported that the multimedia OER module has brought the context of teaching and learning from traditional, solely abstract-theory-based learning to more practical, real-life-based learning. A plethora of teaching guides are being designed with real-life problems and practice because "Students better understand problem solving when the basis for the problems are real-life situations" (Illingworth, 1996, p. 4). Harvey and Averill (2012) report that real life context contributes to effective teaching. Since we deal with math

every day in all situations, having math problems that relate to these situations validate the correlation that students can relate.

It is interesting that teachers reported their perception that students are not motivated, yet 81 out of 131 students reported themselves as self-motivated learners. The response from teachers was not as large as the response from students, so the finding could be skewed. Regardless, research shows that what motivates students to learn are teachers. Teachers with motivated, engaged classrooms have different characteristics and exhibit different behaviors from those teachers with classrooms in which the motivation and engagement of students is low (Girmus, 2011). Specifically regarding math, the teacher is important as a math model and should do the following to motivate students (Girmus, 2011):

- Create a comfortable classroom that supports healthy risk-taking to reduce anxiety.
- Provide meaningful mathematics tasks that are appropriately challenging.
- Provide choices and allow for cooperative learning opportunities.
- Engage in mathematical conversations and emphasize conceptual understanding.
- Allow for mistakes and use them as learning opportunities.
- Importantly, give frequent, substantive feedback.

An OER could encompass several of these recommendations in its design. Comfort of practicing and learning math in your own home could be a huge benefit to an OER.

Hattie and Timperly (2007) state that feedback, whether positive or negative, is one of the most powerful influences on learning. The site design could provide meaningful

mathematics tasks that are appropriately challenging, emphasize conceptual understanding, and give frequent feedback. An OER, by its very nature, allows for mistakes and could utilize them as learning opportunities.

While the number of students reporting video games as helpful in learning math was not a huge majority, there were many (76 in comparison 47) that said games might or would definitely be helpful. Scholars from the University of Wisconsin-Madison argue that video games are a powerful learning tool (Shaffer, Squire, Halverson, & Gee, 2004). The reasons they give directly echo the four dimensions of motivation:

- Video games create virtual worlds in which students can experience and apply in real-time the concepts they are learning in the classroom. This makes abstract theories easier to understand and more concretely applicable to students' everyday lives, increasing interest and value.
- By putting abstract ideas in the context of real-world problems, games help students to more readily understand complex concepts, increasing competence. Competence is also increased by games that allow students to repeat skills until they are mastered and personalize their learning to meet their own skill level.
- Playing video games helps develop social practices and relationships as players work and strategize together, thereby increasing relatedness.

More often than not, in today's society, kids playing video games are a much younger age. iPads have become a very popular tool to engage students in

learning through video games. Mine Craft is an example of a child playing a game that is basically teaching the basic elements of coding.

Recommendations

Delaware Tech has created an OER to provide students and members of the community with an additional resource to improve academic proficiency. The current structure replicates the basic math class, which includes fractions, basic algebra, measurement, whole numbers, multiplication/division, and ratios. There are no pre or post assessments. There are short quizzes in each section, so students can assess how well they know the content. Some content areas have videos and there are many Khan Academy (www.khanacademy.org) links for students to view. We knew the current OER design would benefit from surveying students, employers, and instructors to support the need for the OER. This chapter presents my recommendation in the utilization of an OER at Delaware Tech. After reviewing the data and researching scholarly data, I am making the following recommendations as to what should be included in our OER.

- Include fractions, geometry, and algebra
 - These topics are commonly referred to as the most difficult to understand in basic level math classes.
 - A foundation has to be built on prior knowledge, so mastering these topics from the beginning is critical.
- Include visual tools, mind maps, pictures, images, and structured navigation
 - As stated in the research, most people are visual learners.

- Incorporating a variety of visual tools as supplemental instruction is important because students are more likely to understand a concept more so than just hearing it taught.
- Include real-life examples as they relate to specific age groups and visual stories
 - Students often ask why they need to know how to solve specific math concepts, so incorporating real life examples will teach them the importance of why.
 - Students utilize math concepts daily, which makes it easy for them to relate to.
- Tutorial Videos, constant and substantive feedback, and on every problem
- Students often become frustrated when they do not understand how to solve a problem. Offering constant some type of constant feedback will keep them engaged and also allow them to continue working when they can't solve a problem. Include video games
 - If math can be incorporated into some sort of game of which may interest a student, he/she will most likely be more engaged and willing to learn new math concepts.
 - If someone is enjoying what they are learning, they are more likely to continue and be successful.

Table 2 Recommendations and Expected Outcome

Recommendations	Explanation	Data	Outcome
Fractions, Geometry, Algebra	These three topics are referenced as very difficult math concepts to understand by students and teachers. Students need to have a good foundation of the basics with each of these topics.	Teachers said students have the most difficulty with geometry and fractions. Manufacturers said employees had most difficulty with geometry and algebra. 60 % of students reported these three as the most challenging math concepts.	Students will become more fluent in fractions, geometry, and algebra by mastering the basic levels of each topic through repetition of quizzes, videos, and real-life examples.
Visual Tools, mind maps, pictures, images, and structured navigation	Students better understand math concepts when presented through visual images such as pictures and sequential navigation.	80% of students reported being visual learners. In the general population this number is 65%. One teacher said websites are valuable because they get students actively involved.	Students will grasp math concepts more thoroughly and timely by utilizing visual tools to enhance their learning.
Real life examples	If a student knows why something is good to know for everyday life, they will be more motivated to learn.	Harvey and Averill (2012) report that real life context contributes to effective teaching.	Through real life examples, students will better relate and understand the relevance of how to apply these math concepts.

Table 2 (Continued)

Recommendations	Explanation	Data	Outcome
Video games	They are a powerful learning tool.	62 % of students feel they would be helpful in learning math. Scholars report that video games help students learn complex problems (Shaffer et al., 2004).	Students will most likely be more engaged and willing to practice more if math concepts were incorporated into video games resulting in successful mastery.
Tutorial Videos, constant and substantive feedback, and on every problem	If students have continuous support, they are less likely to become less engaged.	Teachers agree that tutorial videos could be effective if they are dynamic. Hattie and Timperly (2007) state that feedback, whether positive or negative, is one of the most powerful influences on learning.	Students will be more likely to complete lessons and more prepared to move onto the subsequent topics.

In table two, the recommendations are to have math concepts that focus on fractions, geometry, measurement, and basic algebra. Since these concepts seem to be the most difficult, the OER should start with them. This OER would be an all in one learning resource for a majority of students based on the data and research gathered. The next recommendation would be to include real life examples into all problems. Students often do not understand the importance of applying math on a daily basis, so if their math problems demonstrated the importance daily, the connection would be made. The connection would create a better understanding, and as they function in their daily lives, they would start to see daily correlations between what they are learning in math and

everyday experiences. The third recommendation would be to include as many visual supplemental resources as possible. Research and the data collected validate utilizing visual resources as a best learning practice. Students can relate to visuals, which provides them with the opportunity to make a connection with sequential steps of solving a problem.

The intended outcome of the OER is to have a successfully utilized resource available to all. While success may be hard to measure, there are some potentially measureable goals. It is the hope that students, especially, but also the general public would utilize the OER to develop better basic math skills. Basic math skills that would be included in the OER are addition, subtraction, multiplication, division, measurements, fractions, and basic algebra. Pre and post unit assessments could be given to determine whether skills were learned and attained. These assessments could be a valuable supplemental resource for DTCC teachers to suggest to their students, but ideally the general public would also utilize the OER. It is difficult to measure how often someone utilizes the OER, though the hope is that it would be widely used, with at least 300 users a year. The users would register at the site letting us know how many people are utilizing it. A voluntary survey could be administered periodically to ask how often users access the site.

Additional research could be conducted to improve the OER. One important key element of the assessment would be the evaluation of the OER by students. Most OERs do not have an evaluation tool, other than limited assessments based on content. It would be interesting to develop an assessment tool to better inform the OER and its success. In

addition, content and technology is constantly changing, so these trends could be studied too.

The OER movement has been very ambitious over the last several years, which speaks to the need and success of them. Offering a free math resource for anyone to access and have the opportunity to upskill their academic level at their convenience is critical. The research and data support the need of an OER and more specifically locally. People like to have the flexibility of accessing information when it suits their schedules and as often as they would like. Providing similar content to what is taught in a basic level math course across the nation provides everyone with an opportunity to learn. In addition to access, the content must be relevant and engaging. If the content is relevant to their needs and keeps them engaged so they are more willing to continue utilizing the OER, the OER will provide a resource that is very much needed in the community.

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Appendix A

GUIDING QUESTIONS

Questions	Data Sources	Data Analysis	How will this information be used
1. What math content for an OER would be most beneficial to potential users and why?	Surveying business owners and manufacturers in the community who would potentially use the OER	Data collected from the community will provide guidance on what content to provide	This information will be used to determine what math content would be most beneficial to the community.
2. What delivery methods/instructional strategies would be best when making revisions to an OER utilizing Blackboard as the course management system?	Scholarly literature, E-Learning Director, and student surveys	This information will guide the delivery methods	This information will be necessary to determine what will the best delivery methods will be added to provide the most support

Appendix B

STUDENT QUESTIONNAIRE

You are being asked to participate in this survey, which is designed to explore math open educational resources (OER). The research being conducted will ensure that best practices and best resources are put into place in the design of a math OER. The survey should take approximately 15 minutes. Your participation is voluntary, and your answers will be anonymous. Thank you for your time!

1. What math concepts do you find challenging to learn?
2. When trying to understand math concepts, would real life examples be more engaging to you? Explain why or why not. Give an example of a time when a real life example was or was not engaging and helpful to you for your learning?
3. Are you more of a visual or auditory learner? Explain why. Give an example of a time when visuals or auditory experiences were more or less helpful to you in your learning.
4. An Open Education Resource is a free online resource available to anyone, and in this case would teach math concepts. Would you utilize an Open Educational Resource designed to enhance your math skills? If so, what resources would you like to see available?
5. Do you consider yourself to be a self-motivated learner? Explain why or why not. Give an example of a time when you were or were not self-motivated to explain.
6. What motivates you to learn math? Give an example of a situation that was very motivating to you when you were learning mathematics.

7. Would you be more engaged in a math lesson if it was based on a game? If so, explain why. Give an example of a game situation that motivated you, and share why you thought it was motivating.
8. Would understanding how and why a particular math concept was needed prior to the lesson support your learning of mathematics? Explain why or why not. Give an example of a time when you had an experience like this, if you have had one, and share why it was or was not helpful.

Appendix C

FACULTY QUESTIONNAIRE

You are being asked to participate in this survey, which is designed to explore math open educational resources (OER). The research being conducted will ensure that best practices and best resources are put into place in the design of a math OER. The survey should take approximately 15 minutes. Your participation is voluntary, and your answers will be anonymous. Thank you for your time!

1. What seems to be the math concept that students in your classes have struggled with the most?
2. Do you currently use any resources to supplement your mathematics lessons? If so, which resources do you choose and why?
3. Are there additional types of resources that you think would help students learn more effectively? If so, can you describe the types of resources that you think would be helpful? Explain why they would be helpful.
4. Are there types of resources for learning mathematics that could better prepare students for the transition from high school to college? If so, can you describe the types of resources that you think would be helpful? Explain why they would be helpful?
5. What do you know, if anything, about Open Educational Resources? What are they? How do students and instructors use them?
6. Would an Open Educational Resource be beneficial to students? Why or why not?
7. Could tutorial videos be effective for supporting students' independent learning of mathematics? Why or why not?

8. In your experiences, how does a person best learn math?
9. Nationally there is a trend that says many students test below a 12th grade level in math when applying to college. Why do you think this is?

Appendix D

MANUFACTURING QUESTIONNAIRE

You are being asked to participate in this survey, which is designed to explore math open educational resources (OER). The research being conducted will ensure that best practices and best resources are put into place in the design of a math OER. The survey should take approximately 15 minutes. Your participation is voluntary, and your answers will be anonymous. Thank you for your time!

1. What level of mathematics do you require your job applicants have?
2. Are there math concepts that your employees find challenging? If so, what are they?
3. Are certain math concepts required for job advancement? If so, what are they?
4. An Open Education Resource is a free online resource available to anyone, and in this case would teach math concepts. Would you encourage your employees to utilize an Open Educational Resource designed to enhance their math skills? If so, what resources would you like to see available?
5. What math resources are currently available to your employees that align with their job responsibilities?

Appendix E

QUESTIONNAIRE RESULTS

Student Questionnaire Answers

1. What Math Concepts do you find challenging to learn?

Geometry 17

Word problems (knowing when to multiply, divide, add or subtract) 5

Fractions 40

Remembering Formulas 4

Many math concepts are challenging (nothing comes easily)

Working with extremely large numbers (trying to simplify them) 2

Plotting numbers on a number line

Order of operations 5

Algebra 17

Rounding 3

Pemdas 4

Statistics

Conversions of units 7

Ratios 5

Division 5

Percents 4

Decimals 6

2. When trying to understand math concepts, would real life examples be more engaging to you?

Yes 92

No 24

Explain why or why not.

It shows when we will actually need that type of math.

Seeing when to use a particular skill would reaffirm that we do use certain math skills in real life.

So we can relate to it.

Hearing how it applies to real life helps me. 1

Because math is confusing

Knowing that what you learn in school will be used in the outside world makes you more eager to learn.

Give an example of a time when a real life example was or was not engaging and helpful to you for your learning.

Building a dog house that has to be a certain height and width.
 Shopping at Lowes for lumber & sheet rock. You need to know square and linear feet.
 Using sales tax to explain percents.
 Buying things that are discounted explains percents. 5
 Grocery shopping and adding product costs to make sure you have enough money. 6
 Banking
 Working with money 1
 Algebra concepts in programming
 Geometry (finding volume)
 Tipping
 Clinical math (patients medicines) 2
 Balancing a check book
 Cooking/Baking 2

3. Are you more of a visual or auditory learner?

Visual 102
 Auditory 8
 Both 17

Explain why.

Get easily distracted when listening. 2
 Like being shown how to do something.
 Hearing lectures while also taking notes is helpful.
 It makes it easier for me to understand if I see it.
 Once I see the problem being solved and can practice it, it becomes easier.
 If someone is reading to me, I tend not to focus. If someone is showing me, I can figure it out.

Give an example of a time when visuals or auditory experiences were more or less helpful to you in your learning.

Rather have a teacher teaching than learning on a computer.
 Visuals on math lab courses. 2
 Videos that can be rewind 2
 Cooking

4. An Open Education Resource is a free online resource available to anyone, and in this case would teach math concepts. Would you utilize an Open Education Resource designed to enhance your math skills?

No, would rather learn in a classroom. 2
 No, would probably go to a tutor.
 NO 16
 Not sure. 6
 Maybe. 6
 Yes 80

I already use khanacademy.org

If so, what resources would you like to see available?

Help with understanding complex problems.

Unit of Fractions (converting fractions) 9

Basic Business

Videos where someone is using math problems in real life. 5

Decimals

Multiplication 2

Algebra 2

Basics

Order of operations

Percents and rations 2

Division 2

Clinical Math

Ask the tutor option with a live chat available 5

Walk through reviews/step by step 4

Quizzes 2

Practice (if you get the answer wrong, an explanation pops up)

Translation with visual 1

5. Do you consider yourself to be a self-motivated learner?

Yes 81

No 22

Sometimes 8

Explain why or why not.

I want to better my life so that I can have a better life than my parents had.

Going to college where everyone was helpful/nice made me motivated

I rely on teacher feedback to be motivated.

Working by myself enables me to understand better. 2

Earning money to get rich.

Taking online classes means you need to be self-motivated 3

Putting myself through college

If someone tells me I can't do something, I get motivated.

When things are challenging, I don't give up but keep working on it.

I am older now and understand the value of education.

I have some goals in my education path, that I am trying to reach, and I am motivating myself to reach them.

Give an example of a time when you were or were not self-motivated to explain.

Getting an email that says good job is motivating

Knowing that it is the only way to be successful and smart about the career you choose.
When school work piles up, I do better.

6. What motivates you to learn math?

Failing
Explainable math equations 2
Taking it step by step
My job where I need to count money
Passing quizzes
Passing so that I don't have to take math again 6
So that I know what I am doing 2
My grades 3
Goal Setting
One on one help 6
Realizing that I need it for my major and my future 5
Earning a degree/graduating 9
Success/correct answers 6
Understanding how to get money and save it.
New techniques for learning 2
Working on cars, which involves a lot of math
It's fun/I like math. 8
Nothing 10
I need it for my job/ future career. 12
My Dad who is really good at math and wants me to be.
Having to help my kids with math. 4
Building 2
Money/paycheck 3
Knowing I will use it in everyday life. 8
The right teacher. 2
So I don't need a calculator
Listening to music

Give an example of a situation that was very motivating to you when you were learning mathematics.

Learning how to do fractions

7. Would you be more engaged in a math lesson if it was based on a game?

Yes 60
No 47
Maybe 16

If so, explain why.

I would be more engaged because it would be more visual. 2
Learning hands on, I learn faster.

Games are always fun!

You can be competitive and learn at the same time. Who doesn't like games?

It would depend on the game.

I am a very competitive person. 4

Math is not my strong suit perhaps if it were in game form, I'd forget it was math and wouldn't be intimidated.

Give an example of a game situation that motivated you, and share why you thought it was motivating.

Maybe a jeopardy game. 2

I played a math game online for every question you got right the website donated rice to a need family in Africa.

In elementary school, we played a game where the teacher through a ball and gave you a problem. By the time you hit the ball, you had to have the answer. It helped with simple math.

Minecraft

Math Bingo

I use to do study Island and it helped me to stay on track.

Pokemon

8. Would understanding how and why a particular math concept was needed prior to the lesson support your learning of mathematics?

Yes 81

No 25

Explain why or why not.

If I know what I need to learn I can use it to my advantage.

If I knew I was going to use this certain type of math for my career thane I would be all for learning it.

It would make more sense.

I often question when in real life I will use this.

Math is a subject that many people struggle with but is something we use everyday and need it.

Then I would know why I was learning it. 3

Because a lot of what you learn in math you never use in real life.

I already understand why concepts are being taught. 3

Give an example of a time when you had an experience like this, if you have had one, and share why it was or was not helpful.

Carpentry

Manufacturer Answers

1. What level of mathematics do you require your job applicants have?

High school level

Basic math skills plus some algebra and statistics. Algebra and basic math to do formulations. Statistics to do graphs to maintain, read and understand ratios and key productivity indicators and to use "Six Sigma" to do problem solving.

Basic Math

Elementary through high school mathematics

Simple arithmetic. The concept of percentage, calculating averages (hourly employees). In addition to the above, front line supervision needs to understand the concept of average, standard deviation (SPC concepts related to quality)

2. Are there math concepts that your employees find challenging? If so, what are they?

Trigonometry and Geometry; i.e. calculating angles and distances; Geometric tolerance

Statistics. Algebra. Graphs and charts. Ratios.

Not Sure

On the higher end of our employees, business statistics with charts.

Calculating percentages and rates of production. Front line supervision understanding the concept of standard deviation, constraint analysis (product flow rates)

3. Are certain math concepts required for job advancement? If so, what are they?

Yes - specifically in the programming area and machine set-up; plus tool and manufacturing aid design.

Statistics. Algebra. Graphs and charts. Ratios.

Not Sure

No

Understanding how to read charts, the basic concepts of SPC.

4. An Open Education Resource is a free online resource available to anyone, and in this case would teach math concepts. Would you encourage your employees to utilize an Open Educational Resource designed to enhance their math skills? If so, what resources would you like to see available?

Definitely; online tutorial program that could be utilized when shortcomings are identified in the areas discussed above.

Resources to teach the above similar to the Kahn Academy courses found on YouTube.

Sure

Yes, I would like to see "understanding the results of the math equation." For example, when conducting the R2 correlation, what does the decimal answer mean? Run charts and control limits, what does the data represent.

Being able to make calculations using simple reasoning. Rates, percentages, some simple algebraic equations.

5. What math resources are currently available to your employees that align with their job responsibilities?

Geometric tolerancing (more drafting related)

Our company provides some computer based self-learning courses in math skills including use of Excel, basic math, statistics, charts & graphs, algebra and ratios.

None that I'm aware of.

None. Learn as you go.

None. Some attend school.

Faculty Questionnaire Answers

1. What seems to be the math concept that students in your classes have struggled with the most?

Fractions – 3

Decimals

Geometry

Measurement Conversions -2

Understanding the relationships of numbers
Direct and inverse variation

2. Do you currently use any resources to supplement your mathematics lessons? If so, which resources do you choose and why?

Webs sites because they are interactive for students and get students actively involved.
No – we are not allowed to.
Not really.
Worksheets from an alternate text series

3. Are there additional types of resources that you think would help students learn more effectively? If so, can you describe the types of resources that you think would be helpful? Explain why they would be helpful.

More planned opportunity for group work.
More available “guided practice”, but attached to, the assessment. So, students can see their errors later.
Hands-on materials are helpful to students learning math because they help the students to see mathematical relationships and gets students involved.

4. Are there types of resources for learning mathematics that could better prepare students for the transition from high school to college? If so, can you describe the types of resources that you think would be helpful? Explain why they would be helpful?

Currently, Delaware uses problem-based texts. Using resources similar would help.
Also, HS has embraced the calculator and not all at DTCC have done so.
More practice using math reasoning skills and improving “number sense”
I just think they need to develop basic number awareness that comes with learning addition and multiplication.

5. What do you know, if anything, about Open Educational Resources? What are they? How do students and instructors use them?

Not sure, but will investigate.
They are free resources and materials that are available to people who want to learn just about anything. Students can use them as supplemental materials; instructors can use them as additional resources.
Free resources available for teachers and students. Oercommons.org
Do not know about OER

6. Would an Open Educational Resource be beneficial to students? Why or why not?

In the future, yes. I say give them as many resources as possible.
I think so; students really like working on-line if it is simple to use and interactive.
They would be beneficial to the mature learner who wants to learn and is motivated to learn independently.

7. Could tutorial videos be effective for supporting students' independent learning of mathematics? Why or why not?

Tutorial videos could be effective if they are dynamic and show relationships to everyday life. Videos that are strictly a lecture would not be effective because they would be like listening to a lecturer in front of a classroom.
Yes, but they already have videos through Pearson.
Some yes, but many do not have access to a computer.

8. In your experiences, how does a person best learn math?

Combination of "naked math" and problem-based.
A person best learns math by doing math and getting involved in the learning process.
Practice

9. Nationally there is a trend that says many students test below a 12th grade level in math when applying to college. Why do you think this is?

Because they do not know their basic math skills, and they are not mature learners who want to put in the time and effort into learning.

I don't think colleges assess the same way they do in HS. For example, the calculator is a massive part of the learning at high school. Until both camps can agree, students will continue to test low. Students come and take the accuplacer on content they haven't used in 10 years (common denominator, etc.) Very different approaches.

Appendix F
HUMAN SUBJECTS IRB



RESEARCH OFFICE

210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
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DATE: October 10, 2013

TO: Chris Moody
FROM: University of Delaware IRB

STUDY TITLE: [486688-1] A Resource for Academic Success: An Open Educational Resource to Improve Developmental Math Preparation at Delaware Technical Community College

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF
EXEMPT STATUS DECISION DATE: October 10, 2013

REVIEW CATEGORY: Exemption category # 2

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.